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REVIEW ARTICLE

OUTDOOR AIR POLLUTION AND HEALTH: A COMPREHENSIVE REVIEW

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ABSTRACT

In developing countries problem of industrialization, modernization and increasing population degrades the society with polluted air. Moreover, concentration of pollutants increases day by day with addition of harmful gases from exhaust of motor vehicles and industrial sources. With passage of time, people realized that polluted outdoor air has serious effects on their health. Outdoor air pollution is nuisance challenge for public health hazards like cardiovascular disease, respiratory diseases, chronic obstructive pulmonary disease (COPD) and asthma which spread throughout the world. The broad overview of the status of and trends in outdoor air pollution sources, pollutants, and exposures and its health effects are presented. Considering all factors, the goal of the present review is to draw together results from different investigations and present a picture of our current understanding of relationship between outdoor air pollution and health and to inform people about the health effects of outdoor air pollution and to provide an approach to counseling vulnerable people in order to reduce exposure.

INTRODUCTION

The Air pollution may be any atmospheric condition in which certain substances are present in such concentrations that may produce harmful effects on man and its environment. Air Pollution is a global health hazard with serious public health implications, particularly for children and elders. Air pollution includes all contaminants found in atmosphere in the form of gases or particulate and particles of biological origin. The demographic and epidemiological character of populations in ways that are likely to affects in vulnerability to air pollution. The increased number of vehicles, machineries, factories and other oxides makes the environment more polluted. Severe outdoor air pollution problems exist in the developing world, especially in large cities such as Beijing, Shanghai, Bombay, Karachi, Cairo, Sao Paulo and Mexico City (Mage, 1996; Akimoto, 2003). It is fact that developed countries make more air pollution than the developing countries. Developed countries are economically strong and life style is different than the developing and under developing countries so, the exploitation of resources is more. However, many outdoor air quality problems still exist in the developed world and may be unpleasant by increasing use of motor vehicles and industrial chemicals. The air pollution always associated with human civilization, and it began when they invented fire. When the industrialization came into the front line of the development, then the urban climate and air quality changed drastically resulted in the changes in hydrological cycle, agriculture, irregular rainfall, increased drought and flood (Menon *et al.*, 2002).

Air pollution concentrations in urban areas vary both in time and space (Munn, 1981). Time variations are strongly influenced by changes in human activities. Several activities occur repeatedly at regular intervals thus producing cycles in air pollution changes, like daily variations in CO concentration due to the change in traffic density or seasonal variations in air pollution e.g., from heating systems which in moderate climates operate mainly in cold months (Fugas *et al.*, 1991). Human susceptibility to adverse health effects from exposure to air pollution can be related to genetic profile; race and ethnicity; lifestyle, behaviors; socioeconomic position; and location of residence or daily activities (O'Neill *et al.*, 2012).

The urban air quality is very important and enhanced the life of living beings. The recent studies in various places of the world revealed an increase in levels of ozone (O_3) and particulate matter (PM), which leads casualties more with respiratory and cardiovascular diseases (Garrett and Casimiro, 2011). The outdoor air pollution resulted from the chemical reaction of various pollutants from various sources. This is like a huge amount of smog which leads to many health issues. The effect of outdoor air pollution is more in the warmer seasons than the colder seasons. The reasons behind the outdoor air pollution are not only manmade but also, natural reasons, like the emission of methane after the digestion by cattle, emission from wildfire, radioactive decay, and the sulfur and chlorine deposit after the volcanic eruption, but these are very minimum and controllable. Acid rain, greenhouse effect, and ozone depletion are major environmental issues related by the outdoor air pollution.

The prime most reason behind air pollution is due to the combustion of fossil fuels, used for the generation of energy and transportation. Most of the developing countries use more fossil fuel results in increased industrial emission by which the rate of air pollution in the countries also increased. The increasing number of population is another major reason for the pollution and cities are crowded.

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Table 1 Different air pollutants and its effects

Pollutant	Sources	Health effects	References
Particulate Matter	Automobile, bus and truck exhaust, fuel burning (wood stoves, fireplaces), industry, construction.	Infant respiratory mortality. Lung function decreases. Lung growth decreases. Symptoms in asthmatics.	Particulate air pollution was one of the pollutants demonstrated to have serious short-term health effects, even at low ambient levels when absorbed into human lungs (Muneeswaran *et al.*, 2012). Varying mixtures of particles suspended in the breathing air, which vary in size and composition, and are produced by a wide variety of natural and anthropogenic activities (Poschl, 2005).
Ozone	Ozone Produced when nitrogen oxides (vehicle emissions) and volatile organic compounds (VOC) chemically react under sunlight.	Decreases lung growth. Asthma exacerbations. All respiratory hospitalization. Asthma hospitalization. School absence for respiratory illness.	Ozone being a secondary pollutant is not emitted as such by any specific source, rather formed during the atmospheric photo-chemical reactions involving oxides of nitrogen and reactive hydrocarbons emitted from automobiles (Krupa and Manning, 1988). However, other secondary pollutants that are formed under similar conditions and usually coexist with elevated ozone concentrations include peroxyacetyl nitrate (PAN), nitric acid (HNO_3), formaldehyde, and numerous aldehydes, and organic acids that can act as irritants (Amato *et al.*, 2002). Ozone can travel for thousands of kilometers. The atmospheric half life of ozone is 1–2 weeks in summer and 1–2 months in winter (Akimoto, 2003).
Gaseous pollutants Nitrogen dioxide	Nitrogen dioxide Results from high temperature fuel combustion and atmospheric reactions.	Symptoms in asthmatics. Nitrogen dioxide can irritate the lungs and lower resistance to respiratory infections such as influenza.	NO_2, a precursor of photochemical smog, is found in outdoor air in urban and industrial regions and, in conjunction with sunlight and hydrocarbons, results in the production of O_3. NO_2 is a gaseous by-product of the combustion of fossil fuels. In many urban areas mobile source emissions are the major source of NO_2. NO_2 is more likely to reach the lower airways compared to SO_2 due to its lower water solubility. Furthermore, NO_2 may also react as an oxidant (Ackermann-Liebrich and Rapp, 1999).
Carbon Monoxide	Carbon monoxide Formed when carbon-containing fuel is not burned completely, emitted by motor vehicles more than any other source.	Asthma hospitalization. Clinic visits for lower respiratory tract disease, headache. Carbon monoxide enters the bloodstream and reduces oxygen delivery to the body's organs and tissues. Exposure to elevated CO levels is associated with visual impairment, reduced work capacity, and reduced manual dexterity, poor learning ability, and difficulty in performing complex tasks.	Motor vehicles significantly contribute to ambient carbon monoxide (CO) concentrations. Motor vehicles emit CO, but the majority of CO emitted from this source occurs from light-duty, gasoline-powered vehicles. In addition to health concerns from CO exposures, CO may be a useful indicator of the transport and dispersion of inert, primary combustion emissions from traffic sources since CO does not react in the near-road environment (Baldauf, 2009). Carbon monoxide is produced in larger amounts if combustion is not efficient (i.e. a poorly tuned engine), in colder weather or at higher altitudes (Brook *et al.*, 2004). Carbon monoxide has an atmospheric half life of 1– 2 months and can also travel for thousands of kilometers away from its source (Akimoto, 2003).
Sulphur Dioxide	Sulfur dioxide Industrial sites such as smelters, paper mills, power plants and steel manufacturing plants are the main sources.	Asthma hospitalization. Clinic visits for lower respiratory tract disease. It irritates the nose, throat, and airways to cause coughing, wheezing, shortness of breath, or a tight feeling around the chest. The effects of sulfur dioxide are felt very quickly and most people would feel the worst symptoms in 10 or 15 minutes after breathing it in.	Sulfur dioxide (SO_2) is an additional concern in industrial areas. SO_2 is generated primarily from the burning of sulfur-containing fossil fuel and is released into the atmosphere primarily as a result of industrial combustion of high sulfur-containing coal and oil (Amato *et al.*, 2002).
Persistent organic pollutants	Pesticides, some as industrial chemicals and some arise as unintentional by-products of chemical and/or combustion processes.	Organochlorines such as DDT effects birds egg shell thickness Effects on the reproductive potential of fish eating birds. Short-term exposure of humans to high levels of dioxins may result in skin lesions, such as chloracne and patchy darkening of the skin, and altered liver function.	Persistent organic pollutants form a toxic group of chemicals. They include pesticides, as well as dioxins, furans and PCBs. Generally, the generic term ‘‘dioxins’’ is used to cover polychlorinated dibenzo-dioxins (PCDDs) and polychlorinated dibenzo-furans (PCDFs) while polychlorinated biphenyls (PCB) are called ‘‘dioxin like compounds’’ and can act similarly in terms of dioxin-type toxicity (Schecter *et al.*, 2006).
Heavy Metals	Natural sources include volcanoes, degradation of minerals and forest fires, evaporation from soil and water surfaces. Releases from usage of heavy metals impurities, such as coal-fired power and heat production, mining and other metallurgic activities; Releases from intentional extraction and use of heavy metals, such as heavy metal mining, leather production, electroplating production, and manufacture of products containing heavy metals; Releases from waste incineration, landfills etc. (Wu *et al.*, 2006).	Epidemiologic studies have found higher blood and body burdens of metals including lead, mercury, arsenic and cadmium in subjects living near waste incinerators (Hu and Shy, 2001). However, at higher (although relatively low) concentrations they can become toxic (Jarup, 2003).	Heavy metals include basic metal elements such as lead, mercury, cadmium, arsenic and other toxic metals are released into the environment by several processes including waste and coal burning, metal mining and smelting, other industrial processes and volcanic emissions (Lee *et al.*, 2002; Godish, 2003).

The effect of air pollution is different depending on the geographical location, temperature and wind and weather factors. The World Health Organization found that the air quality in large cities of many developing countries is remarkably poor and found that very large numbers of people in those countries are exposed to ambient concentrations of air pollutants well above the World Health Organization guidelines for air quality (Ambient Air Pollution: Health Hazards to Children, 2004, A guide to children health).

Variants of air pollutant

Air pollutants differing in their chemical composition, reaction properties, emission, and persistence in the environment are ability to be transported in long or short distances and their eventual impacts on human and/or animal health. However, they share some similarities and they can be grouped in categories as shown in Table 1 and sources of air pollution as shown in Table 2.

Health hazards to elder people

Low to moderate levels of outdoor air pollutants can greatly increase respiratory problems in the elderly population. A study in 1980–1995 of Tokyo residents aged over 65 years found that increasing airborne outdoor PM10 concentrations were associated with significantly higher rates of asthma and bronchitis (pb 0.001 in both cases) (Ye *et al.,* 2001). Higher levels of PM2.5 were associated with significantly higher

Table 2 Sources of air pollution.

Sources of Air pollution	References
Traffic	Janssen and coworkers recently demonstrated that health impact assessments of traffic-related pollutants based upon PM 2.5 seriously underestimated the health risks compared to an assessment based upon elemental carbon (Janssen NA *et al*., 2011). There is also growing evidence of health effects related to ultrafine particles (Rückerl R *et al*., 2011).
Bioaerosols: molds, bacteria, pollen and others	Bioaerosols are airborne particles (seeds, spores, dander etc.) produced by living organisms. Such bioaerosols include pollen, seeds, bacteria, gram negative bacterial endotoxins, molds (fungi), algae, protozoans, flour, latex and animal dander/waste products. Some bioaerosols are hazardous since they are infectious and/or produce allergens and toxins. Mold spores can travel thousands of miles across the Pacific and Atlantic Oceans and land on other continents (Shinn *et al.,* 2003).
Chemicals	Major sources include petroleum refining, petrochemicals, vehicle exhaust, natural gas fields and distribution lines, storage of fuels and wastes, household products, pesticides, combustion, many industries and volatile emissions from coniferous forests (Breas O, 2003). The chemicals are very harmful and hazardous to human health.

Routes of exposure

Humans enter in contact with different air pollutants primarily through inhalation and ingestion, while dermal contact represents a minor route of exposure. Air pollution contributes, to a great extent, to the contamination of food and water, which makes ingestion in several cases the major route of pollutant intake (Thron, 1996) via the gastrointestinal and respiratory tract, absorption of pollutants may occur, while a number of toxic substances can be found in the general circulation and deposit to different tissues. Elimination occurs to a certain degree by excretion (Madden and Fowler, 2000). Different composition of air pollutants, dose, time of exposure and exposed to pollutant mixtures than to single substances, can lead to various impacts on human health (Kampa *et al.,* 2007).

Health Hazards to Children

Children are more vulnerable to the adverse effects of air pollution than adults because children spend more time outdoors than do adults; they have increased exposure to outdoor air pollution (Wiley *et al.,* 1991). Increased respiratory tract complications in children (eg, wheezing, chronic productive cough, and asthma hospitalizations) have been associated with residence near areas of high traffic density (particularly truck traffic) (Ciccone *et al.,* 1998). Other investigators have linked various childhood cancers to proximity to traffic (Raaschou-Nielsen *et al*., 2001). Children in communities with higher levels of urban air pollution (acid vapor, nitrogen dioxide, particulate matter with a median aerodynamic diameter less than 2.5 m [PM 2.5], and elemental carbon (a component of diesel exhaust) had decreased lung function growth, and children who spent more time outdoors had larger deficits in the growth rate of lung function (Gauderman *et al.,* 2002). Perhaps the most well-known health defect caused by air pollution is asthma, a disease that can be chronic. Ozone, sulfur dioxide, particulate matter like dust, ash and nitrogen oxide has all been known to trigger asthma. About 30 percent of asthma cases in children are as a direct result of environmental pollution (Mission, 2012) particularly outdoor air pollution.

levels of hospitalization for chronic obstructive pulmonary disease in elderly subjects in Vancouver, Canada (Chen *et al.,* 2004). Higher outdoor levels of O_3, PM10, SO_2 and NO_2 were associated with significantly higher rates of hospital chronic obstructive pulmonary disease admissions in Minneapolis, Minnesota, but were not related to significantly higher chronic obstructive pulmonary disease admissions in Birmingham, Alabama (Moolgavkar *et al.,* 1997).

Hazards to plants

Plants also showed responses to air pollution as in case of SO_2 and NO_2, visible injury usually results from exposure to pollutant concentrations above a point around an order of magnitude greater than the threshold for growth and yield reductions in absence of visible, i.e. Chronic injury (Rai *et al.,* 2011). Acute injury by these pollutants vary in their form of various necrotic lesions, ranging from a fine stipple to large patches of dead tissue, with colouration ranging from white to brown black (Taylor *et al.,* 1987).

Hazards to animals

Acid rain formed in the air destroys fish life in lakes and streams, which disturbs aquatic ecosystem and excessive ultraviolet radiation coming from the sun through the ozone layer in the upper atmosphere which is eroded by some air pollutants, may cause skin cancer in wildlife ozone in the lower atmosphere may damage lung tissues of animals.

Hazards to materials

Air pollution has a variety of effects on materials--the corrosion of metals, the deterioration of materials and paints,

and the fading of dyes. There have been a number of attempts at estimating the resultant economic losses due to those detrimental effects of air pollution. The materials most sensitive to pollutants are calcareous building stores and ferrous metals. Manifestations of damage include losses of mass and changes in porosity, discoloration and embrittlement. In the case of stone it is difficult to dissociate the effects of historical concentrations of pollution from current ones and to establish background rates of erosion or decay in the absence of pollutants.

Air Quality Standards

Two types of air quality standards are considered: primary standards set limits to protect public health, including the health of "sensitive" populations such as asthmatics, children, and the elderly. Secondary standards set limits to protect public welfare, including protection against decreased visibility, damage to animals, crops, vegetation, and buildings (Kelishadi *et al.*, 2009). National Air Quality Standards are shown in the Table 3.

adequate reason to institute regular or continuous monitoring and further investigations

Air Quality Index

Air quality is a significant determinant of health. Ambient air quality is also known as air pollution index which measures point to know the change in level of pollutants from standard level and helps to know the effects on human health due to increase in pollution (Senthilnathan, 2007). The air quality index is a tool used by EPA (2000) and other agencies to provide the public with timely and easy-to-understand information on local air quality. The higher value (above 125) of an index refers to a great level of air pollution (Shukla *et al.*, 2010).

The air quality index (AQI) was calculated by the following formula

$$AQI = 100 \times \frac{\text{Observed mean concentration of a pollutant}}{\text{Standard for the respective pollutant.}}$$

Table 3 National Ambient Air Quality Standards

Pollutants	Time Weighted Average	Concentration in Ambient Air: Industrial, Residential, Rural and other Areas	Ecologically Sensitive Area (Notified by Central Government)	Methods of Measurement
Sulphur Dioxide (SO_2), µg/m3	Annual * 24 Hours **	50 80	20 80	-Improved West and Gaeke Method -Ultraviolet Fluorescence
Nitrogen Dioxide (NO_2), µg/m3	Annual * 24 Hours **	40 80	30 80	-Jacob & Hochheiser modified (NaOH-$NaAsO_2$) Method -Gas Phase Chemiluminescence
Particulate Matter (Size less than 10µm) or PM10, µg/m3	Annual * 24 Hours **	60 100	40 60	-Gravimetric -TEOM -Beta attenuation
Ozone (O_3) µg/m3	8 Hours * 1 Hour **	100 180	100 180	UV Photometric -Chemiluminescence -Chemical Method
Lead (Pb) µg/m3	Annual * 24 Hours **	0.50 1.0	0.50 1.0	AAS/ICP Method after sampling on EPM 2000 or equivalent filter paper - ED-XRF using Teflon filter
Carbon Monoxide(CO), mg/m3	8 Hours * 1 Hour **	02 04	02 04	Non dispersive Infrared (NDIR) Spectroscopy
Ammonia (NH_3), µg/m3	Annual * 24 Hours **	100 400	100 400	-Chemiluminescence -Indophenol blue method
Benzene (C_6H_6), µg/m3	Annual * 24 Hours **	05	05	- Gas Chromatography (GC) based continuous analyzer –Adsorption and desorption followed by GC analysis
Benzo(a)Pyrene (BaP) Particulate phase only,ng/m3	Annual * 24 Hours **	01	01	Solvent extraction followed by HPLC/GC analysis
Arsenic (As), ng/m3	Annual * 24 Hours **	06	06	-AAS/ICP Method after sampling on EPM 2000 or equivalent filter paper
Nickel (Ni), ng/m3	Annual * 24 Hours **	20	20	-AAS/ICP Method after sampling on EPM 2000 or equivalent filter paper

Source (NAAQS Monitoring & Analysis Guidelines Volume-I, CPCB, MAY, 2011).

* Annual Arithmetic mean of minimum 104 measurements in a year at a particular site taken twice a week 24 hourly at uniform intervals.

** 24 hourly or 8 hourly or 1 hourly monitored values, as applicable, shall be complied with 98% of the time in a year. 2% of the time, they may exceed the limits but not on two consecutive days of monitoring.

Note: Whenever and wherever monitoring results on two consecutive days of monitoring exceed the limits specified above for the respective category, it shall be considered

Air quality measurement includes both types of pollutants monitored as well as the location of the measurements (Baldauf *et al.*, 2009).

Case Studies of the Outdoor air pollution

In the European project Aphekom, Pascal. M *et al.*, in 2013 studied the effect of ozone and the Particulate matter in 25 cities of Europe. The aim is to find out the health hazards, mortality and hospitalization due to the urban air pollution. Among the 39 million residents in the 25 cities they noticed the cardiovascular mortality is more in the age group of 30 to more than 60 ages at Budapest and Bucharest. There are 2997

cardiac hospitalization reported which was high compared to other cities. The respiratory problems are also increasing the number of cases in the city. Several health impact assessments were reported many health problems in Europe because of the PM and Ozone. Even though still the PM and Ozone concentrations are above the standard of World Health Organization Air Quality Guidelines (WHO-AQG). In Europe, annual mean PM10 should not exceed 40 µg/m3 (limit value set in 2005), and Member States are requested to reduce exposure to PM2.5 in urban areas below 20 µg/m3 by 2015 (legally binding value).

The largest developed country like China, the economic standards leads to the more usage of fossil fuel which resulted in the air pollution. The monitoring of 621 cities shows there are 107 cities failed to meet the country's national ambient air quality standards (NAAQS) (Chinese Ministry of Environmental Protection, 2010). The grey sky formation in the Chinese cities made many health issues in last year's. The mortality among the Chinese population is lower in magnitude by air pollution Europe. The reduction of the fossil fuel usage recommended for the improvement of the air quality also for reducing the climate change. The outdoor pollution affects the infant population in china which is a big issue to be concern, the babies are suffering from cough; obesity and wheeze; grandparents chronic bronchitis and persistent cough and wheeze fewer also the house close to main road were the infants are suffering from and asthma; house close to factory/chimney and persistent cough, wheeze and asthma; classroom close to main road and persistent cough, persistent phlegm and asthma (Guowei Pan *et al.*, 2010).

As the increase in the population and unplanned roads in the Pakistan made quite a lot of problems to the environment by the over fuel combusting. An agriculture country like Pakistan the developmental activities lead to loss many landmasses which used for agriculture and made in to industrial area. The polluted air due to the vehicular movement and the industrial effluents to the air are the prime reasons behind the pollution. The study in most polluted city in Pakistan, Quetta reveals the adverse effect of degrading air quality to the human race (Syed Zafar Ilyas *et al.*, 2009).

Outdoor air pollution has become the fifth largest killer in India after high blood pressure, tobacco smoking, and poor nutrition – says a new set of findings of the Global Burden of Disease report (The Centre for Science and Environment's (CSE)). In Mumbai city, Research studies attempts to identify VOC's in outdoor and indoor air (Anjali *et al.*, 2004). Air quality status of Visakhapatnam on indices basis is analyzed using a non-linear equation for variable parameters i.e. suspended particulate matter (SPM), sulfur dioxide (SO_2) and oxides of nitrogen (NO_x), which are main criteria pollutants in India. For current analysis seasonal air quality data is used, which indicates SPM values in winter at most of the sites and in summer at few sites are exceeding the prescribed standards. Calculated indices reveal that, in winter as well as in summer, most of the locations experienced poor or bad air quality, which is mainly due to higher concentration of Suspended particulate matter and certain extent of Sulphur dioxide values (Reddy MK *et al.*, 2004). In Jaipur, "Air Quality Index" is higher for PM_{10} followed by CO (Renu *et al.*, 2004).

Air Legislation in India

There are various air acts adopted in India which are as follows:-

1948 – The Factories Act and Amendment in 1987 was the first to express concern for the working environment of the workers. The amendment of 1987 has sharpened its environmental focus and expanded its application to hazardous processes.

***1981 - The Air (Prevention and Control of Pollution)* Act** provides for the control and abatement of air pollution. It entrusts the power of enforcing this act to the CPCB.

***1982 - The Air (Prevention and Control of Pollution)* Rules** defines the procedures of the meetings of the Boards and the powers entrusted to them.

1982 - The Atomic Energy Act deals with the radioactive waste.

1987 - The Air (Prevention and Control of Pollution) Amendment Act empowers the central and state pollution control boards to meet with grave emergencies of air pollution.

1988 - The Motor Vehicles Act states that all hazardous waste is to be properly packaged, labelled, and transported (http://edugreen.teri.res.in/explore/laws.htm#air).

Economic effects of air pollution

The economic costs of air pollution are difficult to estimate accurately (Levy, 2003). Exposure to various air pollutants and combinations of air pollutants create major economic costs by increasing mortality, morbidity, and increased absenteeism and lost productivity. Human suffering from adverse health effects related air pollution which is hard to measure in terms of money. In addition, air pollution also creates a large amount of non-human health related economic costs including reduced visibility, global warming, building and vehicle damage, and harm to many types of plants and animals (Curtis *et al.*, 2006).

CONCLUSIONS

The present review is based for the understanding of the status of outdoor pollution across India and other countries in the world. This will give the outline of all health hazards caused by the outdoor pollution to the human race. A review from different part of the world makes a primary knowledge data for the better conservation and wellbeing of life on the earth. This paper discusses the outdoor air pollution and its health effects. Although the role played by outdoor pollutants in the health of human being has yet to be clarified, a body of evidence suggests that urbanization, with its high levels of vehicle emissions and a westernized lifestyle are linked to the rising frequency of Outdoor pollution related diseases seen in both developed and developing countries. The protection of outdoor air quality in the environment must be a first priority goal. Hence, a successful strategy to address outdoor air pollution benefits in reducing the health hazard effect is industries and vehicles. Industries should be encouraged to switch over to cleaner fuels. Energy conservation options are also is encouraged. Moreover, important decisions need to be taken urgently by governments worldwide concerning motor vehicle induced air pollution to reduce the future costs of effects on health and on the environments. Further research on the health

effects of air pollution, medication and nutritional treatments is also needed to reduce the adverse effects of pollutants.

Recommendations

However the research has been done on outdoor air pollution but the problem is still unsolved so, there are various recommendations that we have to adopt are as follows

- More efficient use of energy.
- The use of less-polluting fossil fuels.
- Increased use of non-fossil energy sources.
- The use of newer and environmentally more combustion technologies.
- Strict control of air pollutant emissions.
- Should actively encourage internationally co-ordinate research and development aimed at a better understanding of atmospheric processes and effects of air pollution on man and the environment, and at improving technologies for fossil fuel combustion and control of pollutant emission.
- Should co-operate to improve the availability and quality of data on air pollutant emissions from different categories of polluters.
- Should refer to the guiding principles set out below, which form an integral part of the recommendation, in furthering their air pollution control policies.

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