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# Analysis of Human Health Impacts on Air Pollution at Global Level

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**Abstract: The serious effects of ambient air pollution on human health have been consistently documented by many studies on epidemiology worldwide, and it has been calculated that globally at least seven million deaths are attributable annually to the effects of air pollution. The major air pollutants emitted into the atmosphere by a number of natural processes and human activities include nitrogen oxides, volatile organic compounds, and particulate matter. Along with the poor ambient air quality, there is increase in evidence that indoor air pollution also poses a serious threat to human health, especially in low-income countries that still use biomass fuels as an energy resource. This review summarizes the current knowledge on ambient air pollution in financially deprived populations.**

**Keywords – Particulate matter(PM), NO2, SO2, CI, Emission, Exposure.**

## 1. INTRODUCTION

### *1.1 GENERAL*

Environmental pollution has been a matter of concern for many years. Air pollution is becoming a major health problem that affects millions of people worldwide. In support of this observation, the World Health Organization estimates that every year, 2.4 million people die because of the effects of air pollution on health. A wide range of adverse effects of ambient air pollution on health has been well documented by studies conducted in various parts of the world. There is significant inequality in exposure to air pollution and related health risks: air pollution combines with other aspects of the social and physical environment to create a disproportionate disease burden in less affluent parts of society. WHO periodically reviews the accumulated scientific evidence to update its air quality guidelines. The most recent update was completed in 2005. The guidelines address all regions of the world and provide uniform targets for air quality that would protect the large majority of individuals from the adverse effects on health of air pollution.

The adverse effects on health of particulate matter (PM) are especially well documented. There is no evidence of a safe level of exposure or a threshold below which no adverse health effects occur. More than 80% of the population in the WHO European Region (including the European Union, EU) lives in cities with levels of PM exceeding WHO Air Quality Guidelines. Only a slightly decreasing trend in average concentrations has been observed in countries in the EU over the last decade. Pollution from PM creates a substantial burden of disease, reducing life expectancy by almost 9 months on average in Europe. Since even at relatively low concentrations the burden of air pollution on health is significant, effective management of air quality that aims to achieve WHO Air Quality Guidelines levels is necessary to reduce health risks to a minimum. Exposure to air pollutants is largely beyond the control of individuals and requires action by public authorities at the national, regional and international levels.

### *1.2. SOURCES OF AIR POLLUTION:*

Several factors cause air pollution among them the main factor is transportation , where the abundance of poorly-maintained vehicles, use of petrol fuel, and poor controlling are making transportation the major air polluting sector. Additionally, thermal power plants and some small-scale industries which also affects the air quality . An analysis of different sources of air pollution has revealed that motor vehicles are the leading contributor to air pollution (51.4%) which is followed by industry (24.5%) and dust particles (21.1%), respectively.[Source: CPCB].

### *1.3.HUMAN EXPOSURE TO AIR POLLUTION :*

A primary goal of air pollution regulatory programs is to protect public health from the adverse effects of pollutants. It is necessary to understand all the components of the air pollution system described below in order to determine the health risks posed by the pollutant or the pollution source. Historically, however, the component that has received the least attention is exposure or dose (these two terms are often used interchangeably). In fact, the term exposure has been

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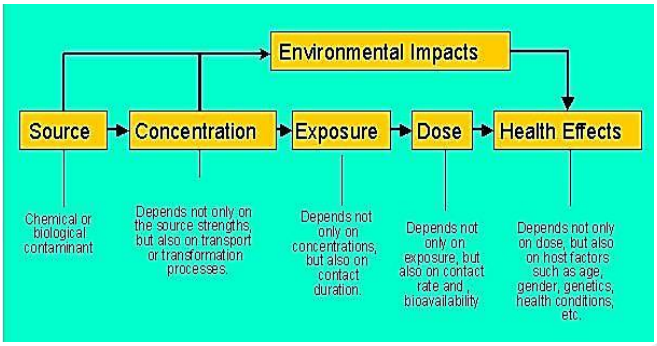
often defined or used in different and sometimes confusing ways in the existing environmental health literature, although the term may describe different processes across different fields of environmental health sciences, such as exposure assessment, risk assessment, industrial hygiene, environmental toxicology, environmental epidemiology, and public health.




The particulate matter is hazardous to the human health due to absorption on their surface of many harmful contaminants such as: heavy metals (lead, cadmium, mercury and the other), organic compounds (polycyclic aromatic hydrocarbons, PCBs, dioxin and furans). Gaseous pollutants, depending on their solubility in the water, are absorbed in the proximal or the distal parts of the respiratory tract. This is important from the standpoint of the health effects. Sulfur dioxide and formaldehyde are highly water-soluble gases, therefore they do not reach the lungs, and they are irritating the airway epithelium of the upper respiratory tract.

### *1.4. SOURCES OF EMISSION VS. SOURCES OF EXPOSURE*

The importance of exposure assessment can be easily seen from the continuum shown in above Fig, as it is a key to linking the pollution source and health effects. Although "dose makes poison" has been well known for centuries, the importance of exposure assessment in air pollution history has not been recognized until about 2 decades ago and is still being underestimated.

### *1.5 Drivers of air pollution:*

The major drivers of air pollution are as follows.

- Population growth urbanization migration
- Economic indices
- Transportation (Road, rail, shipping)
- Energy use
- Biomass burning
- Mining Activities
- Residential fuel use

## 2. REVIEW OF LITERATURE

### *2.1 Various Studies on Human Health effects:*

The health effects associated with particulate matter (PM) in epidemiological studies include long term- and short-term effects of mortality and morbidity of respiratory and cardiovascular diseases and others (Dockery and Pope, 1994; Ostro, 2004; Anderson et al., 2004). These findings are based on numerous studies conducted mainly in Northern America and Western Europe. Similar observations in Central Eastern Europe (CEE), such as Romania, are very rare.

While many similarities exist in the constituents of air pollution around the globe (HEI — Health Effects Institute, 2004), Romania differs from Western Europe and North America in the nature of its air pollution and the health status. In European countries the prevalence of bronchitis is higher and prevalence of asthma appears to be lower than in Western Europe (Leonardi et al., 2002). Levels of particulate matter are higher in Europe and the regional differences within European countries are bigger than in Western Europe and North America (Houthuijs et al.,2001). The pollution in Romania originates not only from Romania itself (Ganev et al., 2008). For instance an immediate increase in respiratory diseases, a lag behind in the physical development of schoolchildren and aggravated functional lung indices were observed. after the advection of Bulgarian air masses polluted with hydrogen chloride (Basmadzhieva et al., 1992). The environmental situation in Romania is an important factor impairing public health.

There is a continuing deterioration of environmental quality in Romania (Hardi,1994). The cities of Romania suffer from high levels of air pollution and, as a consequence, from different respiratory illnesses. People in countries of CEE, are estimated to be exposed to high levels of pollution in urban areas. Outdoor air pollution is an environmental danger where heavy industries are concentrated without adequate technology for emission control (Jedrychowski et al., 1997; Moore, 1995). A first complex approach exploring the association of air pollutants and human health in this regionwas the Central European Study of Air Quality and Respiratory Health (CESAR) (Leonardi et al., 2002). The study aimed at establishing comparable base-line data on respiratory

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health of children and on current exposure to air pollutants in polluted regions in CEE countries and to investigate the relationship between respiratory health and air pollution. Results from CESAR demonstrate that annual mean particulate matter concentration levels in Central and Eastern Europe exceed the limit values of the European Commission. This may lead to a substantial burden of disease and premature death (Houthuijs et al., 2001). Long-term exposure to airborne particulates leads to inflammation of the airways and activationof the cellular and humoral immune system (Leonardi et al.,2000).

## 3. MAJOR AIR POLLUTANTS

### *3.1 OZONE ($O_3$):*

O3 is mainly formed by the interaction of ultraviolet light with both nitrogen oxides and organic compounds. O3 exhibits potent anti-oxidant properties and induces alterations in the airways that depend on concentration and the duration of exposure. Ozone has received a great deal of scientific attention over the past 25 years, and much is now known about how this compound affects lung function and lung morphology. The discovery of the physiological effects of ozone was first reported by Schonbein in 1851. He described typical symptoms including cough and pain in the chest, which are still reported today, although in his case the symptoms were quite severe because of the higher ozone concentrations which he breathed.

### *3.2. Sulfur Dioxide :*

Sulfur dioxide has polluted the atmosphere for most of the earth's history. However, concern over SO2 as a modern pollutant was heightened in the middle of this century by the London"fogs," of which SO2 was a major component. In 1953, Amdur and co-workers examined the responses of men breathing up to 8 ppm SO2 in one of the first controlled studies of humans exposed to air pollutants.

### *3.3 Carbon Monoxide:*

Carbon monoxide is an odorless, colorless gas created primarily by incompletely combusted fuels. CO has a high affinity for hemoglobin, interferes with oxygen transport to the tissues, and is well known to cause poisoning at high concentrations. However, such high levels are of little interest to those concerned with health effects of community air pollution. Because of its association with combustion, death associated with poorly ventilated fires (and hence from CO poisoning).

### *3.4 Nitrogen Dioxide*

Nitrogen dioxide is the main precursor of ozone and as such it is a major component of oxidant air pollution. The major health end points that have been associated with NO2 are increased incidence of lower respiratory tract infections in children and increased airway responsiveness in asthmatics. The small airways are the primary site of $NO_2$-induced damage. In controlled exposure studies, at levels of less than 1 ppm, NO2 does not induce pulmonary function responses or changes in airway responsiveness in healthy subjects, although little, if any, functional evaluation of small airways has been performed. NO2 causes an increase in airway responsiveness to methacholine or histamine in healthy subjects and in asthmatics.

### *3.5 Particulate Matter (PM):*

PM is a complex mixture of solid and liquid particles suspended in air that is released into the atmosphere when coal, gasoline, diesel fuels and wood are burned. It is also produced by chemical reactions of nitrogen oxides and organic compounds that occur in the environment. Vegetation and livestock are also sources of PM. In big cities, production of PM is attributed to cars, trucks and coal-fired power plants.

The health effects of PM depend on several factors, including the size and composition of the particles, the level and duration of exposure, and the gender, age and sensitivity of the exposed individual. Symptoms of exposure may include persistent cough, sore throat, burning eyes and chest tightness. PM may also trigger asthma or lead to premature death, particularly in elderly individuals with preexisting disease. In addition, people who are active outdoors are at higher risk, as physical activity increases the amounts of PM penetrating into the airways. People with disease (e.g. diabetes mellitus, malnutrition) are also at increased risk.

## 4. EFFECTS ON RESPIRATORY HEALTH

The airways are a point of entry for pollutants, which in turn may cause lung disease. For example, PM may be deposited into any of the three respiratory com-partments: the extrathoracic, tracheobronchial and alveolar regions.

Table1: Environmental Protection Agency (EPA) terminology for particle sizes

| EPA Description | Particle Size |
|---|---|
| Super coarse | $d_{pa}$ > 10 mm |
| Coarse | 2.5<$d_{pa}$=10mm |
| Fine | 0.1<$d_{pa}$=2.5mm |
| Ultra fine | $d_{pa}$=0.1mm |

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According to more recent studies, the ultrafine particles may be translocated into the circulation and directly transported to the vasculature and heart where they can induce cardiac arrhythmias and decrease cardiac contractility and coronary flow. Improving our understanding of the biological mechanisms underlying the acute cardiovascular effects of air pollution is essential to define the best prevention strategies . Cardiovascular disease is very common and, as exposure to air pollution, both in the long and short term, contributes to initiation and exacerbation of disease, it is likely that even modest reductions in exposure will result in significant health gain.

## 5. ADVERSE EFFECTS OF AIR POLLUTION ON PREGNANCY OUTCOMES AND INFANT DEATH

| Countries | Estimated relative risk per mg/m | (95% CI) |
|---|---|---|
| KENYA & SOUTH AFRICA | 1.059 (1.015–1.105) | 28.2–557.5 |
| MOROCO & GHANA- | 1.082 (1.011–1.158) | 24.7–364.7 |
| NORTH AMERICA-Region1 | 1.010 (0.991–1.031) | 14.2–87.3 |
| SOUTH AMRERICA-REGION 2 | 1.006 (1.005–1.007) | 94.6–314.8 |
| INDIA-KOLKATTA | 1.059 (1.015–1.105) | 142.9–517.7 |
| INDIA-MUMBAI | 1.082 (1.011–1.158) | 25.0–149.2 |
| INDIA-CHENNAI | 1.010 (0.991–1.031) | 17.0–73.0 |
| AUSTRALIA | 1.006 (1.005–1.007) | 9.9–42.8 |
| CANADA | 1.082 (1.011–1.158) | 14.8–58.5 |
| JAPAN | 1.010 (0.991–1.031) | 10.1–83.3 |

***Table 2: Air Pollution concentration & CI***
Source: Paul et.al(2002)- Scientificworld Journal

In the last two decades there is observed an increase of the number of scientific reports about a proven influence of air pollution on an occurrence of negative health effects, connected with births. They are: preterm births, stillbirths, intrauterine fetus growth retardation, births of newborns with low birth weight and a risk of newborns' death because of respiratory system disorders Birth weight, gestational age, and fetal growth are important indicators of perinatal health. Maternal exposure to sulfur dioxide during the first month of pregnancy increased risk of intrauterine growth retardation as well as LBW when preterm birth was associated with exposure to SO2 during the last month of pregnancy. Study on CO influence on pregnancy were the basis for estimation that one unit change in mean CO concentration during the last trimester of pregnancy increases the risk of low birth weight by 8%. Furthermore, a one unit change in mean CO concentration during the first 2 weeks after birth increases the risk of infant mortality by 2.5% relative to baseline levels.

## 6. THE IMPACTS OF FINE PARTICULATE MATTER ON CARDIOVASCULAR HEALTH

Cardiovascular disease (CVD) constitute a global problem and is the leading cause of death in the world, especially in highly developed countries. Cardiovascular disease is also a major cause of disability and of reduced quality of life . According to forecast, almost 20 million people will die from CVDs, mainly from heart disease and stroke by 2015 . Results from many research studies have demonstrated a strong relationship between levels of airborne particles, sulfur dioxide and other air pollutants and risk of early death from heart disease. Air pollutants have been linked with endothelial dysfunction and vasoconstriction, increased blood pressure (BP), prothrombotic and coagulant changes, systemic inflammatory and oxidative stress responses, autonomic imbalance and arrhythmias, and the progression of atherosclerosis . Using data for Chicago area hospitals for years 1988 to 1993 it was found, that an increase in PM10 level by 10 $\mu g/m^3$ was associated with 1.27%, 1.45%, and 2% increases in hospital admissions for heart disease, chronic obstructive pulmonary disease, and pneumonia, respectively .

## 7. ALLERGIC DISEASES

Allergic diseases such as asthma and allergic rhinitis are very common in children and young adults. In most cases, asthma in these groups of patients is characterized by

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increased synthesis of immunoglobulin E against common allergens. Exposure of these patients to specific aeroallergens such as pollens leads to a series of immunological changes culminating in the symptoms of asthma.

## 8. AIR POLLUTION AND CLIMATE-CHANGE MITIGATION

Climate change can enhance the levels of some environmental pollutants, including O3 and PM2.5. For example, the formation of photochemical smog and O3 increases with higher temperatures.Some of the planned climate-change mitigation strategies include more efficient use of fossil fuels for industrial processes and electricity generation, switching to renewable energy (solar/wind/wave power), increasing the fuel efficiency of vehicles, improving the insulation of buildings, growing new forests, nuclear power and carbon sequestration. It is generally accepted that efforts in all these areas will, at best, prevent further warming but not reverse existing warming.

## 9. CONCLUSION

Air pollution currently affects the health of millions of people. We have presented evidence on the effects of pollutants on patients with limitations in their respiratory capacities. For example, O3 and PM may trigger asthma symptoms or lead to premature death, particularly in elderly individuals with pre-existing respiratory or cardiovascular disease. In addition, pollutants enhance the release of allergenic pollen grains, which results in an increased prevalence of pollen-induced asthma. Thus, the case for action to reduce air pollution is overwhelming and this action can take many forms. Some of these include urban planning, technological developments (e.g. the design of new vehicles that produce less pollution), and at the government level, the introduction of new laws. It has been estimated that reducing both black carbon and O3 levels would prevent over 3 million premature deaths and increase crop yields by around 50 million tonnes annually. Improvements to cooking stoves would also decrease demand for firewood and reduce deforestation in the developing world. If air pollution levels in heavy traffic areas were reduced, the incidence of asthma and other respiratory diseases would be significantly reduced. While it is generally accepted that efforts to reduce air pollution will prevent further environmental changes, they will not reverse existing warming. An increasing number of studies show that in individuals with low anti-oxidant levels, dietary supplements could be used as a promising approach to reducing susceptibility to air pollution, and providing an alternative strategy for neutralizing the effects of pollutants on health.

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