

Air Pollution and Human Health Impacts

Tawfiq Almsatar¹, Abdurhman Mekherm², Hamed Babia³

Abstract :

Air pollution can be defined as a condition in which the concentrations of substances in the atmosphere are high enough to cause measurable effect on man, animals, vegetation or materials. A “substance”, refer to particulate matter which is any natural or anthropological airborne chemical element or compound that can exist in the atmosphere as gases, liquid drops or solid particles .

Particulate matter(PM) is a not a single pollutant, but a complex mixture of many types of pollutants, its extremely made up of acids, organic chemicals, metals, and soil or dust particles , with different physical, chemical and biological characteristics, which determine both its behavior, as well as its environmental and health effects .

Air pollution is a pervasive public health issue with major cardiovascular and health economic consequences, and it should remain a key target for global health policy. The effect of air pollution on other cardiovascular conditions, been less well described .

The World Health Organization (WHO) reported that ambient air pollution was responsible for 3.7 million deaths in 2012, representing 6.7% of total deaths worldwide, and was the cause of 16% of lung cancer deaths, 11% of chronic obstructive pulmonary disease-related death, 29% of heart disease and stroke, and approximately 13% of deaths due to respiratory infection. This paper will review the different types of human disease, as a result of air pollution impacts.

Key words : Indoor/out door air pollution, Particulate matter (PM), Health.

1. Introduction :

Air pollution can be defined as a condition in which the concentrations of substances in the atmosphere are high enough to cause measurable effects on people, animals, vegetation or materials. ‘Substance’ refers to particulate matter, which is any natural or anthropological airborne chemical element or compound that can exist in the atmosphere as gas, liquid drops or solid particles (Seinfeld et al., 1986).

Particulate matter (PM) is not a single pollutant, but a complex mixture of many types of pollutants, composed of acids, organic chemicals, metals, and soil or dust particles (US EPA, 2011), with different physical, chemical and biological characteristics which determine its behavior as well as its environmental and health effects (EPA, 2004).

PM can be described by its ‘aerodynamic equivalent diameter’ (AED). Particles of the same AED will tend to have the same settling velocity. Researchers have traditionally subdivided particles into AED fractions according to how the particles are generated and where they are deposited in human airways: <10, <2.5, and <0.1 μm (PM₁₀, PM_{2.5}, and PM_{0.1}, respectively). Particles with a diameter greater than 10 μm have a relatively small suspension half-life and are largely filtered out by the nose and upper airway. Researchers define particles with a diameter between 2.5 and 10 μm (PM_{2.5-10}) as ‘coarse’, less than

¹ Alzytouna University- Libya.

E.mail : Tawfiq8@gmail.com

² High Institute of Safty and Occupational Health-Libya.

³ Alzytouna Universty, Faculty of Science, Libya.

2.5 µm as ‘fine’, and less than 0.1 µm as ‘ultrafine’. When interpreting PM research, it is important to appreciate that PM₁₀ contains ultrafine (PM_{0.1}), fine (PM_{0.1-2.5}) and coarse (PM_{2.5-10}) fractions (Anderson, 2012).

However, other studies have grouped air pollutants into major and trace or hazardous air pollutants. Major air pollutants comprise six classical pollutants: sulphur dioxide (SO₂), airborne particles, nitrogen dioxide (NO₂), carbon monoxide (CO), lead (Pb), and ozone (O₃). Hazardous air pollutants can be found in much smaller concentrations than major air pollutants, and include different chemical, physical, and biological agents, such as volatile organic compounds (VOCs), radio-nuclides, and micro-organisms (Wiederkehr et al., 1998). This paper discus the potentail impacts of air pollutants on human health.

2. Sources of air pollution (Indoor/outdoor air pollution) :

Vehicle emissions have been identified as a major source of air pollution in metropolitan areas. Diesel vehicles were found to be associated with observed pollutant levels.

Ultrafine particles showed very high concentrations in roadside environments, in addition to NO_x and BC concentrations, with almost equal roadside and on-road values, possibly bcause of the accumulation of primary emissions and secondary PM formation (Agata Rakowska, 2014). Table 1 explains the sources and types of air pollutants.

Table 1. The most common sources of air pollutants

Situation	Emission source	Pollutants
Outdoors	Industrial production	SO ₂ , NO ₂ , ozone, particles, CO, and VOCs.
	Motor vehicles	CO, NO _x , Pb, Radon.
Indoors	<ul style="list-style-type: none"> Building materials: <ul style="list-style-type: none"> Stone, cement Wood products Insulation Fire-proofing Paint Installations and furnishings: <ul style="list-style-type: none"> Heating system, oven/stove Photocopier Ventilation system Occupants : <ul style="list-style-type: none"> Metabolic activity Biological activity Human activity : <ul style="list-style-type: none"> Smoking Room deodorizers Cleaning products Leisure/artistic activities 	<ul style="list-style-type: none"> Radon Formaldehyde, VOCs Formaldehyde, fiberglass Asbestos VOCs, Pb C, CO₂, NO₂, NO, VOCs, particles Ozone Microorganisms CO₂, water vapor Microorganisms CO, particles, Fluorocarbons, scents VOCs, scents VOCs, scents

CO: carbon monoxide ; CO₂: carbon dioxide ; VOC: volatile organic compound; NO: nitrogen oxide ; NO₂: nitrogen dioxide.

The activities of daily life require individuals to spend more than 80% of their time indoors (offices, schools, hospitals, daycare, shopping centers, private homes, etc.); therefore, the air quality of such spaces may affect the health of their inhabitants. WHO has estimated that there are 2 million annual deaths worldwide attributable to indoor air contaminants (IAC) (WHO, 2009), and WHO has ranked this phenomenon tenth among avoidable risk factors in its importance for the health of the general population (WHO,2002) The potential contaminants differ in origin: they are derived from combustion, biological processes and agents, gases, and volatile organic compounds (VOC) (Luis Carazo Fernandez, 2012).

3. Health impacts

The World Health Organization (WHO) reported that ambient air pollution was responsible for 3.7 million deaths in 2012, representing 6.7% of total deaths worldwide, and was the cause of 16% of lung cancer deaths, 11% of deaths related to chronic obstructive pulmonary disease, 29% of deaths due to heart disease and stroke, and approximately 13% of deaths due to respiratory infection.

Air pollution is a pervasive public health issue with major cardiovascular and health economic consequences, and it should remain a key target for global health policy. The effect of air pollution on other cardiovascular conditions has been less well described (Dunlay et al., 2009); however, Table 2 and Table 3 explain the short- and long-term impacts on the cardiovascular system of exposure to PM. Exposure to air pollution is associated with acute cardiovascular events such as myocardial infarction (Nawrot, Perez et al., 2011; Mustafi c H, Jabre, et al., 2012). Where, Table 4 indicates the concentration of air pollutants corresponding to different types of disease.

Several studies of short-term exposure to air pollution have included heart failure hospitalization and mortality, although these endpoints have not been the primary focus in most analyses. Acute exposure to air pollution has been linked to myocardial infarction, but its effect on heart failure is uncertain. Heart failure is an escalating public health issue that affects more than 23 million people worldwide, with an increasing prevalence in elderly people (Anoop SV shah et al., 2013).

Table 2. Global burden of disease: PM 2.5 and PM 10 air pollution as a leading cause of death and disability

Types of disease	Types of pollutants	Concentration of PM levels > µg/m ³	References
Heart failure hospitalisation and heart failure mortality	PM2.5 and PM10	10	<i>Anoop S V hah et al., 2013)</i>
Cardiovascular disease and cardiovascular deaths after acute exposure to particulate air pollution	PM2.5.	5~6	Gold et al., 2000
Coronary artery disease	PM2.5	10	Pope et. al., 2006
Cardiovascular diseases	PM10	10	Byeong-Jae Lee, 2014
Blood pressure	PM2.5	10.5	
Chronic inhalational doses and cancer risks (indoor air pollution)	Naphthalene	0.95	<i>Report on Carcinogens – Naphthalene(2004).</i>
Cancer risk (outdoor air pollution)	Naphthalene	5	<i>Chunrong Jia and Stuarf Batterman (2010).</i>
Asthma	PM2.5	15.9	Elizabeth Nethery et al., 2014
Leukemia risk, pulmonary edema, acute granular tracheitis,	Benzene	0.15	Vlaanderen et. al., 2011

laryngitis, and bronchitis			
Dermal allergies, asthma, neuro-reproductive, hematopoietic, genetic and pulmonary toxicity, and cellular damage	Formaldehyde	0.25	Kim, Jahan and Lee, 2011
Headaches, dizziness, eye irritation, fatigue	Hydrogen sulfide	0.15	United States Agency for Toxic Substances and Disease Registry, 2012
Lung cancer	PM10 PM2.5	10 10	<i>Ole Raaschou-Nielsen et al., 2013</i>
Mortality and hospital admissions due to respiratory causes	PM2.5 Pm10	10 10	Sara et al., 2014
Respiratory infections	Styrene (VOC) benzene	2.0 5.6	Virginia Fuentes-Leonarte et al., 2009

1. Conclusions

In developing countries, the population depends on wood, coal, or biomass fuels to satisfy its basic energy needs. Cooking and/or heating with these energy sources, in many cases over open fires and with no chimney or exhaust system, leads to significant concentrations of indoor air pollution, including both gases and particles in suspension. In poorly ventilated houses in which this type of fuel is used, indoor pollution levels can reach concentrations up to 100 times greater than the currently established limits for outdoor air pollution.

Almost 152 million new episodes of ‘clinical pneumonia’ are reported from developing countries while only 4 million episodes are reported from developed countries. In this estimation, ‘clinical pneumonia’ includes episodes of pneumonia, bronchiolitis and reactive airway diseases associated with respiratory tract infections. The South-East Asia region reports the highest number of episodes of clinical pneumonia.

Air pollution is contamination of the indoor or outdoor environment by any chemical, physical or biological agent that modifies the natural characteristics of the atmosphere. Household combustion devices, motor vehicles, industrial facilities and forest fires are common sources of air pollution. Pollutants of major public health concern include particulate matter, carbon monoxide, ozone, nitrogen dioxide and sulfur dioxide. Outdoor and indoor air pollution cause respiratory and other diseases which can be fatal.

References

- Agata Rakowska , Ka Chun Wong , Thomas Townsend , Ka Lok Chan, Dane Westerdahl, Simon Ng, Gri_sa Mo_cnik, Luka Drinovec, Zhi Ning,(2014), Impact of traffic volume and composition on the air quality and pedestrian exposure in urban street canyon, *Atmospheric Environment* 98 (2014) 260e270.
- Anoop S V Shah, Jeremy P Langrish, Harish Nair, David A McAllister, Amanda L Hunter, Ken Donaldson, David E Newby, Nicholas L Mills, Global association of air pollution and heart failure: a systematic review and meta-analysis Published Online , July 10, 2013, [http://dx.doi.org/10.1016/S0140-6736\(13\)60898-3](http://dx.doi.org/10.1016/S0140-6736(13)60898-3)
- Byeong-Jae Lee, Bumseok Kim and Kyuhong Lee, (2014), Air Pollution Exposure and Cardiovascular Disease, *Toxicol. Res.* Vol. 30, No. 2, pp. 71-75.
- Chunrong Jia and Stuart Batterman, (2010), *Review : A Critical Review of Naphthalene Sources and Exposures Relevant to Indoor and Outdoor Air*, *Int. J. Environ. Res. Public Health* . ISSN 1660-4601.
- Dunlay SM, Redfield MM, Weston SA, et al. Hospitalizations after heart failure diagnosis a community perspective. *J Am Coll Cardiol* 2009; **54**: 1695–702.
- Elizabeth Nethery, Gary Mallach, Daniel Rainham, Mark S Goldberg and Amanda J Wheeler, (2014), Using Global Positioning Systems (GPS) and temperature data to generate time-activity classifications for estimating personal exposure in air monitoring studies: an automated method, *Environmental Health* 2014, 13:33
- EPA, 2004.
- EPA, 2011.
- Gold, D.R., Litonjua, A., Schwartz, J., Lovett, E., Larson, A., Nearing, B., Allen, G., Verrier, M., Cherry, R. and Verrier, R.(2000) Ambient pollution and heart rate variability. *Circulation*, 101, 1267-1273.
- Kim K, Jahan SA, Lee J: Exposure to formaldehyde and its potential human health hazards. *J Environ Sci Health Part C Environ Carcinog Ecotoxicol Rev* 2011, 29:277–299.
- Luis Carazo Fernandez, Ramon Fernandez Alvarez, Francisco Javier Gonzalez-Barcala, Jose Antonio, Rodriguez Portal, Review : Indoor Air Contaminants and Their Impact on Respiratory Pathologies, *Arch Bronconeumol.* 2013;**49(1)**:22–27
- Mustafic H, Jabre P, Caussin C, et al. Main air pollutants and myocardial infarction: a systematic review and meta-analysis. *JAMA* 2012; 307: 713–21.
- Nawrot TS, Perez L, Kunzli N, Munters E, Nemery B. Public health importance of triggers of myocardial infarction: a comparative risk assessment. *Lancet* 2011; 377: 732–40.
- NTP *Report on Carcinogens - Naphthalene, Eleventh Edition*; U.S. Department of Health and Human Services, Public Health Service, National Toxicology Program: 2004; pp. 1-2.
- Ole Raaschou-Nielsen, et.al., [Air pollution and lung cancer incidence in 17 European cohorts: prospective analyses from the European Study of Cohorts for Air Pollution Effects \(ESCAPE\)](http://dx.doi.org/10.1016/S1470-2045(13)70279-1), Published Online July 10, 2013 [http://dx.doi.org/10.1016/S1470-2045\(13\)70279-1](http://dx.doi.org/10.1016/S1470-2045(13)70279-1)
- Sara D. Adar & Paola A. Filigrana & Nicholas Clements & Jennifer L. Peel, Ambient Coarse Particulate Matter and Human Health: A Systematic Review and Meta-Analysis, *Curr Envir Health Rpt* (2014) 1:258–274
- Seinfeld, J.et.al. 1986, *Atmospheric chemistry and physics of air pollution*. New York, John Wiley & Sons.

- Pope C., Muhlestein J., May H., Renlund D., Anderson J., et al.(2006), Ischemic heart disease events triggered by short term exposure to fine particulate air pollution. *Circulation* 114 :2443-2448.
- WHO, 2002, and, 2009.