ACADEMICIA

ISSN: 2249-7137 Vol. 11, Issue 10, October 2021 Impact Factor: SJIF 2021 = 7.492

ACADEMICIA
An International Multidisciplinary Research Journal
(Double Blind Refereed & Peer Reviewed Journal)

DOI: 10.5958/2249-7137.2021.02378.8

A BRIEF STUDY ON INDOOR AIR POLLUTION

Dr. Jayballabh Kumar*; Dr. Jaspreet Kaur**

*Department of Biochemistry, Teerthanker Mahaveer University,
Moradabad, Uttar Pradesh, INDIA
Email id: dr.jbkumar@gmail.com

**Department of Biochemistry, Teerthanker Mahaveer University,
Moradabad, Uttar Pradesh, INDIA
Email id: drjaspreetkaur@rediffmail.com

ABSTRACT

Indoor air pollution (IAP) is a major health hazard that kills millions of people each year. IAP may be caused by a variety of contaminants, therefore it's critical to determine their primary sources and concentrations; as well as develop methods for controlling and improving indoor air quality (IAQ). We examine and evaluate the main sources of significant pollutant emissions, their health impacts, and problems connected to IAP-based diseases, such as sick building syndrome (SBS) and building-associated sickness, in this paper (BRI). In addition, methods and approaches for controlling and reducing pollutant concentrations are highlighted, and current developments in attempts to resolve and enhance IAQ are described, along with their distinct benefits and potentials. The development of new materials for sensors, IAQ-monitoring systems, and smart houses is expected to be a viable approach for controlling and improving IAQ in the future.

KEYWORDS: *Indoor Air Quality, Indoor Pollution, Human Diseases, Smart Home.*

INTRODUCTION

Because most individuals spend 90 percent of their time inside, mostly at home or at work, the quality of the indoor environment has a significant impact on human well-being. Indoor air pollution (IAP) is responsible for the deaths of 3.8 million people per year, according to the World Health Organization (WHO). Inside houses or buildings, IAP may be produced by inhabitants' activities such as cooking, smoking, using electrical equipment, using consumer goods, or emitting from building materials. Carbon monoxide (CO), volatile organic compounds (VOCs), particulate matter (PM), aerosol, biological contaminants, and others are all harmful pollutants found within buildings. As a result, research on air quality management has shifted from outside to interior settings during the last decade, reflecting lifestyle changes related to increasing levels of urbanization. Reduced IAQ has been shown to have a detrimental impact on human health by generating building-related disease. IAP exposure, both short- and long-term, may result in a variety of illnesses. As a result, the development of monitoring systems is critical to IAQ regulation[1]–[5].

Indoor Air Quality (IAQ) and Indoor Air Pollution (IAP):

IAQ, as defined by the EPA, is the air quality within and around buildings and structures, particularly as it pertains to the health and comfort of building occupants. IAP, on the other hand, refers to the presence of pollutants in the interior air of non-industrial buildings, such as volatile organic compounds (VOCs), particulate matter (PM), inorganic compounds, physical chemicals, and biological variables, all of which may have harmful effects on the human body. IAQ has evolved and grown as a study area in order to safeguard humans from such contaminants. Pollutant concentrations, environmental conditions (temperature, airflow, and relative humidity), light, and noise are the primary factors used to assess IAQ. Thermal conditions are important in IAQ for two reasons: I a variety of issues associated with poor IAQ may be addressed easily by changing relative humidity or temperature, and (ii) building materials in high-temperature buildings can be highly released.

Main Pollutants in Indoor Air Environment:

Many indoor air contaminants have been identified as having negative effects on IAQ and human health. NOx, volatile and semi-volatile organic compounds (VOCs), SO_2, O_3, CO, PM, radon, hazardous metals, and microbes are the most common indoor air pollutants. Some of these may be found in both indoor and outdoor settings, while others are native to the outdoors. Organic, inorganic, biological, and radioactive contaminants may all be classed as indoor air pollutants[6]–[8].

Particulate Matters:

Carbonaceous particles in combination with adsorbed organic compounds and reactive metals are classified as PM. Sulfates, nitrates; end toxin, polycyclic aromatic hydrocarbons, and heavy metals are the major components of PM (iron, nickel, copper, zinc, and vanadium). PM is divided into three categories based on particle size: I coarse particles, PM_{10}, with a diameter of 10 m; (ii) small particles, $PM_{2.5}$, with a diameter of 2.5 m; and (iii) ultrafine particles, $PM_{0.1}$, with a diameter of 0.1 m. PM is particularly dangerous since it may be inhaled, creating severe health problems by damaging the lungs and heart. Indoor PM levels have been found to frequently surpass outside PM levels. Particles that move from the outside and particles produced by inside activity are both causes of indoor PM. PM are spread within buildings due to cooking, fossil fuel combustion activities, smoking, machine operation, and household hobbies. Due to its penetrability into the tiny airways and alveoli, $PM_{0.1}$ produced by fossil fuel burning poses a higher health risk than PM_{10} and $PM_{2.5}$.

VOCs:

VOCs (volatile organic compounds) are gases that include a range of chemicals and are released by liquids or solids. One of the most common VOCs is formaldehyde, a colorless gas with an unpleasant odor that is produced by numerous construction materials such as particleboard, plywood, and glues. Indoor VOC concentrations are at least 10 times greater than outside values, independent of building location. Interior VOCs are primarily produced by four sources: I human activities such as cooking, smoking, and the use of cleaning and personal care items; (ii) indoor chemical reactions; (iii) penetration of outside air via infiltration and ventilation systems; and (iv) building materials. Air exchange rates, home age and size, building modifications, outside VOC levels, and door and window opening may all influence VOC concentrations.

NO_X:

Nitric oxide (NO) and nitrogen dioxide (NO_2) are the two main nitrogen oxides, both of which are produced by combustion sources such as stoves and heaters. NO and NO_2 concentrations in the environment fluctuate dramatically depending on local sources and sinks. Their typical concentration in buildings without combustion activities is half that of the outdoors, but indoor levels frequently surpass outside levels when gas stoves and heaters are utilized. NO_2 is generally considered a main pollutant since it is quickly reduced to NO under ambient circumstances. Nitrous acid (HONO) is formed when NO_2 reacts with water. It is a powerful oxidant and a frequent indoor contaminant. Interior NO_2 levels have been shown to be a result of both outside and inside sources; therefore, high outdoor NO_2 levels from combustion or local traffic sources may affect indoor levels.

Ozone:

Ozone is a strong oxidizing agent that is mostly generated in the atmosphere through photochemical interactions of O_2, NO_x, and VOCs. Due to its delayed reactivity with most airborne contaminants, it cannot be utilized to remove other indoor chemical pollutants. Although ozone allows for quick reactions with a variety of indoor contaminants, the reaction products may irritate people and harm materials. The outside environment and the functioning of electrical equipment are the primary sources of indoor ozone. Photocopiers, disinfection devices, air-purifying equipment, and other office machinery are typical sources of indoor ozone gas. Corona discharge and photochemical processes are the two types of ozone emission methods used by these devices.

SO_2:

Among the sulfur oxides (SO_x) found in the atmosphere, sulfur dioxide (SO_2) is the most frequent gas. SO_2 is mainly generated through the burning of fossil fuels, and it mixes with aerosols and PMs to create a complex collection of different air particles. Vented gas appliances, oil furnaces, cigarette smoke, kerosene heaters, and coal or wood stoves are all producers of SO_2. Furthermore, outside air is considered a major source of indoor SO_2. Indoor SO_2 levels are often lower than those seen outside. Because of its reactivation, SO_2 emissions inside are typically low and readily absorbed by interior surfaces. It is well known that the hourly concentration of SO_2 in buildings is often less than 20 parts per billion. Humans are only exposed to SO_2 via inhalation, which may affect respiratory function.

Co_x:

Combustion activities, such as cooking or heating, generate the majority of carbon monoxide (CO) in indoor air. CO may also be introduced into interior settings through infiltration from the outside air. Unvented kerosene and gas space heaters; leaky chimneys and furnaces; back-drafting from furnaces, gas water heaters, wood stoves, and fireplaces; gas stoves; generators and other gasoline-powered equipment; and tobacco smoke are all significant sources of indoor CO emissions. The typical CO concentration in a building without any gas stoves is about 0.5–5 ppm, while the concentration around gas stoves may vary from 5 to 15 ppm, and even 30 ppm or more. CO exposure may have negative health consequences, including I cardiovascular and neurobehavioral impairments at low concentrations, and (ii) unconsciousness or death at high doses.

Toxic Metals:

Human activities and natural processes both emit heavy metals into the atmosphere. Infiltration of outside pollutants (dust and dirt), smoking, fuel consumption products, and building materials are all sources of IAP by heavy metals. Heavy metals in indoor dust may harm people's health if they enter their bodies via inhalation, ingestion, or skin contact. Heavy metals in indoor air are divided into two groups based on their effects on humans, according to the International Agency for Research on Cancer (IARC): I non-carcinogenic elements such as cobalt (Co), aluminum (Al), copper (Cu), nickel (Ni), iron (Fe), and zinc (Zn); and (ii) both carcinogenic and non-carcinogenic elements such as arsenic (As), chromium (Cr), cadmium (Pb).

Aerosols:

Indoor aerosols are either primary aerosols produced by indoor gas-to-particle reactions or secondary aerosols produced by indoor gas-to-particle processes. Furthermore, outside particles that find their way inside are likely to be a source of indoor aerosols. Secondary inorganic aerosols (SIAs) are PMs made up of inorganic components such as anthropogenic or crustal sources and water-soluble ions, while secondary organic aerosols (SOAs) are produced when VOCs are converted from gas to particle.

Radon:

Building materials, soil gas, and tap water are the main sources of indoor radon. Because soil contains small amounts of radium, radon is most likely one of the components of the gas filling soil pores. When it comes to radon emissions from construction materials, every substance that contains tiny quantities of radium has the potential to emit radon. Masonry materials (i.e., stone, concrete, and brick) are the most common sources of indoor radon emission among building materials, with tons of such materials utilized in construction.

Pesticides:

Inorganic and organic pesticides are widely used as impregnation or surface coating protectants for timber construction materials these days. Bacteria, fungus, insects, rodents, and other creatures are all controlled and prevented using pesticides. Pesticides are typically semi-volatile substances in the interior environment, and depending on characteristics like vapor pressure, product viscosity, and water solubility, they may exist as gas or particle. Furthermore, it has been suggested that carpets and textiles may act as long-term reservoirs for organochlorine pesticides. Pesticides in fibers are thought to move into polyurethane foam pads when used in carpets, textiles, and cushioned furniture, resulting in carpets, textiles, and cushioned furniture reflecting an integrated pesticide exposure throughout their lifespan. Furthermore, pesticides may infiltrate buildings from the outside. Because they are protected from sunshine, severe temperatures, rain, and other elements once inside, they may last for months or years. In the indoor environment, possible exposure pathways include dermal absorption, ingestion, and inhalation of particles or volatile molecules containing pesticides. Pesticide exposure is linked to a variety of health problems, including I short-term irritation of the skin and eyes, dizziness, migraines, and nausea, as well as (ii) long-term chronic effects including cancer, asthma, and diabetes.

Biological Pollutants:

Biological allergies (e.g., animal dander and cat saliva), house dust, cockroaches, mites, and pollen) and microbes are examples of biological pollutants found in indoor settings (viruses, fungi, and bacteria). Antigens, or biological allergens, come from a variety of insects, animals, mites, plants, or fungus, and react with particular immunoglobulin E (IgE) antibodies to cause an allergic reaction. Furry pets (dog and cat dander), house dust mites, molds, plants, cockroaches, and rodents are common indoor sources of allergies, but there are also outdoor ones. Viruses and bacteria are often transmitted by humans and animals. Exposure to biological allergens has been shown to induce sensitization, respiratory infections, respiratory allergic disorders, and wheezing, while indoor exposure to bacteria and viruses is likely to produce noninfectious and infectious health consequences.

LITERATURE REVIEW

J. Hao et al. discussed about Indoor air pollution and its control[9]. The present state of interior air pollution and its management in China is examined by outlining the polluting characteristics of key indoor air pollutants, the methods and techniques used to control indoor air pollution, and the significant issues that now plague indoor air pollution control. Although formaldehyde and benzene interior pollution has been successfully reduced in China in recent years, toluene and xylenes indoor pollution remains a significant problem. Furthermore, research indicates that particulate matter (PM), biological pollutants, and semi-volatile organic compounds (SVOCs) indoor pollution is a significant problem in China. In China, the creation and implementation of IAQ-related laws and standards, research on indoor air pollution and its management, and the growth of the indoor environmental monitoring and cleaning sector have all played important roles in avoiding and managing indoor air pollution. However, issues like the lack of mandatory IAQ standards, the lack of regulation and labeling of pollutant emissions from indoor decorating and refurbishing materials, the lack of an effective performance evaluation system for air cleaning products, and the lack of proper air cleaner maintenance must all be addressed in order for IAQ to improve further.

M. Bentayeb et al. discussed about Indoor Air Pollution and respiratory health[10]. There are few studies on the impact of indoor air pollution on the elderly respiratory system. The goal of this review is to provide available epidemiological data to synthesize current understanding on the harmful respiratory consequences of indoor air pollution in those over 65 years old. We selected relevant articles published in English between 1991 and 2011 on the respiratory health consequences of indoor air pollution in elderly (>65 years) using the MEDLINE database via PubMed. A total of 61 studies were found, and 33 relevant publications were chosen after applying the following inclusion criteria: I epidemiologic studies published in English in peer-reviewed journals between January 1991 and December 2011, (ii) study population aged 65 or older, and (iii) outcome of respiratory symptoms and disease excluding lung cancer. The majority of studies found links between major indoor air pollutants and different short- and long-term respiratory health outcomes including wheezing, dyspnea, cough, phlegm, asthma, COPD, lung cancer, and, more infrequently, lung function loss. Chronic obstructive pulmonary disease (COPD) and ambient cigarette smoke have the most consistent connection (ETS). In order to establish causal connections between exposures to indoor air pollution and underlying processes in this sub-population, further research in the senior population is required.

DISCUSSION

Indoor air pollution is the deterioration of indoor air quality caused by hazardous chemicals and other elements, and it may be up to ten times more damaging than outside air pollution. According to statistics, the health effects of interior air pollution significantly exceed those of outdoor air pollution in developing nations. Excess moisture, volatile organic compounds, carbon monoxide, and radon are four significant indoor air contaminants, according to the Environmental Protection Agency. The majority of indoor air pollution is caused by sources that emit gases or particles into the atmosphere. Pollution is continuously released by things like construction materials and air fresheners. Indoor pollution is also caused by other sources such as cigarette smoke and wood-burning stoves. Some contaminants in indoor air have been present for a long time. By not smoking inside and keeping craft materials in well-ventilated locations, you may help the environment. Ensure that your gas stove is well-ventilated, and keep clutter to a minimum to avoid interior air pollution.

CONCLUSION

To summarize, contaminants in the indoor air environment have a major role in the development of human illnesses. PM, VOCs, CO, CO_2, ozone, radon, heavy metals, aerosols, pesticides, biological allergens, and microbes are just a few of the indoor air pollutants that may cause poor indoor air quality and therefore damage human health. The majority of these pollutants come from two primary sources: I human activity in buildings, such as combustion, cleaning, the use of certain building materials during construction or restoration, and the operation of electronic equipment; and (ii) transportation from outside sources. Even though these pollutants are often present in low quantities in buildings, long-term exposure may pose serious health concerns. Sick building syndrome (SBS) and building-related disease are the two most common types of building-related illness (BRI). Many methods and procedures for the management and reduction of pollutant concentrations have been adopted to minimize IAP's effects. The development of improved materials for sensors, IAQ-monitoring systems, and the smart home is anticipated to be useful in the future for the control and improvement of IAQ.

REFERENCES

1. H. J. Qu, H. P. Qin, T. T. Yao, and S. J. Luan, "Validation of a prediction method for indoor air pollution," *Huanjing Kexue/Environmental Sci.*, 2008.

2. B. Barnes, A. Mathee, E. Thomas, and N. Bruce, "Household energy, indoor air pollution and child respiratory health in South Africa," *J. Energy South. Africa*, 2009, doi: 10.17159/2413-3051/2009/v20i1a3296.

3. J. W. Peabody *et al.*, "Indoor air pollution in rural China: Cooking fuels, stoves, and health status," *Arch. Environ. Occup. Heal.*, 2005, doi: 10.3200/AEOH.60.2.86-95.

4. Y. Han, N. Zhu, N. Lu, J. Chen, and Y. Ding, "The sources and health impacts of indoor air pollution," 2010, doi: 10.1109/ICBBE.2010.5515150.

5. A. Stanković, M. Nikolić, and M. Arandjelovič, "Effects of indoor air pollution on respiratory symptoms of non-smoking women in Niš, Serbia," *Multidiscip. Respir. Med.*, 2011, doi: 10.1186/2049-6958-6-6-351.

6. J. Zhang and K. R. Smith, "Indoor air pollution: A global health concern," *British Medical Bulletin*. 2003, doi: 10.1093/bmb/ldg029.

7. T. Chen and H. Liao, "The Disease Burden of Indoor Air Pollution From Solid Fuel Use in China," *Asia-Pacific J. Public Heal.*, 2018, doi: 10.1177/1010539518761481.

8. Max Roser and Hannah Ritchie, "Indoor Air Pollution - Our World in Data," *"Indoor Air Pollution". Published online at OurWorldInData.org*. 2018.

9. J. Hao, T. Zhu, and X. Fan, "Indoor air pollution and its control in China," in *Handbook of Environmental Chemistry*, 2018.

10. M. Bentayeb *et al.*, "Indoor air pollution and respiratory health in the elderly," *J. Environ. Sci. Heal. - Part A Toxic/Hazardous Subst. Environ. Eng.*, 2013, doi: 10.1080/10934529.2013.826052.