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CONCENTRATION OF PARTICULATE MATTER AND ITS ENVIRONMENTAL IMPACTS: A LITERATURE REVIEW OF IRAQ'S AIR QUALITY

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ABSTRACT
Particulate matter (PM) is one of the most contaminants that has a greater influence on health than the others. Each chemical component of PM has a unique toxicity, which might change depending on the time of day and location. According to many research on PM, the relationship between PM and morbidity and mortality varies depending on the location. This article reviews some of Iraqi studies that have examined the subject of particulate matter. The latest findings indicate a rise in the concentration of suspended particles in the air of Iraq due to activities such as burning fossil fuels, electricity generation, transportation, industrial processes like cement manufacturing, the re-suspension of dust caused by wind and dust storms. These factors also pose a potential risk for various diseases including cancer, respiratory disorders, and cardiovascular diseases. It is also detrimental to plants.

KEYWORDS: Air Quality, Contaminants, Particulate Matter.

INTRODUCTION

Unpolluted air is considered crucial for the physical and mental wellness of humans. Nevertheless, air pollution remains a significant threat to world health. The World Health Organisation (WHO) has estimated that the impact of urban outdoor and indoor air pollution, which includes heart or lung illness and respiratory damage, is responsible for about 2 million premature deaths annually. Nearly half of all illnesses are caused by individuals living in underdeveloped countries, thus they are borne mostly by them.

Common air pollutants found globally include particulate matter (PM) such as PM10 and PM2.5, ozone, carbon monoxide, sulphur dioxide, and nitrogen oxides.[1] Particulate matter is one of these contaminants that has a greater influence on health than the others.[2] Seasons and locales have an impact on the makeup of ambient particulate matter.[3] It is composed of components such as carbon (OC), elemental carbon (EC), nitrate, sulfate, and trace metals (iron, vanadium, nickel). Based on particular local and regional sources, such as road or soil dust vehicle emissions, biomass burning, sea salt spray, and wildfires, these components show temporal fluctuations.[4]

Each chemical component of PM has a unique toxicity, which might change depending on the time of day and location. According to multicity research on PM, the relationship between PM and morbidity and mortality varies depending on the location[5], and variations in chemical composition are partly responsible for this variance. Therefore, it remains unclear if some PM components are more concerning for public health than others. In addition to endangering the health of people and animals, these pollutants also pose a threat to plant life everywhere.[6]

Particulate matter classification and source

Particulate matter (PM) comes in two varieties: coarse and fine. PM2.5 is typically the only particle that comes to mind when we discuss tiny particles. Conversely, particles with a size between 2.5 µm and 10 µm, known as PM2.5 and PM10 respectively, are classified as coarse particles. The relative diameters of PM10 and PM2.5 particles as shown in, 'Fig. 2'; the combined term for these two types of particles is total suspended particles (TSP).[7] Being exposed to air with a high concentration of particles, particularly PM2.5, can be highly detrimental to human health. These particles have the ability to penetrate our respiratory systems deeply and can lead to physiological damage.

In cities, PM is emitted from a multitude of sources. Power plants, manufacturing, and vehicle exhaust that burns fuel are sources of fine particle pollution. Coarse

particles originate from several sources such as road debris, construction dust, and wind-blown dust. Certain substances, including black carbon, are emitted directly into the atmosphere from their original sources. These substances are known as primary pollutants. Nevertheless, additional contaminants, such as sulphur dioxide (SO2), nitrogen oxides (NOx), and volatile organic compounds (VOCs), have the ability to chemically interact with existing primary pollutants present in the atmosphere, resulting in the formation of fine particles known as secondary aerosols.[8]

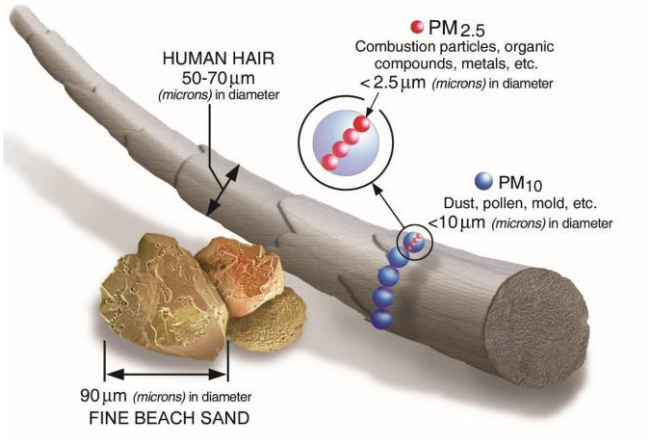

Fig. 1: A comparison of the particle sizes.

The transportation and energy generation industries, especially local generators, are major sources of air pollution in Iraq, which exacerbates environmental problems.[9] Furthermore, natural gas produced by the ongoing burning of oil fields contributes to emissions and is linked to Iraq's deteriorating air quality. The deterioration of air quality is associated with various reasons, such as the utilization of low-quality fuel in transportation, power generation, and industrial activities; emissions from industrial facilities; dust storms; the incineration of waste; and a rise in unauthorized logging. According to reports, Baghdad is the second-largest metropolis in the Middle East. The air quality in that location has experienced a substantial deterioration as a result of the elevated levels of airborne particulate matter (PM). The truth is, not much is known about PM's beginnings in this city. As a result, the lack of information makes it more difficult to create management strategies that would reduce air pollution.[10]

Concentrations of particulate matter and environmental impacts

PM2.5 is the main kind of particulate matter pollution. Because of its small particle size, PM2.5 may stay in the environment for long periods of time and enter the lungs by inhalation. PM2.5 that has been deposited may cross the blood barrier, enter the circulatory system, and then operate on many organs and systems, causing injury to one's health.[11]

Multiple studies have demonstrated that particulate matter (PM) can cause damage to various organs and systems, such as the immune system, nervous system, digestive system, respiratory system, and reproductive system. Additionally, PM has both immediate and long-lasting negative effects on human health. Plants are essential to maintaining ecological balance because they create a clean, favorable environment for human habitation. They function as the respiratory system's main oxygen centers globally. They consistently provide us with substantial quantities of complimentary oxygen.[12]

Local air pollution has a significant impact on native plant species, making it a prominent environmental concern in the area. The impact of air pollution on plants and animals is influenced by the physiological and chemical characteristics of the pollution, as well as the duration of its presence in the atmosphere.[13] The majority of them exhibit physiological alterations before any observable damage to the leaves occurs.[14] The study utilized various physiological data, including the concentration of ascorbic acid, the total chlorophyll content in the leaves, the pH of the plant extract, and the relative water content in the leaves.[15] 'Table 1' presents the overall concentration of total suspended particles in several cities in Iraq, as reported in the Al-Kasser investigation conducted in 2021.[16]

Table 1: Concentration of total suspended particles in Iraq from 2012 to 2020.

TSP (µg/m^3)	Site	Year
3555.6	Kirkuk	2012
2241.37	Baghdad	2012
3223.24	Daura	2014

1400	Baghdad	2015
9480.17	Al Najaf	2015
3985	Baiji	2016
4000	Baiji	2016
317	Baghdad	2016
510.2	Maysan	2018
2098	Baghdad	2018
4397.57	Karbala	2018
6609.68	Baghdad	2018
1807.28	Al-Diwaniyah	2018
114.94	Karbala	2018
757.02	Babylon	2019
1798.1	Al Najaf	2020
4787.6	Wasit	2020

In one of his research, Al-Dulaimi (2021) examined the potential hazards associated with the exposure of Iraqi cement workers to various sizes of particulate matter, including PM1, PM2.5, PM7, PM10, and TSP. The findings demonstrated that the levels of PM2.5 and PM10 were higher than those allowed by the National Ambient Air Quality Standards. The blood parameters and levels of tumour necrosis factor (TNF-α) in the exposed personnel were markedly elevated compared to the control group.[17]

During a distinct inquiry spanning from September 2019 to August 2020, the levels of PM10 and PM2.5 were observed and examined in four cities in Iraq (Al-Najaf, Al-Muthanna, Maysan, and Kirkuk), along with PM2.5 in Baghdad. The purpose was to determine the relative risk (RR) associated with prolonged exposure to PM2.5 and its impact on public health. The study evaluated the comparative risks of death from lung cancer, ischemic heart disease, stroke, acute lower respiratory illness, and chronic obstructive pulmonary disease in each of the five cities. Out of all the cities that are being examined, Baghdad has the highest mortality rate from lung cancer due to PM2.5 exposure.[18] Furthermore, the stations in Baghdad have not complied with Iraqi and World Health Organization (WHO) limits on the amount of Total Suspended Particles (TSP) in the air.[19]

A study that assessed the level of suspended particulate matter in the surrounding air at several Baghdad City areas found that it was 585.1 μgm^{-3}. The Air Pollution Tolerance Index (APTI) values for four plant species, namely Olea europaea L., Albizia lebbeck (L.) Benth., Ziziphus spina-Christi (L.) Desf., and Eucalyptus camaldulensis Dehnh, can be estimated using four biochemical parameters: pH, ascorbic acid concentration, total chlorophyll content, and relative water content of plant leaves. All plant species assessed in polluted areas had elevated values for each of the four-air pollution-related metrics, in comparison to samples from the control site. These factors can be used to characterize the kind and level of tolerance that these plants display.[15] Al-Obaidy *et al*., 2019 showed that, in comparison to the Baghdad tourist island, the average concentration of PM (480.80 $\mu g/m^3$) and all other air pollutants increased in the four study locations. Seven distinct plant species' leaf responses to air pollution were also investigated. *Eucalyptus camaldulensis* leaves had the biggest rate of leaf length (11.03) cm, whereas *Albizia lebbeck* leaves had the highest rate of leaf width (5.51) cm and leaf area (49.63) cm^2. *A. lebbeck* leaves had the greatest number of stomata and epidermal cells, with counts of 101.25 and 738.85, respectively. The leaves of *Dodonaea viscasa* had the highest stomatal index value, which was 14.21.[20]

CONCLUSIONS

The current study, after thoroughly examining multiple Iraqi studies on particulate matter, concludes that the burning of fossil fuels, electricity production, transportation, industrial processes like cement manufacturing, wind-induced dust resuspension, and dust storms contribute to an elevated level of suspended particles in the air. This increase in particulate matter poses a potential risk for various diseases, including cancer, respiratory disorders, and cardiovascular diseases. Furthermore, it has a negative impact on plants.

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