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Role of Particulate Matter in Air Pollution and Its Effect Due to Medical Waste

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ABSTRACT

Human activities influence the environment and environment affects the health of humans. Both are interlinked with each other. Environment has mainly two components, biotic and abiotic. Biotic components consist of microorganisms and living organisms. Abiotic component has three sub components. One of them is atmosphere, another one is Lithosphere and third one is hydrosphere. Environmental pollution can be termed as the introduction of substances, harmful to human beings and other living organisms, into the environment. The pollutants may be solids, liquids or gases which are present in concentration higher than the usual concentration which reduces the quality of the environment. In this paper we present about the role of particulate matter in air pollution and its effects due to medical waste.

Keywords : Particulate Matter, PM2.5, PM10, Medical Waste.

I. INTRODUCTION

The three main pollutions are water pollution, soil pollution and air pollution. Recently air pollution has attracted utmost attention as evidenced by extensive studies going on in the field. Industrialization, urbanisation and changing lifestyle have polluted the air to such an extent that ninety percent of human are forced to inhale polluted air. Even short-term exposure to polluted air leads to diseases such as coughing, asthma, wheezing, COPD, respiratory disorders, shortness of breath and so on. This is indicated by high rate of hospitalisation. Long term exposures are even more disastrous. The situation has not deteriorated in a short time. Nature is giving warning signals at regular intervals but humans have behaved as deaf. Consequently, the situations have become so worst that there is no way out.

II. REVIEW

Air pollution is a complicated phenomenon. Introduction of particulate components or a mixture of toxic gases into clean air which have detrimental effects on human health is called air contamination. Composition of pollutants depends on its source. Studies across the globe have shown that air pollution increases mortality as well as morbidity. Clinical research has shown that PM has deleterious effects of wider range in comparison to gaseous components of pollution. The cardiovascular system is affected significantly by PM air pollution. It enhances the death risk. Heart failure, thrombotic stroke, and ischemic heart diseases are some common examples. Endocrine disruption is also caused by air pollution. Air pollution also contributes to metabolic disorders such as diabetes, mellitus, and obesity. The acceptance of epidemiological evidence for the detrimental effects of air pollution is on the rise. The mechanisms of toxic effects of PM pollution are also being clearer. This understanding is essential to minimize and prevent the bad effects of PM air pollution. Mortality is expected to get doubled by 2050 if the present trends of air pollution continue. Millions of deaths are caused per year [1-3]. Some of the major factors responsible for such deaths are low physical activity, high cholesterol, drug abuse and air pollution. Air pollution causes deaths via cardiovascular diseases such as acute thrombotic/ischemic events. Air pollution also reduces worker productivity [4] and number of healthy life years. The air pollution is higher in developed countries due to emissions of toxic gases from industries but effects of these pollution also harm nearby developing/underdeveloped countries [5-7]. The mechanism by which air pollution induces cardiovascular diseases has been studied [8-14]. Air pollutants having detrimental effects on respiratory and cardiovascular systems is a complex mixture of particulate and gaseous components. Source of pollutants, sunlight, weather conditions, wind direction, and emission rate are some of the important factors of air pollution. Nitric oxide NO, nitrogen dioxide NO_2, sulfur dioxide SO_2, carbon monoxide CO and ozone O_3 are the important gaseous components of particulate matter [15-16] . Volatile organic chemicals (VOCs) are absorbed on carbonaceous particles and constitute polluting particulate matter. Many reactive metals like copper, iron, zinc, nickel or vanadium are also associated with these droplets [17]. Classification of particulate matter is done on the basis of particle size. Division is made into three categories namely PM0.1, PM2.5 and PM10 depending on diameters of the particles as 0.1, 2.5 and 10 micrometers respectively. They are also called ultra fine, fine or coarse particles respectively. Natural industrial sources produce coarse particles which generally do not penetrate the upper bronchus. Combustion of fossil fuels produces fine and ultrafine particles which pose a greater threat to health as they penetrate small airways and alveoli [18-19]. Metal and organic components of particles vary with location but the correlation between PM2.5 levels and negative cardiovascular outcomes is independent of location.

III.MATERIALS AND METHODS

PM10 and PM 2.5

In the present millennium, extensive and increasing applications of PM10 and PM 2.5 indicators have been used for I – O pollution studies. Significant difference in outdoor and indoor environments regarding PM10 PM 2.5 mass concentration. Chatout Sidou et al and Dipouli et al have reported higher concentrations of PM particles in outdoor environments than in indoor environments [20]. Vicente et al compared indoor pollution between working and nonworking hours and found that pollution during working hours is much higher than the nonworking hours. A study to differentiate between occupancy and no occupancy was conducted by Branis et al by using sampling techniques of different kinds [21]. Several similar studies have also been done [22]. It was found that indoor pollution is higher in restaurants, dormitories, and classrooms in comparison to supermarkets, computer rooms, offices, and libraries [22]. Studies on air pollution due to less Frequently adopted particles such as PM5, PM4, PM2, and PM1 have alsobeen carried out [23-25].

Methods

There were three parts to this study:

1) an air quality perceptions survey;
2) an evaluation of PM; and
3) a comparison of air quality perceptions with AQI scores as calculated from measured PM.

A survey was distributed to understand the perceptions and concerns of Chapra Town residents and workers related to air quality. In addition, PM concentrations (PM2.5, PM10) were measured over a one- month period from two locations within Chapra Town. The daily mean PM concentrations (μg/m3) were used to calculate an AQI score and compare with perceived air quality.

Design

The perceptions of air quality among Chapra Town residents and workers in this study were examined with the use of a descriptive survey design.

Participants

The inclusion criteria for survey participants were those who are able to read and write in English, work or live in Chapra Town, and are 18 years of age or older.

Measure

The ten to fifteen-minute survey asked participants a total of 29 questions including two qualifying questions, eleven demographic questions, as well as seven questions on air perceptions, three on informational sources, two on daily outdoor activities, three on health effects related to poor air quality, and any additional comments. Twenty-four of these questions were in a closed-ended format and five of these questions were in an open-ended format. Survey questions were adopted on the basis of those used in two previous research studies (Brown et al., 2016; Reames & Bravo, 2019). The survey conducted by Brown *et. al.* (2016) was developed and conducted alongside a Community Advisory Group who supported the argument that research was needed to address air quality as a primary concern; survey question development; guidance for recruiting participants; and interpretation of results. Reames and Bravo (2019) assessed survey responses from the MARC Annual Air Quality Public Awareness Surveys between 2009 and 2012. Some of the questions used from these studies were revised to improve readability and applicability to the Chapra Town area.

Procedure

Following University Institutional Review Board approval, the survey and cover letter were made available via Quadratics, an online survey platform, during September 2022. A cover letter was provided to explain the details of the survey and consent was given after the respondent agreed they were over the age of 18 and they lived or worked in Chapra Town. Participants were asked to rate the air quality during the month of August because ozone is the highest in the summer and residents and workers spend more time outdoors. Participants were recruited through the distribution of postcards at outdoor malls, parks and libraries. The postcard included a QR code with a link to the Qualtrics survey. Additionally, an email blast with a link to the survey was sent to faculty, staff, and students of one college at a state university. Finally, a link to the survey was posted on various social media group sites.

IV. RESULTS AND DISCUSSION

Survey data were downloaded from Qualtrics and uploaded into SPSS 26. The data were summarized using descriptive statistics (e.g. means, frequencies).

Preparation of Master chart and interpretation of data

The information in this chapter includes the survey data collected in September 2023 related to perceptions of air quality in August and the air sampling data collected in August 2023. The results for the survey are presented. The air sampling results are found, and compares the calculated AQI and perceptions of air quality.

Effect of the Medical Waste on Air Quality

Tables-1 and 2 present the beliefs participants had about the effects of Medical Waste on air quality. When asked about direct effects of the Medical Waste, many of the participants (62.6%) reported they thought the air quality was the same in Chapra Town as before the pandemic. However, just over half (54.0%) reported Medical Waste indirectly made the air quality somewhat better in Chapra Town.

Table-1: Direct and Indirect Effects of Medical Waste on Air Quality in Chapra Town of Bihar

Effect	Direct Effect		Indirect Effect	
	n	Percent (%)*	n	Percent (%)*
Much worse	3	1.7	3	1.7
Somewhat worse	19	10.9	18	10.3
The same	**109**	**62.6**	56	30.9
Somewhat better	43	24.7	**94**	**54.0**
Much better	0	0.0	3	1.7

*valid percentage reported to account for missing data

About one third of the participants (32.6%) thought the Medical Waste moderately affected the air quality in other locations around the Bihar.

Table-2: Effect of Medical Waste in Other Locations in Chapra Town of Bihar

Effect	n	Percent (%)*
Extremely	15	8.6
Very much	45	25.9
Moderately	**59**	**32.6**
Slightly	33	12.6
Not at all	22	12.2

*valid percentage reported to account for missing data

Impact of Air Quality on Daily Activities

Table-3 summarizes the likelihood a respondent would adjust their daily activities if they knew the air quality was "bad or unhealthy." Participants reported they were likely to change their daily activities by staying inside with the windows and doors closed (35.3%) and limiting their outdoor daily activities such as work

(35.3%), exercise/sports (34.7%), and hobbies (32.9%). An example of an "other" daily activity they adjusted was driving less when they knew the air quality was bad or unhealthy.

Activity	Very unlikely n (%)*	Unlikely n (%)*	I'm not sure n (%)*	Likely n (%)*	Very likely n (%)*
Exercise or play sports less outside	18 (10.4)	45 (26.0)	24 (13.9)	**60 (34.7)**	26 (15.0)
Do less hobbies outside (e.g. gardening)	21 (12.1)	54 (31.2)	16 (9.2)	**57 (32.9)**	25 (14.5)
Work outside less	16 (9.2)	51 (29.5)	16 (9.2)	**60 (34.7)**	30 (17.3)
Stay inside with windows and doors closed	24 (13.9)	33 (19.1)	15 (8.7)	**61 (35.3)**	40 (23.1)
Other	9 (22.5)	5 (12.5)	21 (52.5)	3 (7.5)	2 (5.0)

*valid percentage reported to account for missing data

Table 3: Likelihood of Adjusting Daily Activities

Correlation Between PM2.5 and PM10 at Each Site

PM2.5 and PM10 are highly correlated as shown in Figures 2 and 3. This indicates the smaller particles (PM2.5) are contributing more to the overall PM mass. Subsequently, PM2.5 concentrations will only be presented in the remaining chapter.

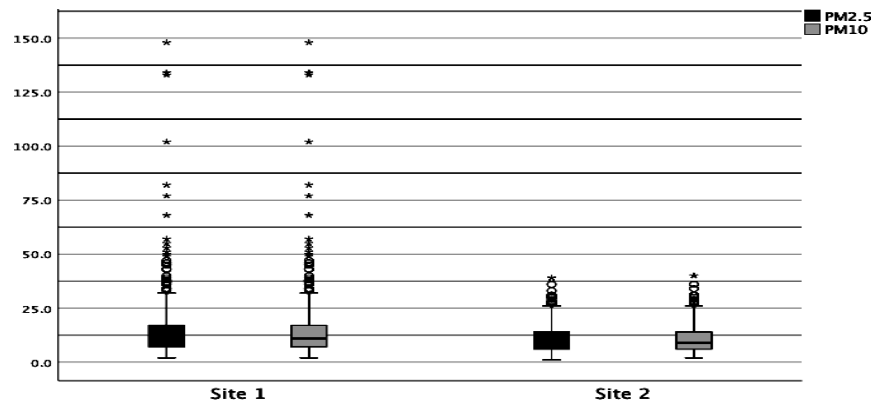

Figure 1: Boxplot of PM2.5 and PM10 Levels by Sampling Site

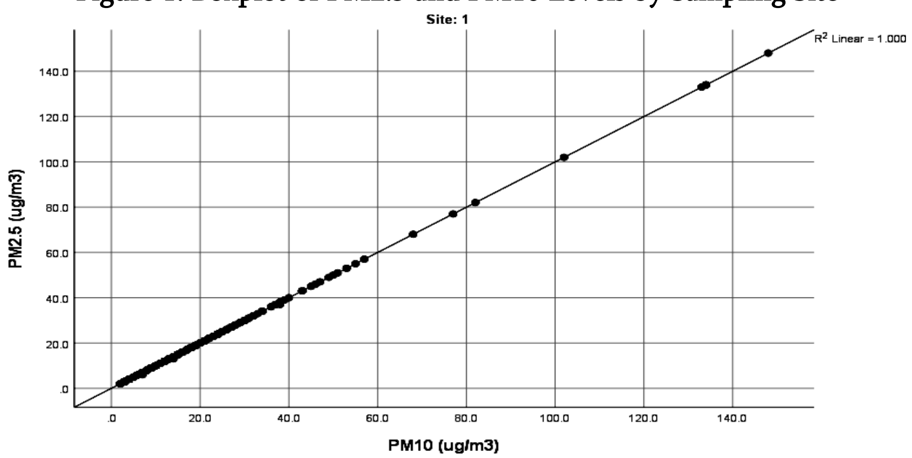

Figure 2: Linear Regression of PM2.5 and PM10 Levels measured at Site 1

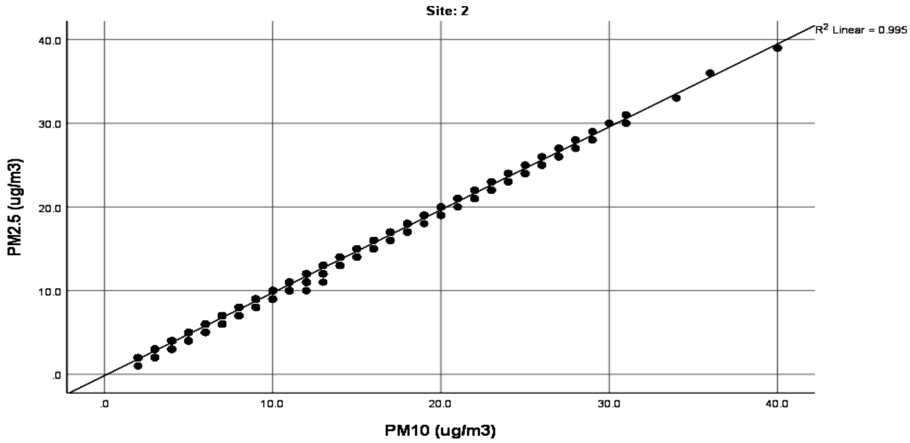

Figure 3: Linear Regression of PM2.5 and PM10 Levels measured at Site 2

V. CONCLUSIONS

The majority of participants perceived the air quality in Chapra Town as either unhealthy for sensitive groups (41.0%) or moderate (39.9%). Chapra Town residents and workers identified sources of air pollution as factories, manufacturing companies, and cars (all LMV) and trucks (all HMV). Approximately 40% of participants thought they had, or their family members had health problems exacerbated by poor air quality. The EPA, University researchers, and News media (television, radio, and newspaper) were the top credible information sources related to air quality.The evaluation of PM revealed that smaller particles contributed more to the overall concentration. PM2.5 was statistically different ($p < 0.001$) between sampling Site 1 (14.2 $\mu g/m^3$) and sampling Site 2 (10.3 $\mu g/m^3$). These differences may be attributed to their geographic location.

The calculated AQI categories for air quality were moderate for Site 1 and good for Site 2. AQI values were better than the perceptions of the residents and workers in Chapra Town. An understanding of the perceptions of air quality among residents and workers in Chapra Town, including the relationship to measured PM or AQI, may assist local agencies or communities with air quality management. Based on the results of this study, air quality does not appear to be a major problem in Chapra Town and existing campaigns to reduce air pollution and increase awareness of its health impacts may have had positive outcomes and should be continued.

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