ORIGINAL ARTICLE

The Injurious Particulate matter Concentrations in the Atmosphere in Lahore

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ABSTRACT

Aim: Measurement of various particulate matter levels in some areas of Lahore and to ascertain if they are within the world recommended levels.
Study design: This was a cross sectional study to measure the particulate matter concentration in 24 hours.
Place and duration: The study was conducted in Lahore at various areas which were logistically convenient to the authors.
Methodology: A monitoring electronic device was used to measure PM2.5, PM1 and PM 10 in some areas of Lahore.
Results: The average concentration of all particulate matters measured were very high beyond the levels recommended by the WHO.
Conclusion: All the measured particulate matters concentrations in Lahore were too high (average PM2.5 -79.43 µg/m3) as compared to the WHO recommended levels (25 µg/m3) in a 24 hour period and can predispose to serious respiratory and cardiovascular diseases
Keywords: Particulate Matter, Particle Size, Environmental Monitoring

INTRODUCTION

Pollution contains particulate matter which is a mixture of solid particles of various sizes and chemical composition and liquid droplets which are just as varied in their chemistry. These particles are very small and much smaller than the diameter of the human hair[1].

These particles are of classified into two main types which is based on their sizes. The finest one is of the size of 2.5 micrometres (0.0025 mm) and are called the "fine" particles. To comprehend the size of these particles, it is helpful to mentally think of them being about 30 times smaller than the diameter of a human hair.

These are the dangerous particles inhaled in a smoke or a haze, such as covers the city of Lahore in highly injurious levels.

The other particles known as PM 10 (10 micrometer) are larger than the PM 2.5 particles, but never the less very minute still. These are present in the wind blown dust.

In order to ascertain their concentrations either in a 24 hour period or in a long term period such as a colander year, the unit used for their concentration present in the air is measured in mass per volume of air- micrograms per cubic meter (µg/m3).

The PM 2.5 and PM 10, are composed of acids (such as of nitrates, sulfates, organic chemicals, metals, soil, dust particles, allergens, pollens or various molds.

Thus, these particles can be liberated from construction sites, unpaved roads, fields, smokestacks or fires, power plants, industries and vehicles[2].

METHODOLOGY

A new specific pollution monitor with multi- item measuring capability was used to measure the particulate matters (PM2.5, PM1,PM10) in the air. The machine was calibrated before every use.

Lahore is a huge city and it is not possible to take readings from every locality or area. A route was decided which was logistically convenient and fairly representative of Lahore including affluent and non-affluent areas and busy and not so busy areas.

For accurate readings the monitor is kept in the open environment for at least 3 minutes so that the surrounding air has a good chance to penetrate the monitor sensor window. The readings were finally tabulated for analysis and discussion.

RESULTS

The Highest concentration of the particulates called the 'fine' particulates were in the areas where it is most expected such as The Data Darbar (90 µg/m3) due to the large number of people that visit the shrine with accompanying 'Chingxie" rickshaws bellowing out smoke and un-burnt fuel from inefficient and un-tuned engines.

The lowest concentration was in the Government Officers Residence 1 which is a strictly gated area and is not a thorough fare and thus is free from heavy traffic, especially the motorcycle rickshaws.

On average, the concentration of the PM2.5 was 79.43 µg/m3, which is way beyond what the WHO or the Environment Protection Agency has recommended. Similarly, PM1 and PM10 were 187 µg/m3 and 244 µg/m3 on average, respectively, again not in the recommended limit zones.

The average concentration of the PM2.5 in the present study falls into the fourth category (40.0–106.9 µg/m3 which is the worst environmental state categorized by the environmental agency of Australia. The WHO recommends 25 µg/m3 as the safe environmental levels of PM2.5 worldwide.

Table 1. Measured levels of various Pollutants.

	PM 2.5 µg/m^3	PM 1 µg/m^3	PM 10 µg/m^3
Jail Road	73	199	265
Ferozepur Road	81	190	164
Lytton Road	80	164	196
MAO College	77	170	223
Kacheri	77	160	200
G.C.U	77	198	253
Data Darbar	90	259	330
Bhati Gate	80	200	268
Shahalami	84	203	247
Bansanwala Bazar	80	185	256
Gawalmandi	85.5	175	232
Lakshmi	80.3	263	340
Montgomery Road	79	200	256
Shimla Pahari	82	189	245
Davis Road	84	182	223
G.O.R 1	61	155	207

DISCUSSION

Pollution is a worldwide problem but the developing world is affected by it more due to defective policies and inefficient infrastructure. The laws which in this Country which are made to safeguard the health of the citizens are present but not implemented.

In 2016 several writ petitions were filed before the Lahore High Court against high levels of smog, air pollution and poor air quality, mainly focussing on Lahore and its vicinity.

The Smog Commission was formulated in Walid Iqbal vs. Federation of Pakistan Writ Petition No. 34789/2016, by Chief Justice Syed Mansoor Ali Shah. Its purpose was to combat smog by formulating policies that would introduce low sulphur fuels, ban the burning of rice stubble, solid waste and other hazardous materials, increase tree plantations alongside planned urban development, and adopt Euro-II standards for vehicular emissions etc.

Many of these policies such as the adoption of Euro Emission Standards for vehicles and the introduction of four stroke CNG rickshaws were highlighted in the earlier case of Mansoor Ali Shah vs. Government of Punjab, PLD 2007 Lah. 403. This case emphasised Pakistan's international obligations under the Stockholm Convention 2001, which is a global treaty to protect the environment and human health from pollution. Pakistan is also party to the 1985 Vienna Convention on Protection of the Ozone Layer and the 1992 United Nations Framework Convention on Climates Change (UNFCCC).

Moreover, apart from international treaty obligations, the case of Ms. Shehla Zia and others v. WAPDA PLD 1994 SC 693 illustrate the importance of the environment as well;

"Article 9 of the Constitution provides that no person shall be deprived of life or liberty save in accordance with law. The word 'life' is very significant as it covers all facts of human existence. The word 'life' has not been defined in the Constitution but it does not mean nor can be restricted only to the vegetative or animal life or mere existence from conception to death…Life includes all such amenities and facilities which a, person born in a free country is entitled to enjoy with dignity, legally and constitutionally. A person is entitled to protection of law from being exposed to hazards of electromagnetic fields or any other such hazards which may be due to installation and construction of any grid station, any factory, power station or, such like installations."

Lastly, the protection of dignity of man is a fundamental right of a Pakistani citizen guaranteed under Article 14 of the Constitution 1973. Both Article 9 and 14 harmonise together to protect the dignity of man from living in a toxic polluted environment

.As far as the PM10 is concerned it is recommended that it should not exceed 50 µg/ m3 in 24 hours or not to be exceeded more than 35 times in a calendar year. 3

The European directive recommends that whenever PM 2.5 is measured for pollution purposes other chemicals should also be measured at the same time such as Sulphates, nitrates And organic carbon compounds.4

Sulphates in PM2.5 are likely to exist in the forms of sulphuric acid, ammonium bisulphate, ammonium sulphate, sodium sulphate and other metal sulphates. These species tend to become mixed with non-sulphate components in atmospheric particles. 5

$PM_{2.5}$ particles result from the burning of fossil fuels (such as coal), organic matter (including wood and grass) and most other materials, such as rubber and plastic. Vehicles, power plant emissions and bushfires are all major sources of fine particles. 6

It is seen by a UK Governmental environmental agency that rural area background particulate matter concentrations effect the PM 2.5 concentration in the urban setting to about 60-80%. Here the PM 2.5 is chemically mostly, ammonium compounds of nitrate and sulphate. 7

It was also discovered that black carbon was the major component of the PM 2.5 associated road traffic emissions and solid fuel used for domestic combustion. Black carbon is a major component of the PM2.5 associated with road traffic emissions and domestic (oil and solid fuel) combustion.

Primary emissions from road traffic make a significant (up to 50%) contribution to the urban background concentration of PM2.5 above the rural concentrations mentioned earlier.

The pedestrians on the pavement are exposed to substantial concentrations of PM 2.5 up to one third of the concentration present on the roads in the vicinity. This effect will be present to up to one meter of the kerb.

The PM 2.5 concentration rises in the evenings as the cooking period arrives (solid fuel combustion) which also contributes to the total urban particulate concentration.

PM2.5 during the evening period, which may be due to solid fuel combustion and particles released during cooking[8].

The World Health Organization has issued guidelines related to the allowable concentrations of various pollutants. In this study which is the first part of two part study, the PM 2.5 and PM 10 are the focus of study. In the second stage of this study various other atmospheric pollutants will be measured as well.

The WHO allows, 25 µg/m3 in a 24-hour mean time period for the PM 2.5 particulates. Whereas for the PM 10 the allowable levels are 50 µg/m3 in a 24-hour mean time period[9].

The WHO aims to reduce the PM2.5 in developing countries from 35 µg/m3 to 20 µg/m3. This will then reduce the pollution related deaths by 15%. The criticalness of the situation in Lahore can be judged by the fact that the PM 2.5 levels measured in the present study in the areas of Gawalmandi and Data Sahib was 85.5 µg/m3 and 90 µg/m3 respectively. These are obviously are way beyond the above recommended levels of 35 µg/m3. But the interesting and more worrying footnote to this is the fact that European cities which are within the recommended levels are also expected to have 8.6 months lower life spans due to exposure to human sources of PM2.5.

Perhaps it will be prudent to revisit the allowable levels of the particulate matters and make their allowable levels more rigid.

As far as the PM10 is concerned it is recommended that it should not exceed 50 µg/ m3 in 24 hours or not to be exceeded more than 35 times in a calendar year.

In the present study, the Air Quality Index remained in the 'Severe" (151-200) and colour code- "Red" which is labeled as the 'unhealthy' limits for most of the localities in a) Lahore, whereas for some like, Data sahib, Lakhshmi, Bhati Gate and Montgomery Road areas the AQI monitor sounded the 'alarm' as the values approached 200-300 (b) colour code- purple) indicating the last level of worst pollution classification of "very unhealthy[10]'.

These particles are a nuisance for the traffic as well as for the aviation industry. The fine particulates are the major source of the 'haze' over the polluted cities of the world especially in the developing world. For the aviation industry they are a source of constant concern regarding delayed flights etc due to reduced visibility.

Particulates can be carried over long distances by the wind and can thus settle down on the ground or water. This can result in various geological and ecological alterations and makes lakes and streams acidic. The composition of the soil, coastal waters rivers and farms become toxic and productivity of these sources diminishes. The effects of acidic waters are well known from fish deaths to crop and human ailments.

Apart from this ecological damage, the particulate matter also damages architecture due to the acid in its water droplets. Old monuments especially made of marble are particularly susceptible.

Humans are affected by these particulates as well. The particulate matter especially the fine particles of 2.5 microns or smaller can get into the inner reaches of the pulmonary tree in the lung.

The vulnerable members of the society especially the very young and the very old are particularly affected by the pollution particles. The over 65s are more susceptible and develop pulmonary and heart problems. The fatalities in the old can occur due to arrhythmias and heart attacks especially in ones who have preexisting coronary artery disease, congestive heart failure, and asthma or chronic obstructive pulmonary disease.

Children are also vulnerable as they have to walk to school next to the toxic fumes on the roads. These children can develop asthma and other respiratory diseases[11,12].

It is seen in studies that long term exposure has its own set of health problems such as bronchitis or even pre mature death. Whereas, short term exposure such as of some hours can make preexisting lung (asthma, bronchitis) or heart (arrhythmias) conditions worse.

Patients can show symptoms of nose, eye and throat irritations such as nasal itching and sneezing with or without a nasal discharge. There can be watery eyes. A chesty cough phlegm may be an indication of tracheal irritation.13

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Evidence from two cohort studies enlisted below demonstrated that long-term exposure to particulate air pollution resulted in increased mortality in U.S. cities.

Dockery et al. (1993) conducted a 20-year prospective cohort study starting in 1974 based on 6 cities (the Harvard Six Cities Study).

Pope et al. (1995) conducted retrospective cohort study involving 156 cities followed by the American Cancer Society (ACS),1982.

The recent evidence however, suggests that both short-term and long-term exposure to particulate air pollution increases mortality[14,15,16].

Investigations of the linings of the lung and fluid of patients with inflammatory diseases (e.g. asthma and cystic fibrosis) showed a lower pH and buffering capacity and a strong associations between long-term exposure to PM2.5 and mortality. Ill health effects can be expected when annual mean concentrations approach the range of 11–15 µg/m3. - this is the annual long term effects of the PM 2.5 levels.

An annual mean PM2.5 concentration of 35 µg/ m3 has been shown to be associated with significant mortality in the developed world.

This American cancer Society's study by noted an association between fine particulate matter in the air and mortality. Their conclusion was that there was a 5% increase of short term mortality. They also suggested that Short term-PM10 concentrations of 150µg/ m3 and PM2.5 concentrations of 75µg/m3 are associated with about a 15% higher long-term mortality risk relative to the air quality guideline levels. 18

CONCLUSION

All the measured particulate matters concentrations in Lahore were too high as compared to the WHO recommended levels and can predispose to serious respiratory and cardiovascular diseases. It is worth stressing the importance of the 'fine' particles in the air which have a tremendous impact not only on the ecology of our country but on the geology as well. It is paramount for very one in the rural or the urban areas to realize the potentially deadly effects of these particles. The city planners and the Government in the shape of the

environment protection department have a significant role to play in strictly implementing the guidelines of the WHO, but also it is the common person's primary responsibility to prevent their children from developing into future patients of allergic rhinitis, asthma and other respiratory diseases. In this study, the areas of Lahore which were under study showed dangerous levels of pollution.

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