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Short Communication

COVID-19 Lockdowns in Industrial Areas and Outdoor Climatology Indices

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Abstract

The study focuses on the ambient air pollutants levels before and during the COVID-19 pandemic in two major industrial estates. The data was collected from different Environmental Protection Agency (EPA) certified laboratories. The results revealed that before the COVID-19 pandemic or lockdown the levels of ambient air pollutants were above the Punjab Environment Quality Standards (PEQs) limit, during lockdown conditions these were within PEQs limits. The change was gradual due to a decline in emissions coming from different sources like vehicles and industries during the period of COVID-19 and limited human movement within the study area. The Sunder Industrial Estate (SIE) was less polluted as compared to Quaid e Azam Industrial Estate (QIE), but in the case of different pollutants, some pollutants in SIE were high compared with QIE. It was observed that the ambient air pollutants meditations will reduce regularly and keep declining to the least limit during the COVID-19 induced lockdowns. In crux, the quality of ambient air in the study area improved notably during the lockdown registering reduced concentrations of NOx, SO_2, SPM, CO, and PM emissions, resulting in health benefits for the population.

Keywords: COVID-19, air pollutants, industrial estates, ambient, emissions

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Introduction

The COVID-19 related restrictions were imposed as a result of the spread of novel coronavirus (SARS-CoV-2) that was first detected and reported in China in December 2019 [1] and declared as a worldwide threat on March 11, 2020, by the World Health Organization [2]. To adapt and control the danger of community-wide transmission at numerous places around the world, lockdown measures were taken confining the movement of people, reduction in vehicle movement, and closing businesses. In a major lockdown (about 14 hours) people were forced on the 22 of March and a short time later followed by two back-to-back main lockdowns first from the 24 of March to 13 of April and second from the 14 of April to 03 of May [3, 4].

Due to the COVID-19 restrictions, the quality of air changed immediately and became another interesting subject to explore and research. Reduction in nitrogen dioxide (NO_2) concentration in mainland China from 10 to 25 February (mostly home isolation period) contrasted with 01 to 20 January 2020 (preceding isolate) were distinguished utilizing satellite data from both the NASA and European Space Agency (ESA) [5]. The outcomes bolster the possibility that air contamination could be significantly improved in urban communities where transport was a significant source [6, 7]. In any state, 1 out of 8 deaths is happened due to air pollution and this may contribute to 2nd major disease burden after hunger. In any case, the lockdown measures in the midst of the plague escort ecological reclamation all the while, and the noteworthy natural medical advantages may decrease the sickness trouble in the future we assume. Ambient air contamination has natural origin points and anthropogenic activities [8-11]. Ambient air pollution is caused due to anthropogenic activities especially fuel combustion from motor vehicles, power generation, heating, and waste incineration/burning [11, 12]. For the past few decades, Pakistan is among the countries that developed rapidly in terms of industry and manufacturing goods which helped raise the living standards. However, this nation paid a heavy price in terms of worsening outdoor and indoor air pollution. For instance, according to the data reported by Word Air (2018), two of Pakistan's major cities were among the top 30 most polluted places in the world recording about 1,11,000 deaths per year potentially due to the unqualified and poor ambient air quality [13]. Unfortunately, Pakistan is ranked the 2nd most polluted country in the world after Bangladesh with an average emission load of $PM_{2.5}$ of 65.8 μg/m^3 per year [10, 14, 15]. The current study is conducted to identify the difference in ambient air quality attributes during and before lockdown due to the COVID-19 pandemic surrounding the various industrial estates of Lahore. Looking at the current scenario in Pakistan, this research work highlights the importance of variation in ambient air quality indices and the interpretation of community interventions and perceptions using it as a case study.

Materials and Method

Two industrial estates named as site A (SIE) and site B (QIE) are located in Lahore. A survey plan was developed based on defined sampling sites to obtain accuracy and precision in the knowledge of ambient air and its pollutants and considered necessary environmental parameters.

Ambient Air Quality Monitoring

Monitoring of the outdoor air quality at selected sampling sites to analyze the level of priority pollutants in urban areas such as carbon monoxide (CO), nitrogen oxides (NO_x), sulphur dioxide (SO_2), ozone ($O_{3)}$, particulate matter of $PM_{2.5}$ and PM_{10}, and the total suspended particulate (TSP). Representative sampling sites were chosen based on factors including wind speed, wind direction, temperature, and land uses among others. Ambient air quality was measured using instruments wireless single gas detector made by Honey Well. The carbon monoxide, ozone, sulfur dioxide nitric acid, hydrogen fluoride, and nitrogen oxide was measured through ToxiRae Pro and dragger gas detection. The particulate matter was measured using continuous particulate monitoring (CPM) air sampler through the gravimetric sampling technique. The monitoring was carried out for a period of 24 hours. The data was recorded automatically after each 10 min. Carbon monoxide (CO) was monitored using Environmental SA CO12e CO Analyzer which records CO levels using a non-dispersive infrared absorption method. The detection range of the analyzer is 0 to 5000 parts per million. To investigate the temporal change, continuous data for 24 hours was also measured. Oxides of Nitrogen (NO, NO_2,) were monitored by using the Environmental SA AC32e NO_x Analyzer using the chemiluminescence (CLD) technique. The detection limit of the analyzer is 1 ppm. Continuous data were recorded for 24 hours. The SO_2 levels were monitored using Environmental SA AF22e SO_2 Analyzer. The APNA-360 SO_2 analyzer detects SO_2 using an Ultra Violet Fluorescence technique in which SO_2 molecules in the sample are activated by ultraviolet radiation generating a characteristic fluorescence between 220 and 240 nm. This fluorescence is calculated, and the amount of SO_2 is derived from fluorescence intensity variations. The analyzer measurement range is 0-1 ppm. Continuous 24 h data was collected. Surface Ozone measurements are made by thermo scientific model 49 C and I or Two Technologies Model 205 ozone monitors. These instruments are dual cell UV photometers that function on the absorption of UV light by ozone at 254 nm and relate the UV absorption to the ozone concentration following the Beer-Lambert law. The ozone concentration is calculated from the UV light intensities detected from the two cells by comparing the difference in the two cells.

The level of particulate matter in terms of PM_{10} was measured in ambient air using a high-volume air sampler. The determination range of the equipment varies from 2 to 1000 µg/m^3 with a detection limit of 0.5 µg/m^3. PM_{10} sampling was done at the designated sampling location for 24 h 1000 µg/m^3 with the lowest detection range of 0.5 µg/m^3. The study describes the participant's basic knowledge, the general perception of air quality index, exposure, and effects.

Results and Discussion

Results of the ambient air monitoring showed variation for both sites from December 2019 to May 2020. Different ambient air attributes showed variation from the PEQs standards (Table 1). All the measured attributes were above the PEQ's standards except the ozone. During these months, the measured $PM_{2.5}$, PM_{10}, SPM, CO, NO, NO_2, SO_2, and O_3 were within PEQ's limits in Mar., Apr., and May, while in Dec., Jan., and Feb. above the PEQ's Limits. SIE showed the highest values in comparison with QIE except NO which was higher in QIE during Dec. 2019 over SIE.

Results regarding ambient air quality revealed that respondents as literate (76%) and illiterate (22%) persons answered as they know about the ambient air quality, whereas 24% (literate) and 78% (illiterate) respondents don't know about it. Study concerning air pollution. Personal concern on air quality improvement in Lahore during lockdown (e) revealed that respondents as literate (58%) and illiterate (32%) persons answered as they were concerned about it, whereas 42% (literate) and 68% (illiterate) respondents had not any concerns about it.

Results regarding the air pollution effects on the environment and health revealed that respondents as literate (88%) and illiterate (62%) persons answered they know that air pollution causes harmful effects on the environment and health, whereas 12% (literate) and 38% (illiterate) respondents were did not think to feel these effects. Betterment in health due to better inhaling air process during lockdown revealed that respondents as literate (78%) and illiterate (56%) persons answered they feel healthy due to better air they inhale during

Table 1. Ambient air monitoring of experimental sites during 2019-2020.

Parameter µg/m^3		December, 2019		January, 2020		February, 2020	
	PEQs	Site A	Site B	Site A	Site B	Site A	Site B
$PM_{2.5}$	35	40.21	39.32	37.34	36.11	40.24	38.61
PM_{10}	150	179.31	161.00	165.31	163.23	176.74	169.13
SPM	500	357.24	317.14	327.21	310.41	383.43	321.54
CO	05	5.18	5.07	5.74	4.57	6.34	5.17
NO	40	57.13	57.23	59.13	57.87	61.51	59.66
NO_2	80	98.43	95.14	83.13	85.51	87.44	86.89
SO_X as SO_2	120	145.23	142.11	137.72	135.08	140.22	137.18
O_3	130	18.23	18.11	15.27	14.41	17.91	15.21
Parameter µg/m^3		March, 2020		April, 2020		May, 2020	
	PEQs	Site A	Site B	Site A	Site B	Site A	Site B
$PM_{2.5}$	35	26.37	25.23	22.37	21.25	24.21	25.63
PM_{10}	150	97.21	77.78	84.67	82.19	89.94	85.23
SPM	500	271.32	266.08	262.65	264.13	281.15	273.08
CO	05	4.21	4.11	3.84	4.09	4.27	4.11
NO	40	21.05	20.56	20.15	19.58	22.34	21.67
NO_2	80	37.14	36.12	35.27	34.72	37.74	36.98
SO_X as SO_2	120	32.43	31.17	31.72	30.19	33.13	31.24
O_3	130	8.90	8.78	7.88	7.91	10.41	8.30

PM = Particulate Matter, SPM = Suspended, Particulate Matter, CO = Carbon Monoxide, SO_2 = Sulfur Dioxide, NO = Nitrogen Oxide, NO_2 = Nitrogen Dioxide, O_3 = Ozone, Site A = SIE; Site B = QIE; PEQs = Punjab Environmental Quality Standards.

the lockdown, whereas 22% (literate) and 44% (illiterate) respondents didn't feel such kind of improvement.

Up to 2019, climate change significantly affected human living. As industrialization was expanding, hazardous gas emission was increasing on annual basis throughout the world. These gases included CO, NO_x, CO_2, and SO_2. These gases were also added to the air by burning coal and oil in power plants. Increasing vehicle load on roads also imparted a significant amount of these gases to the environment. Only SO_2 causes severe diseases by supporting the inhaling of ultrafine particles to living beings [16]. In the published literature, a correlation between pollution to education, age, and social indicators is reported [17]. On the other hand, some studies reported no gender preference in assessments of environmental concerns [18]. Before lockdown, a decrease in ozone concentrations was related to air quality and the rise in pollutants levels. The concentration of specific pollutants was not only concerned with industrial or vehicle emission, but different meteorological parameters as air circulation between the northern and southern hemisphere, rain fall patterns, solar intensity, sunshine duration also affect pollutant transportation between different cities of even far countries [19]. During COVID-19 disease attack, considerable change in global climate was observed. Drop in vehicle and industry emissions resulted in declined CO and NO_2 concentrations in the air [14]. From January to March 2020, improvement in air quality was observed in the Indian subcontinent. This improvement can be explained by the fact that major industries had stopped working in neighboring countries [20]. An increase of about 15% in the O_3 layer was also reported by different research agencies. In this study even though survey sample was skewed, it should be considered tentatively indicative of public [21]. The results described the opinion of those middle-class persons who are aware with the importance of air pollution in developing countries. The opinions are supported by other studies which are also describing improvements in air quality during lockdown, as in Brazil [22], China [23], India [24], Italy [25], and the USA [26]. COVID-19 lockdown may also be helping to set air quality standards which should be maintained during routine life activities after lockdown throughout the world [27]. The ambient air quality guidelines of WHO are [(carbon monoxide = 30 mg/m^3 (I hour) and 10 mg/m^3 (24 hours); nitric oxide = 20 µg/m^3; nitrogen dioxide = 40 µg/m^3 (yearly average); sulphur dioxide = 125 µg/m^3 (24 hours); ozone = 150-200 µg/m^3; PM_{10} = 50 µg/m^3 (24 hours); $PM_{2.5}$ = 25 µg/m^3 (24 hours)] and the standards for suspended particulate matter (SPM) are currently not available [28]. The air quality standards by the European Union (UN) are [(carbon monoxide = 10 mg/m^3 (8 h); nitrogen dioxide = 200 µg m^{-3}(1 h) and 40 ng m^{-3} (1 year); Sulphur dioxide = 350 µg/m^3 (1 h) and 125µg/m^3 (24 h); ozone = 120 µg/m^3 (8 h); PM_{10} = 50 µg/m^3 (24 h) and 50 µg/m^3 (1 year); $PM_{2.5}$ = 25 µg/m^3 (1 year)] and the standards for nitric oxide (NO) and suspended particulate matter (SPM) are currently not available [29].

Since the last decade, major governmental policies are seeking to control air pollution by decreasing emission amounts and gradually raising energy efficiency standards. Long-term policies on air pollution control are essential to precisely detect changes in their applications ascribed to new interventions.

Conclusion

This study highlights the changes in ambient air quality with literate and illiterate community perceptions of air pollution in two major industrial estates. Significant variation in ambient air quality was noticed from Dec. 2019 to May 2020. It is observed that there is a large variation in approach to monitoring air quality changes during the lockdown, and pre- and post-lockdown restrictions varied among researchers, and in general, most countries reported a significant reduction in the concentration of major urban pollutants such as SO_2, NOx, CO, PMs, and SPM that is most likely attributed to lower contribution by vehicular and industrial emission. People residing in these estates are exposed to better air quality concerning the commencement of pandemic-induced mitigation actions. Consequently, an integrated assessment approach to exposure to atmospheric pollutants in both indoor and outdoor settings is required in the management of maintaining air quality and the reduction of health-related risks.

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Conflict of Interest

The authors declare no conflict of interest.

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