Scientific Research Publishing

Journal of Geoscience and Environment Protection, 2021, 9, 110-123
https://www.scirp.org/journal/gep
ISSN Online: 2327-4344
ISSN Print: 2327-4336

Short-Term Air Quality Gains of COVID-19 Pandemic Lockdown of Port Harcourt, Nigeria

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How to cite this paper: Adeyemi, A. J., Kanee, R. B., Edokpa, D. O., & Ede, P. N. (2021). Short-Term Air Quality Gains of COVID-19 Pandemic Lockdown of Port Harcourt, Nigeria. *Journal of Geoscience and Environment Protection, 9,* 110-123.
https://doi.org/10.4236/gep.2021.92007

Received: September 22, 2020
Accepted: February 17, 2021
Published: February 20, 2021

Abstract

The air quality index (AQI) of a location informs how clean or unhealthy the ambient air is. While COVID-19 pandemic on one hand threatened the health of mankind globally, on the other hand was a respite to poor air quality of most cities. This study evaluated the positive effects of the brief COVID-19 lockdown on the air quality of Port Harcourt city, Nigeria. Air quality parameters aimed at assessing air quality index of Port Harcourt Metropolis before, during and after COVID-19 pandemic lockdown were monitored and compared. Data were analysed and AQI of sampled locations computed using the US EPA recommended standard procedure. Results from the study showed that, the ambient air quality of Port Harcourt was hazardous for breathing before lockdown. During shutdown of activities, the air quality improved to unhealthy status, with an average reduction AQI of 261.7 points. However, an average increase of 100.7 points, resulting to very unhealthy air status for residents after lockdown was observed. The unhealthy status during lockdown shows that anthropogenic activities were still on despite the Pandemic shutdown of economic activities. Also, decrease in levels of the criteria air pollutants was observed. Before lock down, the range levels of SO_3, NO_2, CO, O_3, $PM_{2.5}$ and PM_{10} were <0.1 - 1.2 ppm, <0.1 - 0.1 ppm, 8 - 28 ppm, <0.1 ppm, 20 - 140 μg/m^3, 15 - 135 μg/m^3, respectively. In the period of lockdown, the levels reduced considerably, especially CO and $PM_{2.5}$ and PM_{10} (1 - 12 ppm, 5 - 60 μg/m^3, and 10 - 50 μg/ m^3). Conversely, after lockdown, there was upsurge in levels of the pollutants, especially CO and $PM_{2.5}$ and PM_{10} (4 - 16 ppm, 10 - 110 μg/m^3, 10 - 90 μg/m^3). Authorities are expected to establish routine air quality measurements stations and communicate daily air quality to residents, for public health precaution purposes. Shutdown of industrial activities instituted by Government in curtailing the surge of COVID-19 pandemic could likely be a novel environmental model for mitigating air pollution in highly hazardous air pollution emergency domains.

Keywords

Air Quality Index, Air Pollution, COVID-19 Pandemic, Lockdown, Port Harcourt

1. Introduction

Coronavirus disease 2019 (COVID-19) is a highly infectious and communicable disease caused by the recently discovered coronavirus, which arose from severe acute respiratory syndrome coronavirus 2 (SARS-COV-2) infection (WHO, 2020; Zhou et al., 2020). With the outbreak observed in December 2019 in Wuhan, China and WHO declaring it a pandemic on 11 March 2020 (WHO, 2020), diverse public health emergency measures were invoked. As the number of deaths and infections continued to increase across the world, national, sub-national and city level governments introduced stringent non-pharmaceutical measures such as economic lockdown, travel restrictions and bans, social distancing, shutdown of schools and public activities, isolation, and quarantine as effective response in curbing the spread of the disease (Anderson et al., 2020; Gatto et al., 2020; Gourinchas, 2020; Tobías, 2020; UNESCO, 2020). The lockdown of cities halted industrial and almost all other human economic and social activities (Wang et al., 2020; Bao & Zhang, 2020; Cristina et al., 2020). This study applied the tool of air quality indexing to establish how the restrictive measures that accompanied COVID-19 Pandemic impacted the air quality of Port Harcourt, Nigeria.

The air quality index (AQI) of a location shows the daily air quality and tells how clean or unhealthy the ambient air is, with associated public health concern after breathing unhealthy air (US EPA, 2014). While the trend in morbidity and mortality of COVID-19 continued to rise in most of 2020, the environment was observed to be recovering from long-term air pollution levels (Cristina et al., 2020; Paital, 2020; Arora et al., 2020; Mahato et al., 2020; Yuri et al., 2020). Unlike cities such as Abuja (Kanee et al., 2020a), long before the lockdown of Port Harcourt, residents have been experiencing particulate matter deposits in the form of soot haze on surfaces and black stains in nasal orifices with increasing trends of cardiopulmonary disease and deaths documented (Ede & Edokpa, 2017; Edokpa & Ede, 2019; Yakubu, 2017; Fienemika et al., 2018; RSMENV, 2019; Kanee et al., 2020b).

Air pollution is said to result from diverse sources including petroleum refining and gas flaring, vehicular and traffic emissions, heavy duty and industrial machines incomplete combustions, open waste burnings, biomass, etc. (Augustine, 2012; Ladan, 2013; Taiwo, 2016; Abowei & Tawari, 2012; Guo et al., 2018; Chen et al., 2017; Fu & Gu, 2017; RSMENV, 2019). Adverse effects on human health have been strongly associated with poor air quality especially among vulnerable population like children and population in petroleum industrial ecology (Mudu, Terracini, & Martuzzi, 2014; Maduka & Tobin-West, 2017; Fienemika et al., 2018; Oliveira, Slezakova et al., 2019; Broekstra et al., 2019). During the lockdown, some anthropogenic activities known to generate pollution were suspended which could be responsible for observed decline in ambient air pollution across cities all over (Bao & Zhang, 2020; Asumadu et al., 2020).

Studies have established a link between higher concentrations of air pollutants and higher risk of COVID-19 infection (Zhou et al., 2020), and this may possibly explain the high number of COVID-19 infection in Port Harcourt relative to other cities in Nigeria. With recorded air quality gains from the lockdown of cities however, mortality from non-communicable disease associated with ambient air pollution in petroleum industrial places have been demonstrated to decline significantly by Gautam (2020). To provide evidence-based data for environmental and public health policies towards the attainment of default clean, healthy and air pollution free environment, the context of pandemic lockdown provides a rare opportunity to assess the effects of industrial and other anthropogenic related activities on air quality of Port Harcourt metropolis. In this study, air quality data before, during and after lockdown were sampled across selected locations of Port Harcourt metropolis and complemented with satellite data and findings extrapolated for possible gains on air quality and the health of residents.

2. Materials and Methods

2.1. Study Design

Routine measurements of air quality parameters across Port Harcourt before, during and after the lockdown of the city were carried out. The measurements were fitted into an air quality index tool in order to establish trends in the healthiness of the city's atmosphere.

2.2. Sampling

Sampling locations were chosen based on a randomised approach. Activity types were however factored into the process because Port Harcourt is a sprawling landscape of over 2.5 million inhabitants. It straddles a core urban area and a conurbation of adjoining towns like Nchia, Oyigbo and Okrika, within which are industrial and commercial layouts; low and high residential areas. The borders of the study area are also surrounded by the activities of artisan refineries which generates black carbon emissions locally known as "soot" that infiltrate the boundary layer atmosphere of Port Harcourt. Sampling sites established before the lockdown were leveraged although research team's level of access into some neighbourhoods in view of imposed movement restrictions during the lockdown was sometimes challenging. **Figure 1** shows the sampled locations across Port Harcourt metropolis.

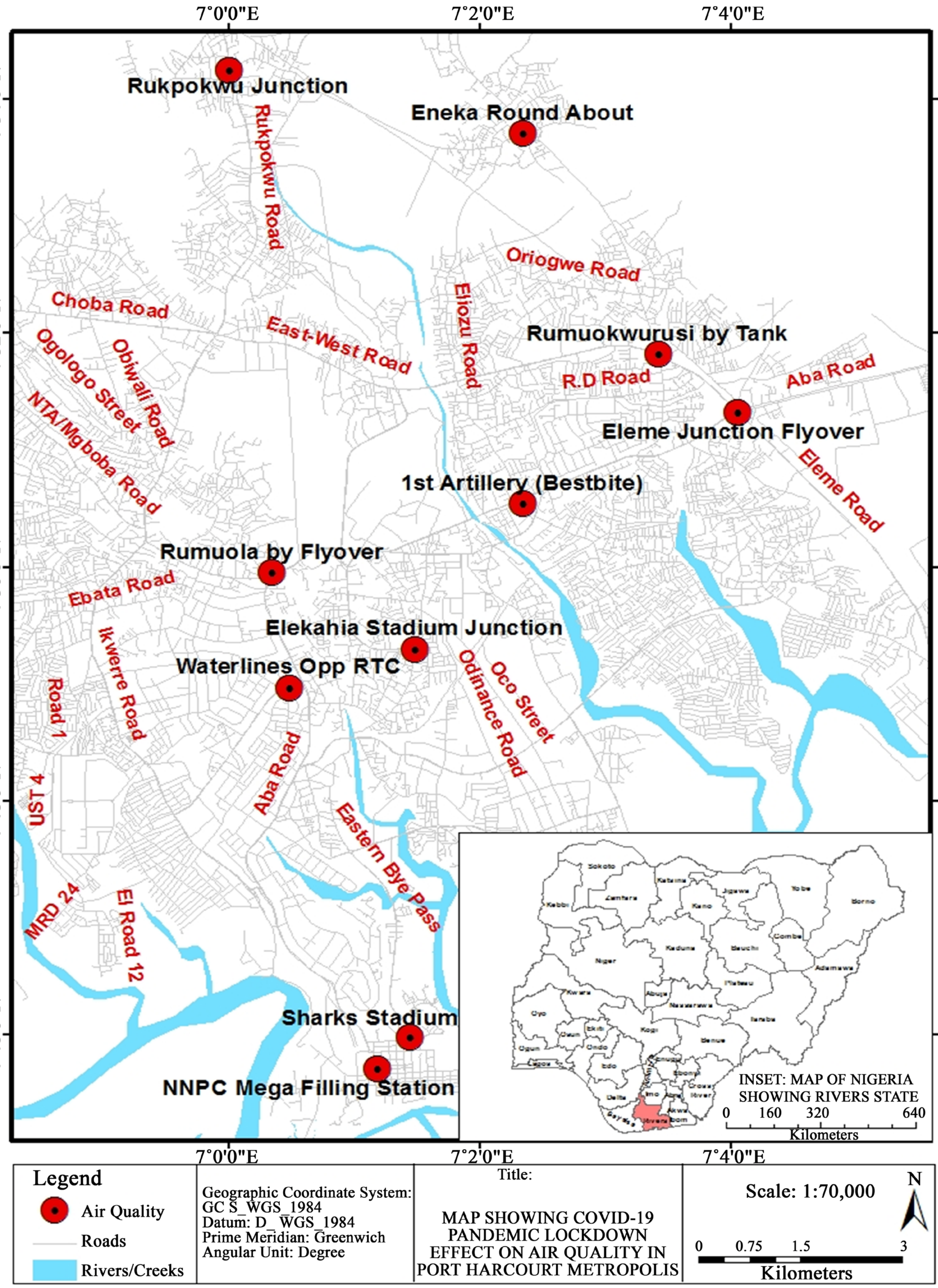

Figure 1. Port Harcourt Metropolis.

2.3. Data Collection

The measurement values before lockdown (BL) were obtained from an earlier conducted exercise in March, 2020. Air quality parameters during lockdown (DL) was recorded from 18th to 20th of May, 2020 and assessment after (AL) lockdown (post-movement restriction) was conducted between 2nd to 5th June 2020. The three sets of measurements (BL, DL and AL) were conducted within 12:00 and 15:00 hours. Additionally, satellite data was retrieved via a satellite remote sensing application through a System for Integrated Modelling of Atmospheric Composition (SILAM). SILAM is a global-to-meso-scale dispersion model established for atmospheric composition, air quality, and emergency decision support applications, as well as for inverse dispersion problem solution. The model incorporates both Eulerian and Lagrangian transport routines, 8 chemico-physical transformation modules (basic acid chemistry and secondary aerosol formation, ozone formation in the troposphere and the stratosphere, radioactive decay, aerosol dynamics in the air, pollen transformations), 3- and 4-dimensional variational data assimilation modules. The obtained air quality dataset is made available on a 1500 × 751 latitude-longitude grid at a resolution of 0.24 × 0.24 degrees, which corresponds to about 25 km resolution.

A hand held instrument, EGVOC-180, was used for measuring the particulates in the ambient air by optical method. The criteria pollutants like sulphur dioxide (SO_2), nitrogen dioxide (NO_2) and carbon monoxide (CO) were measured using a digital direct reading BOSEAN-BH-4S (Model: 1902314 & 19028499) portable multi gas detector which detects gases continuously with high-sensitivity sensor. A GARMIN OREGON 550T GPS Receiver instrument configured in the Nigerian Mina datum with the geodetic co-ordinates of the points already imputed into the system was used to georeferenced the sampling stations. In the navigation mode, the equipment provided a compass of the targeted position, elevation above sea level and the UTM Coordinates of this target position.

2.4. Data Analysis

The AQI for the pollutants were evaluated following a standard formula developed by the United States Environmental Protection Agency as shown in Equation (1) (US EPA, 2014).

$$I_p = \frac{I_{Hi} - I_{Lo}}{BP_{Hi} - BP_{Lo}} \left(C_P - BP_{Lo} \right) + I_{Lo} \tag{1}$$

Where:

I_P = the index for pollutant P;

C_P = the rounded concentration of pollutant P;

BP_{Hi} = the breakpoint that is greater than or equal to C_P;

BP_{Lo} = the breakpoint that is less than or equal to C_p;

I_{Hi} = the AQI value corresponding to BP_{Hi} and;

I_{Lo} = the AQI value corresponding to BP_{Lo}.

Table 1. US EPA breakpoint and air quality index.

PM_{10} (µg/m^3)	$PM_{2.5}$ (µg/m^3)	CO (ppm)	SO_2 (ppm)	NO_2 (ppm)	AQI	Level of Health Concern
0 - 54	0.0 - 15.4	0.0 - 4.4	0.000 - 0.034	-	0 - 50	Good
55 - 154	15.5 - 40.4	4.5 - 9.4	0.035 - 0.144	-	51 - 100	Moderate
155 - 254	40.5 - 65.4	9.5 - 12.4	0.145 - 0.224	-	101 - 150	Unhealthy for sensitive group
255 - 354	65.5 - 150.4	12.5 - 15.4	0.225 - 0.304	-	151 - 200	Unhealthy
355 - 424	150.5 - 250.4	15.5 - 30.4	0.305 - 0.604	0.65 - 1.24	201 - 300	Very unhealthy
425 - 504	250.5 - 350.4	30.5 - 40.4	0.605 - 0.804	1.25 - 1.64	301 - 400	Hazardous
505 - 604	350.4 - 500.4	40.5 - 50.4	0.805 - 1.004	1.65 - 2.04	401 - 500	Hazardous

The Equation (1) was utilised based on the pollutants concentrations data and breakpoints shown in Table 1. It is shown that the AQI is divided into six classes with definite colour codes and boundaries: Good (0 - 50), Normal (51 - 100), Unhealthy for sensitive groups (101 - 150), Unhealthy (151 - 200), Very unhealthy (201 - 300) and Hazardous (>300). To estimate the AQI, the field measurements values of the following pollutants namely, particulate matter (PM_{10} and $PM_{2.5}$), carbon monoxide (CO), sulphur dioxide (SO_2) and nitrogen dioxide (NO_2) were collated. However, the most important of the pollutants was the particulates with significant record values. Thereafter, the average value from each pollutant was converted into individual index based on breakpoint boundary as shown in Table 1. The AQI equation was computed and programmed in Microsoft excel software format for flexible computation and responsive graphical user interface configuration. The format was configured to take about 7 air pollutants input values.

2.5. Quality Assurance

The research was managed and administered according to strict Quality Assurance procedures under the control of specific procedures, which ensures that objectives and requirements are achieved. Research procedures conformed to International Standard of Quality Management System (ISO 9001:2018), Environmental Management System (ISO 140001:2018) and Occupational health and safety management systems (ISO 45001:2018).

3. Result

Study result presented in Table 2 showed the mean values of the air quality index parameters measured before, during and after lockdown. Table 3 showed the ranges of measured parameters, while Table 4 showed the BL, DL and AL computed AQI of each of the sampled locations and the respective AQI indicator. Using the sampled areas as representation, Table 2 also showed the average AQI of Port Harcourt metropolis BL, DL and AL. The computed index and indicators are compared with the EPA reference AQI indicator (Figure 2)

Table 2. Results of air quality index parameters measured before (BL), during (DL) and after (AL) lockdown.

Location	Time	SO_2 (ppm)	NO_2 (ppm)	CO (ppm)	O_3 (ppm)	$PM_{2.5}$ (μg/m^3)	PM_{10} (μg/m^3)	AQI	Colour Indicator
Rumuola by Fly-over N04˚49'57.8" E007˚00'20.7"	BL	0.8	0.1	18	<0.1	95	80	462	HAZ
	DL	0.1	<0.1	1	<0.1	18	15	161	UH
	AL	0.2	0.1	9	<0.1	60	40	234	VUH
1st Artillery by (Best bite) N04˚50'38.7" E007˚02'16.7"	BL	0.4	0.04	20	<0.1	50	45	335	HAZ
	DL	0.2	<0.1	4	<0.1	14	12	234	VUH
	AL	0.2	<0.1	10	<0.1	30	20	234	VUH
Rumukrushi by Tank N04˚51'49.8" E007˚03'25.0"	BL	0.7	0.2	24	<0.1	125	120	429	HAZ
	DL	<0.1	<0.1	6	<0.1	25	18	163	UH
	AL	0.2	0.1	12	<0.1	40	30	243	VUH
Eneka Round-About N04˚53'43.1" E007˚02'20.5"	BL	0.4	0.05	8	<0.1	20	15	331	HAZ
	DL	<0.1	<0.1	3	<0.1	20	10	140	UHSG
	AL	0.1	0.04	6	<0.1	30	20	163	UH
Waterline opposite RTC N04˚48'58.5" E007˚00'29.0"	BL	0.6	0.1	16	<0.1	120	105	391	HAZ
	DL	<0.1	<0.1	4	<0.1	42	28	140	UHSG
	AL	0.1	0.1	7	<0.1	80	60	208	VUH
Elekahia Stadium Junction NO4˚49'19.91" E007˚1'27.13"	BL	0.5	0.004	12	<0.1	35	20	364	HAZ
	DL	<0.1	<0.1	2	<0.1	5	10	140	UHSG
	AL	0.1	<0.1	8	<0.1	10	10	188	UH
Sharks Stadium NO4˚45'55.55" E007˚1'19.5"	BL	0.7	0.02	10	<0.1	40	35	429	HAZ
	DL	<0.1	<0.1	3	<0.1	15	10	140	UHSG
	AL	0.4	<0.1	4	<0.1	30	20	331	HAZ
NNPC Mega Filling Station NO4˚45'42.69" E007˚1'9.72"	BL	0.8	0.04	22	<0.1	135	110	462	HAZ
	DL	0.1	<0.1	4	<0.1	20	15	140	UHSG
	AL	0.3	0.02	8	<0.1	80	70	298	VUH
Eleme Junction Flyover N04˚53'43.1" E007˚02'20.5"	BL	1.2	0.1	28	<0.1	140	135	593	HAZ
	DL	0.2	<0.1	12	<0.1	60	50	257	VUH
	AL	0.6	0.05	16	<0.1	110	90	391	HAZ
Rukpokwu Junction N04˚54'11.7" E006˚59'19.0"	BL	0.9	0.02	14	<0.1	50	45	495	HAZ
	DL	<0.1	<0.1	5	<0.1	15	15	159	UH
	AL	0.2	0.01	8	<0.1	20	18	391	HAZ

Key Index
Hazardous (HAZ)
Unhealthy (UH)
Very Unhealthy (VUH)
Unhealthy for sensitive groups (UHSG)

Table 3. Lower and upper limits of measured air quality parameter values.

Timing	SO_2 (ppm)	NO_2 (ppm)	CO (ppm)	O_3 (ppm)	$PM_{2.5}$ (μg/m^3)	PM_{10} (μg/m^3)
Before Lockdown (BL)	<0.1 - 1.2	<0.1 - 0.1	8 - 28	<0.1	20 - 140	15 - 135
During Lockdown (DL)	<0.1 - 0.2	<0.1	1 - 12	<0.1	5 - 60	10 - 50
After Lockdown (AL)	0.1 - 0.6	<0.1 - 0.1	4 - 16	<0.1	10 - 110	10 - 90

Table 4. Satellite data for mean air quality status of Port Harcourt city after lockdown.

Date	Air Quality Parameters (μg/m^3)					
	SO_2	NO_2	CO	O_3	$PM_{2.5}$	PM_{10}
15/7/2020						
Morning	1	8	389	12	34	51
Afternoon	1	2	251	12	38	50
Night	2	18	699	25	23	48
16/7/2020						
Morning	1	4	401	10	26	52
Afternoon	1	2	218	74	29	59
Night	1	13	527	11	20	56
17/7/2020						
Morning	1	1	550	7	19	56
Afternoon	1	1	229	68	22	51
Night	1	11	275	27	15	45

Good (0-50)	None
Moderate (51-100)	Usually sensitive people should consider reducing prolonged or heavy outdoor exertion.
Unhealthy for Sensitive Groups (101-150)	The following groups should reduce prolonged or heavy outdoor exertion: • People with lung disease, such as asthma • Children and older adults • People who are active outdoors
Unhealthy (151-200)	The following groups should avoid prolonged or heavy outdoor exertion: • People with lung disease, such as asthma • Children and older adults • People who are active outdoors Everyone else should limit prolonged outdoor exertion.
Very Unhealthy (201-300)	The following groups should avoid all outdoor exertion: • People with lung disease, such as asthma • Children and older adults • People who are active outdoors Everyone else should limit prolonged outdoor exertion.

Figure 2. AQI score and corresponding public health precautions for residents (US EPA, 2014).

and the possible implications on exposed inhabitants.

Results showed that ambient concentration values for particulates of sizes $PM_{2.5}$ and PM_{10} BL, DL and AL ranged from 15 - 140 μg/m^3, 5 - 60 μg/m^3 and 10 - 110 μg/m^3 respectively (Table 3). The highest, medium and lowest domains of particulates concentrations before lockdown were at stations 1, 3, 5, 8 and 9; stations 2, 6, 7 and 10; and station 4 respectively (Table 2). During lockdown the lowest and highest domains of ambient particulates concentrations were stations 6 and 9 respectively with ranges between 5 - 60 μg/m^3 across all the stations. However, after lockdown, there was a rise in particulates concentrations with range from 10 - 110 μg/m^3 (Table 3). The highest ambient particulates concentrations were observed during these periods were at stations 8 and 9 while station 6 had the lowest ambient mean value indicating a domain of low start of economic and anthropogenic activities after lockdown. For other criterial pollutants such as SO_2, NOS and CO, ambient concentrations were higher before and after lockdowns with the various ranges as shown on Table 3. It is shown from Table 1 that stations 1 - 3, 5 - 6, 8 - 10 recorded higher ambient mean CO values while station 7 recorded the lowest mean CO emitted domain (Table 2). After lockdown, stations 3, 9 and 10 showed an increase in mean CO ambient levels which indicate the resumption of anthropogenic activities. Mean satellite data as shown on Table 4 revealed a minimal to moderate air quality tropospheric status of Port Harcourt city after lockdown for the stated dates.

The air quality index (AQI) analysis as displayed on Table 2, showed that the ambient air quality status of Port Harcourt boundary layer was hazardous throughout all the stations before lockdown and these ranged from 331 - 593. Stations 1, 3, 4, 7, 9 and 10 were among the highest hazardous AQI domains. Unhealthy to very unhealthy AQI status was observed during lockdown with AQI range from 140 - 234 (Table 2). Stations 4 - 8 maintained unhealthy status for sensitive groups during this period. Very unhealthy AQI status dominated most of the stations after lockdown with stations 7, 9 and 10 assuming hazardous status. This indicated the rapid deteriorating effects of Port Harcourt air quality status after the period of lockdown. All through shutdown of activities, the air quality upgraded to unhealthy status, with an average reduction AQI of 261.7 points (Table 5). However, an average increase of 100.7 points, resulting to very unhealthy air status for residents after lockdown was observed.

Table 5. Average air quality index of Port Harcourt before, during and after COVID-19 pandemic lockdown.

Time	AQI	Colour Code/ Indicator	Lockdown Effect (difference between BL & DL)	Post-Lockdown Effect (difference between DL & AL)
BL	429.1	Hazardous		
DL	167.4	Unhealthy	261.7	100.7
AL	268.1	Very Unhealthy		

4. Discussion

Over the years, Port Harcourt metropolis and some other cities in Nigeria have been experiencing high ambient air pollution levels and high health burdens, especially respiratory diseases and deaths associated with poor air quality (Fienemika et al., 2018; RSMENV, 2019). An assessment of air quality and means of improvement in the area has both local and international relevance. Providentially, the lockdown measures across most cities of the world have brought opportunity to account for emissions impact on the health of the society. Therefore, the outcome of this study may help to review how far anthropogenic activities are responsible for poor air quality and the resultant health burdens on the city. It could also help validate lockdown as a periodic novel environmental strategy for restoring the environment and provide sustainable, air pollution free and inhabitable ecosystem to urban people. It was disclosed by Fuwaper et al. (2020) that the most substantial impact of the lockdown period in Port Harcourt was during the early phase in March 2020, where about 21.9% and 37.3% reduction in NO_2 and SO_2 ambient air concentrations. It was also disclosed that a 1.1% and 215% decrease was observed during the next month. It should be emphasized that while the effect of the lockdown slightly lessened ambient air quality due to the key reductions in air emissions bearing anthropogenic activities within the urban areas, the operations of illegal refineries that take place in the rural domains immediately outside the boundaries of Port Harcourt metropolis subsisted. These differences in operational anthropogenic activities both in the urban and rural domains are due to the dissimilar intensities of lockdown enforcement (Fuwaper et al., 2020).

COVID-19 pandemic on one hand threatened the health of people globally, and on the other was an environment restoring factor (Paital, 2020). This prompted the global concern and attention to analysing air quality status of cities in the course of the pandemic. Across most cities of the world, temporary reduction in emission levels, especially criteria pollutants and improvement in air quality have been documented amidst industrial shutdown period and city lockdown (Jain & Sharma, 2020; Bao & Zhang, 2020). There are quit a handful of studies concerning changes in air quality during the lockdown amidst COVID-19 pandemic, hence the result of this study specifically related to Port Harcourt is not isolated from others as improvement in air quality due to lockdown of cities is also apparent all over the globe.

Port Harcourt metropolis is a petroleum industry driven city and have been recognized for poor ambient air quality. Result from this study showed that the ambient air quality of Port Harcourt was hazardous for breathing before lockdown. While during shutdown of activities, the air quality improved to unhealthy status, with an average reduction of AQI of 261.7 points. However, an average increase by 100.7 points, resulting to very unhealthy breathing air status for residents after lockdown was observed (see **Table 4**). Also, decrease in levels of the criteria air pollutants was observed (see **Table 2**). Like other studies by

Yuri et al. (2020) the impact of the short-term lockdown on the air quality of Port Harcourt was substantial, meaning that all residents could have inhaled somewhat better air, except for sensitive groups (US EPA, 2014). However, upon resumption of activities and movement of people in the city after the lockdown, the ambient air quality deteriorated than it was during the lockdown.

Irrespective of the general improvement in air quality (decrease in AQI) seen during lockdown, levels of pollution and air quality differed across the city. During lockdown, sampled areas such as Eneka, Water Lines, Elekahia Stadium road, Sharks stadium axis and NNPC Mega Filling station in Port Harcourt old township recorded air quality status (AQI of below 150) fairly acceptable for breathing of residents, except for sensitive groups (US EPA, 2014). However, despite the lockdown areas such as Eleme Junction Fly-over, Rukpokwu Junction, Rumukrushi by Tank and Rumuola by Fly-over recorded AQI score of over 150 and above in the lockdown period, which is very unhealthy for all residents and worst for sensitive groups (US EPA, 2014). The variance in ambient pollution levels could result from high saturation of pollutants in the atmosphere, proximity to commercial and high vehicular and industrial activities, proximity to coastal areas where artisanal refining takes place and gas flaring by oil multinationals, as well as dispersion and emission dynamics premised on wind direction and other weather variables (Ede & Edokpa, 2017; Yakubu et al., 2017; Asumadu et al., 2020).

5. Conclusion and Recommendations

The study showed that ambient air quality of Port Harcourt has long been inundated with pollutants known to be hazardous to human health. Though air quality was observed to have slightly improved during the lockdown, however the drop in pollution levels could not result to acceptable good air quality (0 - 50) AQI due to persistent and long term saturation of pollution levels. Except for sensitive groups who remained at risk of exposure irrespective of the slight decrease in pollution levels; generally, Port Harcourt residents are likely to have experienced more environmentally friendly boundary layer atmosphere during the lockdown periods as reduction in ambient air pollution increases populations' life expectancy by over a year. Good (0 - 50) was not recorded across the sampled locations before, during and after the lockdown periods. Perhaps long and extended shutdown could have more beneficial effects to both sensitive groups and the entire populations. Establishing continuing and routine air quality measurements stations and the communication of daily air quality to residents could likely control air pollution on full resumption of economic activities. This is to ensure that the population, especially the sensitive groups and the more vulnerable target population are protected from severe public health complications. The non-pharmaceutical measures such as shutdown of industrial activities instituted by governments of most nations in curtailing the surge of coronavirus pandemic could likely be an environmental model for mitigating air pollution and its associated health burdens.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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