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The COVID-19 lockdown impact on air quality: A Case Study of Two Districts in Kabul City, Afghanistan

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ABSTRACT

The COVID-19 pandemic spread rapidly worldwide, causing millions of deaths. To curb transmission, many countries imposed lockdowns, leading to a noticeable improvement in air quality. During the peak of the pandemic, Kabul, Afghanistan's capital and one of the world's most polluted cities, enforced a three-month lockdown. This study evaluates the impact of the lockdown on Kabul's air quality by analyzing variations in pollutant concentrations ($PM_{2.5}$, PM_{10}, CO, NO_2, SO_2, and O_3) across two districts before and during the lockdown. Air quality data from the National Environmental Protection Agency was evaluated using a paired-samples *t*-test. The results revealed a significant decline in pollution levels. Pre-lockdown, Kabul's air quality was severely degraded, with $PM_{2.5}$ (334–362 µg/m³) and PM_{10} (491–518 µg/m³) exceeding standards by 4.5× and 3×, respectively, while NO_2 peaked at 565 µg/m³ (7× the limit). During Lockdown, concentrations of $PM_{2.5}$, PM_{10}, NO_2, and SO_2 dropped, nearing permissible levels. This suggests that reduced human activities lead to cleaner air. These findings highlight the benefits of strategic emission controls, offering policymakers actionable insights for improving Kabul's air quality.

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INTRODUCTION

Coronaviruses are a group of single-stranded, non-segmented RNA viruses classified within the family *Coronaviridae* (Cui et al., 2019; Wege and Ter Meulen, 1982). These viruses are known to infect both humans and animals, causing a spectrum of respiratory and gastrointestinal diseases with varying degrees of severity (Perlman, 1998). The novel coronavirus strain responsible for COVID-19 emerged in Wuhan, China, in late 2019 and rapidly spread worldwide, resulting in a global pandemic. This disease, caused by a previously unidentified coronavirus, has since posed unprecedented challenges to public health systems worldwide (Wege et al., 1982). On March 11, 2020, the World Health Organization (WHO) formally declared COVID-19 a pandemic, recognizing its extensive reach and impact on global populations. As of the time of writing this article, over 800 million confirmed cases and approximately seven million deaths have been reported worldwide (WHO, 2020). Beyond the severe public health consequences, COVID-19 has profoundly affected societal structures, economies, and daily social life. Notably, it has also had significant environmental repercussions, including temporary improvements in air and water quality due to widespread lockdowns and reduced human activity (Kitamura et al., 2020). These multidimensional impacts highlight the complex nature of the pandemic and the importance of integrated responses across health, social, and environmental domains.

To curb the transmission of COVID-19, healthcare professionals and public health authorities recommended a series of preventive measures, including lockdowns, quarantines, social distancing, and self-isolation. These interventions proved to be effective mechanisms in mitigating the rapid spread of the viral disease, particularly in densely populated urban areas (Gautam, 2020). The first Lockdown was enforced in Wuhan, China, the epicenter of the outbreak, which subsequently served as a global model for pandemic containment strategies (Wang & Su, 2020). Although such measures imposed significant socioeconomic burdens, including job losses, economic slowdowns, and psychological distress, they simultaneously generated environmental benefits. Notably, global reports documented significant reductions in air, water, and noise pollution, as well as improvements in urban air quality and visibility (Shrestha et al., 2020). Additionally, wildlife activity increased in several regions, possibly due to reduced human interference and vehicular traffic (Talukdar et al., 2024), highlighting the intricate link between anthropogenic activity and ecological balance.

The five major air pollutants, particulate matter ($PM_{2.5}$ and PM_{10}), nitrogen dioxide (NO_2), sulfur dioxide (SO_2), and ozone (O_3) originate from a range of anthropogenic and natural sources, including industrial emissions, vehicular exhaust, biomass burning, and volcanic activity (Kennes and Veiga, 2013). These pollutants are known to pose significant public

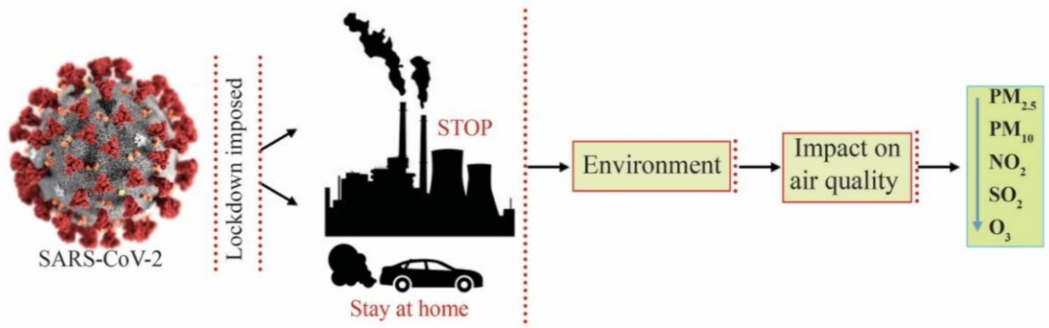

Figure 1. *Graphical summary of the lockdown effects*

health risks by exacerbating respiratory and cardiovascular conditions. Numerous epidemiological studies have established a strong correlation between long-term exposure to air pollution and the increased incidence of chronic diseases such as asthma, chronic obstructive pulmonary disease (COPD), and heightened vulnerability to infectious diseases, including viral respiratory illnesses like coronavirus (Persinger et al., 2002; Burnett et al., 2014). Poor air quality not only impairs individual health but also places a substantial burden on healthcare systems. Globally, it is estimated that air pollution contributes to approximately 4.6 million premature deaths each year, underscoring its critical role as an environmental health hazard (Cohen et al., 2017).

Studies such as Kumari and Toshniwal (2020) reported that COVID-19 lockdown measures led to notable improvements in air quality across highly polluted urban centers in Asia, Europe, Africa, and the Americas. These improvements were marked by significant reductions in concentrations of key air pollutants, including particulate matter ($PM_{2.5}$ and PM_{10}), carbon monoxide (CO), and nitrogen dioxide (NO_2), primarily due to the temporary break in industrial operations, vehicular traffic, and other anthropogenic activities. These findings highlight not only the scale of human influence on air quality but also the potential effectiveness of targeted environmental policy interventions in reducing pollution levels. The observed environmental response during the lockdown period provides a compelling case for integrating sustainable urban planning, stricter emission regulations, and clean energy transitions to mitigate air pollution and protect public health in the long term (Fig. 1).

The first wave of the COVID-19 pandemic reached Afghanistan on February 24, 2020, marked by the initial confirmed case reported in Herat province, which shares a border with Iran—a country that was then experiencing a severe outbreak and high mortality rates associated with the virus (Usmani et al., 2020). Due to the delayed implementation of effective response measures and limited healthcare infrastructure, the virus quickly spread across all 34 provinces, with densely populated urban centers, such as Kabul, experiencing the highest number of infections. In response to the escalating health crisis, the Afghan government introduced a series of restrictions between March and May 2020. These measures included full or partial suspensions of academic institutions, factories, and markets, as well as bans on public gatherings, aimed at curbing viral transmission and protecting public health amid limited medical resources (Usmani et al., 2020).

Kabul's air pollution crisis, driven by rapid urbanization, inadequate infrastructure, unregulated solid waste burning, and emissions from outdated vehicles, has consistently ranked the city among the most polluted capitals globally (Torabi & Nogami, 2016; Sediqi & PG, 2010). These long-standing conditions made the COVID-19 lockdown an important event for evaluating potential shifts in air quality. The temporary suspension of industrial activities, transportation, and public movement during the Lockdown created a unique opportunity to examine the environmental consequences of reduced anthropogenic activity. However, the absence of comprehensive studies on the indirect effects of the COVID-19 lockdown in Kabul represents a significant research gap. This underscores the need for localized investigations. In this context, a critical question emerges: To what extent did the COVID-19 lockdown measures affect the concentrations of key air pollutants $PM_{2.5}$, PM_{10}, NO_2, CO, O_3, and SO_2 in Kabul, particularly within its most impacted districts?

The present study was conducted to assess the impact of the COVID-19 lockdown on air quality by comparing the concentrations of six major air pollutants, $PM_{2.5}$, PM_{10}, NO_2, CO, O_3, and SO_2 in two selected districts of Kabul before and during the lockdown period. Addressing this research gap is essential for shaping effective environmental and public health policies at both local and national levels. The findings offer valuable insights that could support policymakers in designing evidence-based strategies, including targeted lockdowns or emission control measures, to reduce air pollution and mitigate its adverse health effects on the residents of Kabul city.

METHODS AND MATERIALS

Study site: Kabul, the capital of Afghanistan, is situated in a narrow valley across the Kabul River and nestled between the Hindu Kush mountains. The city is 1800 meters above sea level and lies between latitude 3454 north and longitude 6917 east. Kabul is home to approximately five million people, with around 80% residing within 22 districts (Rasouli, 2022). For this research, the 6^{th} and 16^{th} districts were randomly selected (Fig. 2).

Data collection: The data of primary and secondary air pollutants (PM2.5, PM10, NO2, SO2, CO, and O3) for both districts were obtained from the sensors of the National Environmental Protection Agency (NEPA) of Afghanistan. The data collection was divided into two periods: (i) three months before the Lockdown (December 2019–February 2020) and (ii) the lockdown period (March 2020). Hourly data was recorded over 24 hours and then averaged, ensuring the highest level of accuracy.

Data analysis: A comparative approach was conducted to analyze air pollutant concentrations before and during the Lockdown. Both concentrations were compared to NEPA standards (Table 01). Microsoft Excel was used to calculate the mean, median, and standard deviation for each pollutant before and during the Lockdown, and a two-tailed

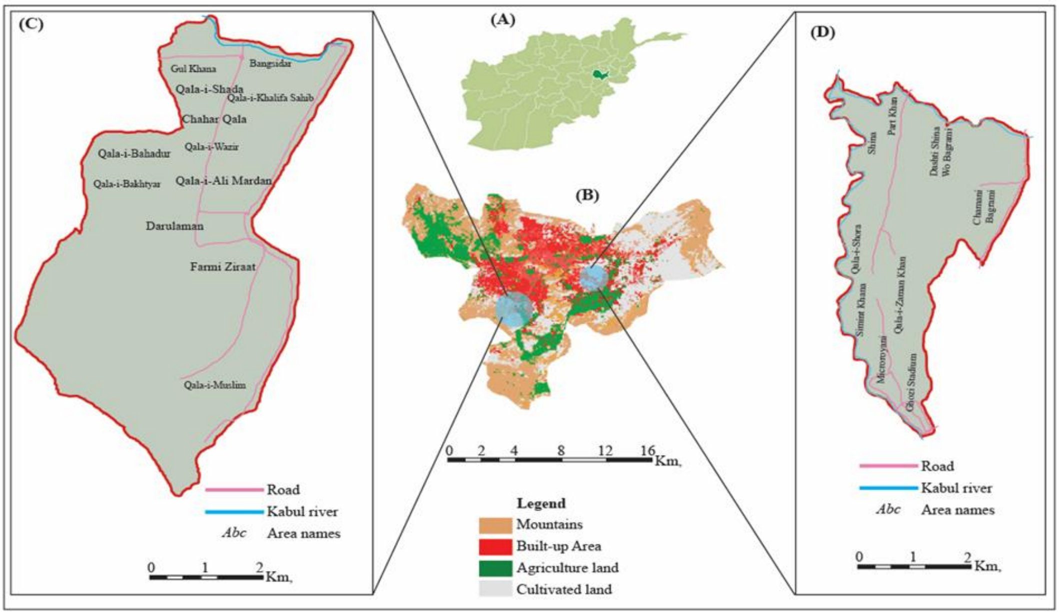

Figure 2. *Map of Afghanistan (A), Kabul city (B), District 6^{th} (C), and 16^{th} (D) of Kabul city. The figure is drawn using geographic information systems (GIS)*

paired-samples *t*-test was applied to quantify the differences between the mean values of the datasets.

FINDING

In this study, we analyzed air quality data provided by the NEPA across two districts of Kabul City, comparing pollutant concentrations before and during the COVID-19 lockdown period. The evaluated pollutants included $PM_{2.5}$, PM_{10}, NO_2, SO_2, CO, and O_3, with their permissible limits as defined by NEPA (Table 1).

Before the Lockdown, all measured pollutants exceeded national air quality standards by substantial margins. Particulate matter concentrations were at an alarming stage: $PM_{2.5}$ levels reached 334 µg/m³ and 362 µg/m³ in December, 4.5 times higher than the 24-hour standard limit of 75 µg/m³. PM_{10} concentrations were recorded as 491 µg/m³ and 518 µg/m³, more than triple the permissible limit of 150 µg/m³.

Gaseous pollutants also demonstrated severe exceedances: Nitrogen dioxide (NO_2) peaked at 565 µg/m³ in February, seven times higher than the national standard (80 µg/m³). Sulfur dioxide (SO_2) levels consistently surpassed the 50 µg/m³ limit. These findings suggest that pre-lockdown air quality in Kabul was severely compromised, posing a significant public health risk to the city's residents.

Following the implementation of the lockdown policy, a marked reduction in pollutant concentrations was observed in both study districts: $PM_{2.5}$ and PM_{10} levels decreased significantly, though they remained above guidelines in some areas. NO_2 and SO_2 concentrations exhibited a decline, aligning more closely with national standards. Similar trends were observed for CO and O_3, though their reductions were less dramatic compared to particulate matter. The comparative levels of pollutant levels of both districts are summarized in Table 1, while Figure 3 illustrates the temporal trends before and during the Lockdown. The data suggests that restrictions on various human activities, vehicular movement, industrial activity, and construction during the Lockdown contributed to measurable air quality improvements. While reductions were consistent across both districts, spatial variability was observed, likely due to differences in traffic density, industrial presence, and residential emissions. Overall, the preliminary data strongly support a correlation between reduced human activity and lower pollution levels.

Table 1. *The concentration of pollutants in both districts before and during the lockdown period.*

parameters	Allowable concentration	Time-weighted average	6th district		16th district	
			Before Lockdown	During Lockdown	Before Lockdown	During Lockdown
Carbon monoxide	10 µg/m³	8 hours	9.6	9.6	8.6	5
Nitrogen dioxide	80 µg/m³	24 hours	565	83	547	80
Ozone (O_3)	100 µg/m³	8 hours	155	106	112	99
PM_{10}	150 µg/m³	24 hours	491	146	518	123
$PM_{2.5}$	75 µg/m³	24 hours	334	105	362	102
Sulfur dioxide	50 µg/m³	24 hours	335	49	195	3.5

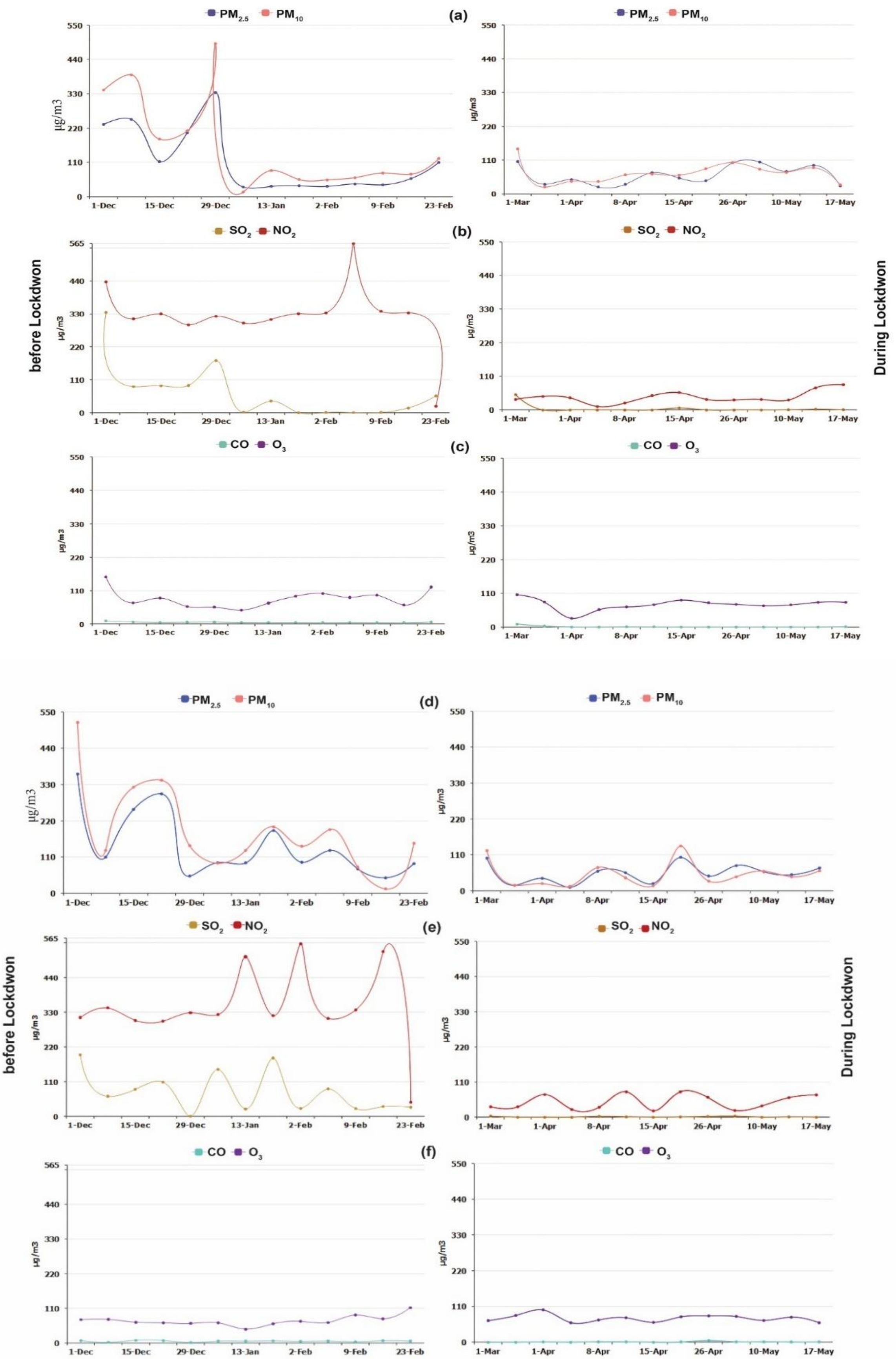

Figure 3. *The concentration level of air pollutants: a,b, and c represent the 6th districts, while d,e, and f represent the 16th districts of Kabul city. Each pollutant is compared before and during the Lockdown*

DISCUSSION

This study investigated the impact of the COVID-19 lockdown on air quality in two districts of Kabul, Afghanistan. The data analysis revealed that the temporary reduction in human activity, particularly in vehicular traffic and industrial operations, led to measurable declines in several key air pollutants, primarily nitrogen dioxide (NO_2), sulfur dioxide (SO_2), and carbon monoxide (CO). These findings are consistent with international trends observed during the global Lockdown, which underscore the critical role of anthropogenic emissions in urban air pollution (Muhammad et al., 2020; Wang et al., 2020). The observed reductions suggest that interventions targeting the transportation sector and energy use can yield meaningful environmental benefits, even in polluted urban environments such as Kabul.

Kabul, the capital and most populous city of Afghanistan, has undergone rapid unplanned urban expansion over the past two decades. This city was initially designed for a population of approximately 500,000 people (Torabi & Nogami, 2016), whereas it is now home to nearly 5 million residents (World Population Review, 2020). This rapid population increase has placed immense pressure on urban infrastructure and public services, leading to widespread informal settlements, overburdened road systems, and energy shortages (Sediqi, 2010; Rasouli, 2022). Due to ongoing conflict and the destruction of infrastructure, many households and businesses rely on wood-burning stoves, diesel generators, and low-quality fuels for heating and electricity generation. These sources are a significant contributor to local air pollution (Sediqi, 2010).

Kabul's unique topography also exacerbates its air quality issues. The city is situated in a basin-like valley surrounded by mountains, a geographical configuration that impedes the natural dispersion of air pollutants. This physical setting often leads to temperature inversions, atmospheric conditions in which a layer of warm air traps pollutants near the ground, resulting in dense concentrations of harmful substances such as particulate matter ($PM_{2.5}$), carbon monoxide, and nitrogen oxides (Rasouli, 2022). These effects are particularly severe during the winter months due to increased fuel burning for heating.

The transportation sector in Kabul is another primary source of pollution. The city is plagued by outdated vehicles, many of which are second-hand imports that fail to meet modern emissions standards. Fuel quality is generally poor, and roads are often narrow, congested, and poorly maintained (Torabi & Nogami, 2016). The combination of these factors contributes to a significant and persistent output of traffic-related air pollutants such as NO_2, PM_{10}, and CO. According to pre-pandemic sensor data collected by the National Environmental Protection Agency (NEPA), air quality levels in Kabul had already reached hazardous thresholds, with pollutant concentrations frequently exceeding World Health Organization (WHO) guidelines.

The onset of the COVID-19 pandemic in early 2020 brought about drastic changes in human activity worldwide. Government-imposed lockdowns, travel bans, and industrial slowdowns significantly reduced anthropogenic emissions in many urban centers. Multiple studies from around the globe reported improvements in air quality during the lockdown periods. For example, NO_2 levels dropped by 30% globally, while cities such as Delhi and Mumbai in India saw reductions of 40–50% (Pal et al., 2022; Muhammad et al., 2020). In China, CO_2 emissions fell by 18.7% in the first quarter of 2020 compared to the same period in 2019, with the transportation sector alone contributing to a 61.9% reduction (Wang et al., 2020). NASA (2021) similarly observed a 25% decrease in NO_2 and a 30% reduction in CO_2 emissions worldwide. These levels of emission reduction had not been achieved through previous climate treaties or regulatory interventions (Lenzen et al., 2020).

Kabul mirrored these global patterns during its partial Lockdown, which lasted approximately three months. Among the pollutants studied, NO_2 showed the most pronounced decline, particularly in Districts 6 and 16. This decline is strongly associated with reduced vehicle use, affirming the central role of traffic in contributing to NO_2 concentrations. In contrast, changes in $PM_{2.5}$ and ozone (O_3) levels were modest and not statistically significant. $PM_{2.5}$ concentrations during the Lockdown were recorded at 0.66 in District 16 and 0.126 in District 6, while O_3 concentrations were 0.246 and 0.167, respectively. These relatively small shifts can be attributed to persistent sources such as household combustion of low-grade fuels, open waste burning, and emissions from nearby thermal power stations (Torabi & Nogami, 2016). This suggests that air pollutants with multiple, diffuse sources may not respond as quickly to mobility restrictions as those directly tied to vehicular emissions.

The evidence from Kabul adds to a growing body of literature showing that substantial improvements in air quality are possible, even in short time frames, when human-generated emissions are significantly reduced. These findings have critical implications for urban policy and environmental management. Specifically, they highlight the potential benefits of investing in clean transportation infrastructure, phasing out highly polluting fuels, regulating vehicle imports, and enforcing emissions standards. The rapid improvement in air quality during the Lockdown demonstrates that such changes are not only desirable but achievable.

Nevertheless, the study is not without limitations. The duration of the Lockdown was relatively short, limiting the ability to observe long-term trend variations. The data collection focused on only two districts, which may not fully represent the conditions across the city. Furthermore, although this study focused on environmental indicators, it did not account for socioeconomic factors that may influence pollution levels, such as household income, access to energy, or public awareness of environmental issues. Future studies should incorporate more districts, cover longer timeframes, and explore additional variables to build a more comprehensive picture of Kabul's air quality dynamics.

In addition, meteorological conditions such as wind speed, temperature, and humidity were not analyzed in detail in this study, but they can significantly influence pollutant dispersion. A more robust analytical framework that incorporates meteorological data could enhance the accuracy of future assessments and inform the design of targeted air management strategies.

Despite these constraints, the COVID-19 lockdown offered an unexpected yet invaluable opportunity to observe the real-time impact of reduced human activity on the urban environment. The temporary improvement in Kabul's air quality should serve as a wake-up call for policymakers and stakeholders to adopt sustainable urban planning strategies. These might include expanding public transportation, introducing clean energy technologies, incentivizing green construction, and increasing public awareness about the health risks associated with pollution.

CONCLUSION

The findings of this study show that short-term reductions in anthropogenic activities, such as those caused by the COVID-19 lockdown, can lead to measurable improvements in urban air quality. In Kabul, concentrations of pollutants like NO_2, SO_2, and CO declined significantly, confirming the dominant role of traffic and fuel combustion in air pollution. Although reductions in $PM_{2.5}$ and O_3 were limited, the overall results align with global trends and emphasize the potential for evidence-based policy to address environmental and public health challenges. Moving forward, the temporary environmental gains observed during the pandemic should be leveraged to inform long-term strategies for sustainable urban development. The experience of the lockdown provides not only a case study but also a benchmark for what can be achieved through concerted policy action and community engagement. Lastly, the temporary cleanup of the environment was a window of opportunity for policy makers, decision makers, and researchers to make fruitful efforts in-depth investigations for the ecosystem resilience, climate action, and ecological sustainability.

AUTHORS CONTRIBUTIONS

- Asmatullah Usmani drafted and edited the first draft of the article.
- Wais Mohammad Lali Conceptualization, data collection, analysis, and figure drawing.
- Bilal Ahmmad Rahimi Review & editing.

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CONFLICT OF INTEREST STATEMENT

The authors declare that they have no conflict of interest.

DATA AVAILABILITY STATEMENT

All the data generated or analysed during this study will be available upon request.

REFERENCES

Burnett, R.T., et al. (2014). Global estimates of mortality associated with long-term exposure to outdoor delicate particulate matter. Proceedings of the National Academy of Science, 111(32), 14701-14706. https://doi.org/10.1073/pnas.1803222115

Cohen, A. J., Brauer, M., Burnett, R., Anderson, H. R., Frostad, J., Estep, K., & Forouzanfar, M. H. (2017). Estimates and 25-year trends of the global burden of disease attributable to ambient air pollution: an analysis of data from the Global Burden of Diseases Study 2015. The Lancet, 389(10082), 1907-1918. https://doi.org/10.1016/S0140-6736(17)30505-6

Cui J, Li F, Shi ZL (2019). Origin and evolution of pathogenic coronaviruses. Nature Reviews Microbiology 17(3):181-192. https://doi.org/10.1038/s41579-018-0118-9

Dutheil, F., Baker, J. S., & Navel, V. (2020). COVID-19 as a factor influencing air pollution? Environmental pollution, 263, 114466. https://doi.org/10.1016/j.envpol.2020.114466

Fu, F., Purvis-Roberts, K. L., & Williams, B. (2020). Impact of the COVID-19 pandemic lockdown on air pollution in 20 major cities around the world. Atmosphere, 11(11), 1189. https://doi.org/10.3390/atmos11111189

Gautam, S. (2020). COVID-19: Air pollution remains low as people stay at home. Air Quality, Atmosphere & Health, 13, 853–857.

Government of the Islamic Republic of Afghanistan. State of Afghan Cities; UN-Habitat: Kabul, Afghanistan, 2015; Volume 1.

He, M. Z., Kinney, P. L., Li, T., Chen, C., Sun, Q., Ban, J.. & Kioumourtzoglou, M. A. (2020). Short-and intermediate-term exposure to NO2 and mortality: a multi-county analysis in China. Environmental Pollution, 261, 114165. https://doi.org/10.1016/j.envpol.2020.11416

Kampa, M., & Castanas, E. (2008). Human health effects of air pollution. *Environmental pollution*, *151*(2), 362-367. https://doi.org/10.1016/j.envpol.2007.06.012

Kennes, C., & Veiga, M. C. (2013). Introduction to air pollution. *Air Pollution Prevention and Control: Bioreactors and Bioenergy*, 1-18. https://doi.org/10.1002/9781118523360.ch1

Kitamura, Y., Karkour, S., Ichisugi, Y., & Itsubo, N. (2020). Evaluation of the economic, environmental, and social impacts of the COVID-19 pandemic on the Japanese tourism industry. Sustainability, 12(24), 10302. https://doi.org/10.3390/su122410302

Kumari, P., & Toshniwal, D. (2020). Impact of Lockdown on air quality over major cities across the globe during COVID-19 pandemic. Urban climate, 34, 100719. https://doi.org/10.1016/j.uclim.2020.100719

Lenzen, M., Li, M., Malik, A., Pomponi, F., Sun, Y. Y., Wiedmann, T., & Yousefzadeh, M. (2020). Global socioeconomic losses and environmental gains from the Coronavirus pandemic. PloS one, 15(7), e0235654. https://doi.org/10.1371/journal.pone.0235654

Muhammad, S., Long, X., & Salman, M. (2020). COVID-19 pandemic and environmental pollution: A blessing in disguise?. Science of the total environment, 728, 138820. https://doi.org/10.1016/j.scitotenv.2020.138820

Pal, S. C., Chowdhuri, I., Saha, A., Ghosh, M., Roy, P., Das, B., ... & Shit, M. (2022). COVID-19 strict lockdown impact on urban air quality and atmospheric temperature in four megacities of India. Geoscience frontiers, 13(6), 101368.https://doi.org/10.1016/j.gsf.2022.101368

Perlman S (1998). Pathogenesis of coronavirus-induced infections. In Coronaviruses and Arteriviruses (pp. 503-513). Springer, Boston, MA. https://doi.org/10.1007/978-1-4615-5331-1_65

Persinger, R. L., Poynter, M. E., Ckless, K., & Janssen-Heininger, Y. M. (2002). Molecular mechanisms of nitrogen dioxide-induced epithelial injury in the lung. Molecular and cellular biochemistry, 234, 71-80.

Rasouli, H. (2022). Climate change impacts on water resource and air pollution in Kabul Sub-basins, Afghanistan. *Advances in Geological and Geotechnical Engineering Research*, 4(1), 11-27. https://doi.org/10.30564/agger.v4i1.4312

Rasouli, H. (2022). Climate change impacts on water resource and air pollution in Kabul Sub-basins, Afghanistan. *Advances in Geological and Geotechnical Engineering Research*, 4(1), 11-27.: https://doi.org/10.30564/agger.v4i1.4312

Sediqi, A., & PG, I. (2010). A preliminary assessment of air quality in Kabul. *reason*, *250*, 767-792.

Sharma, S., Zhang, M., Gao, J., Zhang, H., & Kota, S. H. (2020). Effect of restricted emissions during COVID-19 on air quality in India. Science of the total environment, 728, 138878. https://doi.org/10.1016/j.scitotenv.2020.138878

Shrestha, A. M., Shrestha, U. B., Sharma, R., Bhattarai, S., Tran, H. N. T., & Rupakheti, M. (2020). The lockdown caused by the COVID-19 pandemic has reduced air pollution in cities worldwide. https://doi.org/10.31223/osf.io/edt4j

Singh, V., Singh, S., Biswal, A., Kesarkar, A. P., Mor, S., & Ravindra, K. (2020). Diurnal and temporal changes in air pollution during COVID-19 strict Lockdown over different regions of India. Environmental Pollution, 266, 115368. https://doi.org/10.1016/j.envpol.2020.115368

Talukdar, A., Bhattacharya, S., Pal, S., Pal, P., & Chowdhury, S. (2024). Positive and negative impacts of COVID-19 on the environment: A critical review with sustainability approaches. *Hygiene and Environmental Health Advances*, *12*, 100107. https://doi.org/10.1016/j.heha.2024.100107

Torabi, E., & Nogami, A. (2016). Environmental assessment of suspended particulate matter over the Kabul City, Afghanistan. In Proc. 44th Annual Meeting of Environmental

Systems Research, Conference of Japan Society of Civil Engineers, Tokyo Metropolitan University, Tokyo, Japan

Tosepu, R., Gunawan, J., Effendy, D. S., Lestari, H., Bahar, H., & Asfian, P. (2020). Correlation between weather and COVID-19 pandemic in Jakarta, Indonesia. Science of the total environment, 725, 138436.https://doi.org/10.1016/j.scitotenv.2020.138436

Usmani, A., Baseer, A. Q., Rahimi, B. A., Jahid, A., Niazi, P., Monib, A. W., & Lali, W. M. (2020). Coronavirus disease 2019 (COVID-19) pandemic: What is the level of knowledge, attitude, and practice in Kandahar, Afghanistan. African Journal of Microbiology Research, 14(9), 465-470. https://doi.org/10.5897/AJMR2020.9369

Wang, Q., & Su, M. (2020). A preliminary assessment of the impact of COVID-19 on environment–A case study of China. Science of the total environment, 728, 138915. https://doi.org/10.1016/j.scitotenv.2020.138915

Wang, Q., Lu, M., Bai, Z., & Wang, K. (2020). Coronavirus pandemic reduced China's CO2 emissions in the short term, while stimulus packages may lead to emissions growth in medium-and long-term. Applied energy, 278, 115735. https://doi.org/10.1016/j.apenergy.2020.115735

Wang, Y., Wen, Y., Wang, Y., Zhang, S., Zhang, K. M., Zheng, H., & Hao, J. (2020). Four-month changes in air quality during and after the COVID-19 lockdown in six megacities in China. Environmental Science & Technology Letters, 7(11), 802-808. https://pubs.acs.org/doi/10.1021/acs.estlett.0c00605

Wege H, Ter Meulen V (1982). The biology and pathogenesis of coronaviruses. In Current topics in microbiology and immunology (pp. 165-200). Springer, Berlin, Heidelberg. https://doi.org/10.1007/978-3-642-68528-6_5

Wege, H., Siddell, S. T., & Ter Meulen, V. (1982). The biology and pathogenesis of coronaviruses. Current topics in microbiology and immunology, 165-200. https://doi.org/10.1007/978-3-642-68528-6_5

World Health Organization (2020) Coronavirus disease (COVID-2019) situation reports. Geneva: World Health Organization. Retrieved March 23, 2020, from (www.who.int/emergencies/diseases/ novel -coronavirus-2019/situation-reports).

World Population Review. (n.d.). Kabul population. Retrieved July 6, 2024, from https://worldpopulationreview.com/world-cities/kabul-population