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Analisis Dampak Lockdown pada Polutan Udara Utama di Era Pandemi COVID-19: *Literature Review*

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ABSTRACT

Lockdown applied in big cities around the world as an effort to prevent the spreading of COVID-19. Lockdown has shown a major impact on the air quality. The decline of pollution happened because of the reduction of anthropogenic activities, especially in transportation and industry. This research method examines various articles about the impact of the COVID-19 lockdown on air quality and aims to describe changes in pollutants in the atmosphere. This study used several search engines (Scopus, Science direct, springer, PubMed, and google scholar). The results of the lockdown were proven to reduce the concentration of pollutants $PM_{2.5}$ (21.8% - 39%), PM_{10} (22.9% - 75%), NO_2 (54.3% - 96%), SO_2 (7.6% - 215.5%), CO (35% - 64.8%). The decreasing NO_2 concentration causes the O_3 concentration to increasing (15% - 525%) in the atmosphere. This is due to the limitation of titration process of O3 by NO especially in the urban areas. Limiting transportation activities and industrial activities can be one of the strategies for controlling COVID-19 and air pollution. The right source of pollution control will improve air quality and improve people's lives.
Keywords: *air quality; COVID-19; lockdown; major cities*

ABSTRAK

Lockdown diterapkan di kota-kota besar di dunia sebagai upaya pencegahan penyebaran COVID-19. Penguncian telah menunjukkan dampak besar pada kualitas udara. Penurunan pencemaran terjadi karena berkurangnya aktivitas antropogenik, terutama di bidang transportasi dan industri. Metode penelitian ini mengkaji berbagai artikel tentang dampak lockdown COVID-19 terhadap kualitas udara dan bertujuan untuk mendeskripsikan perubahan polutan di atmosfer. Penelitian ini menggunakan beberapa mesin pencari (Scopus, Science direct, springer, PubMed, dan google scholar). Hasil lockdown terbukti menurunkan konsentrasi pencemar $PM_{2.5}$ (21.8% - 39%), PM_{10} (22.9% - 75%), NO_2 (54.3% - 96%), SO_2 (7.6% - 215.5%), CO (35% - 64,8%). Penurunan konsentrasi NO_2 menyebabkan peningkatan konsentrasi O_3 (15% - 525%) di atmosfer. Hal ini dikarenakan keterbatasan proses titrasi O_3 oleh NO khususnya di wilayah perkotaan. Pembatasan kegiatan transportasi dan kegiatan industri dapat menjadi salah satu strategi pengendalian COVID-19 dan pencemaran udara. Sumber pengendalian pencemaran yang tepat akan meningkatkan kualitas udara dan meningkatkan taraf hidup masyarakat.
Kata kunci: kualitas udara; COVID-19; *lockdown*; kota besar

PENDAHULUAN

Penyakit Coronavirus Disease 2019 (COVID-19) adalah jenis penyakit baru yang sebelumnya tidak pernah teridentifikasi pada manusia. Virus penyebab COVID-19 adalah Sars-CoV-2[1]. Pada 30 Januari 2020, *World Health Organization* (WHO) telah menetapkan COVID-19 sebagai *Public Health Emergency of International Concern* (PHEIC)[2]. Kasus COVID-19 meningkat pesat dan telah menyebar antar negara[3]. WHO kemudian menyatakan wabah COVID-19 sebagai pandemi global pada 11 Maret 2020[4]. Jumlah kasus dan kematian akibat COVID-19 semakin meningkat, mengharuskan pemerintah menetapkan kebijakan lockdown untuk mengurangi kasus COVID-19[5]. Mobilitas masyarakat dibatasi untuk mengurangi penyebaran COVID-19. Akibatnya, kegiatan komersial[6], industri[7], transportasi[8], dan hiburan[9] ditutup selama pandemi COVID-19.

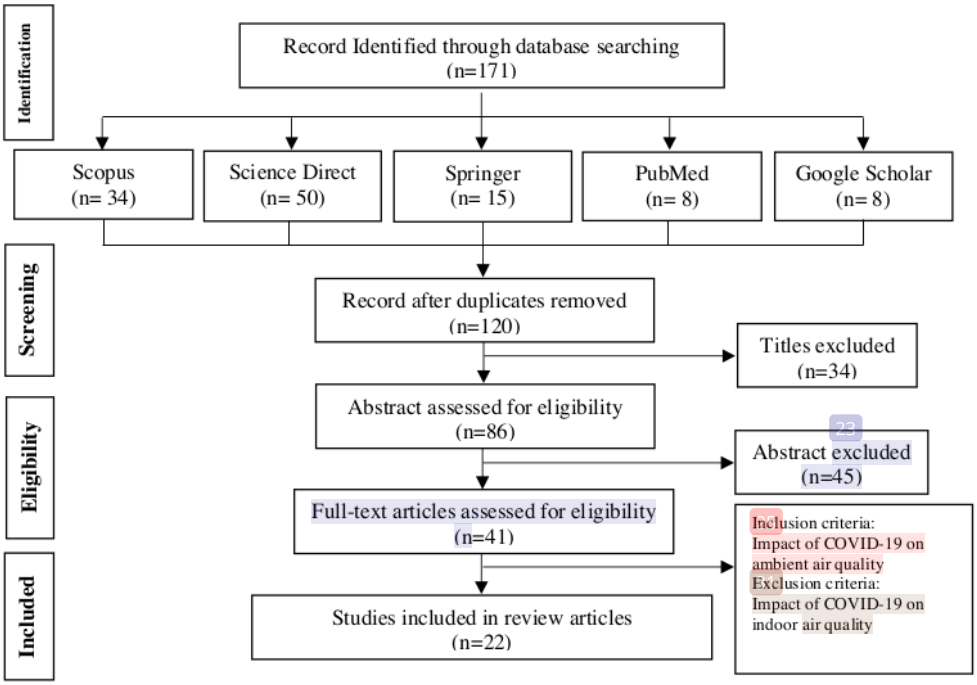
Prinsipnya COVID-19 ditularkan melalui kontak orang ke orang[10,11]. Kebijakan paling efektif yang diterapkan untuk mengurangi penyebaran COVID-19 adalah social distancing dan lockdown[12,13]. Dampak positif lockdown terhadap lingkungan, pembatasan aktivitas yang menghasilkan polutan. Banyak penelitian yang menemukan bahwa kualitas udara di kota-kota besar membaik akibat menurunnya jumlah kendaraan bermotor dalam kegiatan transportasi dan industri selama lockdown[5,14,15,16]. Meskipun demikian, lockdown yang dilakukan di seluruh dunia berdampak negatif terhadap perekonomian, kehidupan sosial dan budaya[17].

Polusi udara ambien menyebabkan 4,2 juta kematian setiap tahun di kota-kota besar[18]. Kegiatan antropogenik industri, sektor energi, dan lalu lintas kendaraan merupakan penyumbang terbesar gas

pencemar[19,20,21]. Penerapan lockdown akibat pandemi COVID-19 telah mengakibatkan perubahan yang cukup besar pada polusi udara di seluruh dunia[22]. Perubahan konsentrasi polutan di atmosfer ($PM_{2.5}$, PM_{10}, NO_2, SO_2, CO, dan O_3) telah dilaporkan di India[23], Italia[24], China[25], United State[26], Korea[27], Spanyol[28]. Penelitian ini bertujuan untuk mendeskripsikan perubahan konsentrasi parameter kualitas udara ($PM_{2.5}$, PM_{10}, NO_2, SO_2, CO, dan O_3) di kota-kota besar di dunia. Kami menyajikan persentase perubahan parameter kualitas udara selama periode *lockdown* COVID-19 dan membahas kemungkinan kontributor perubahan kualitas udara.

METODE

Studi literatur dilakukan untuk mempelajari, memahami, dan menafsirkan studi yang ada tentang topik yang sama. Penelitian ini menggunakan beberapa database, seperti Scopus, Science Direct, Springer, PubMed dan Google Scholar. Pencarian artikel dilakukan mulai Agustus hingga Desember 2020. Kata kunci yang digunakan dalam pencarian adalah *"air quality"*, *"COVID-19"*, dan *"lockdown"*. Ekstrasi data dilakukan dengan mempertimbangkan pendekatan Population, Intervention, Control, Outcome, Study Design (PICOS)[29]. Studi dimasukkan dalam ulasan kami jika memenuhi kriteria inklusi: (1) Kajian perubahan parameter kualitas ambien udara selama periode lockdown COVID-19 di kota besar; (2) Study menyajikan data persentase perubahan parameter kualitas udara; (3) Artikel diterbitkan dalam bahasa Inggris. Untuk kriteria eksklusi: (1) Studi yang meneliti perubahan kualitas udara dalam ruangan; (2) Tidak menyajikan data persentase perubahan parameter kualitas udara ambien.



Gambar 1. Temuan artikel mengenai perubahan konsentrasi polutan di udara akibat lockdown di era pandemi COVID-19

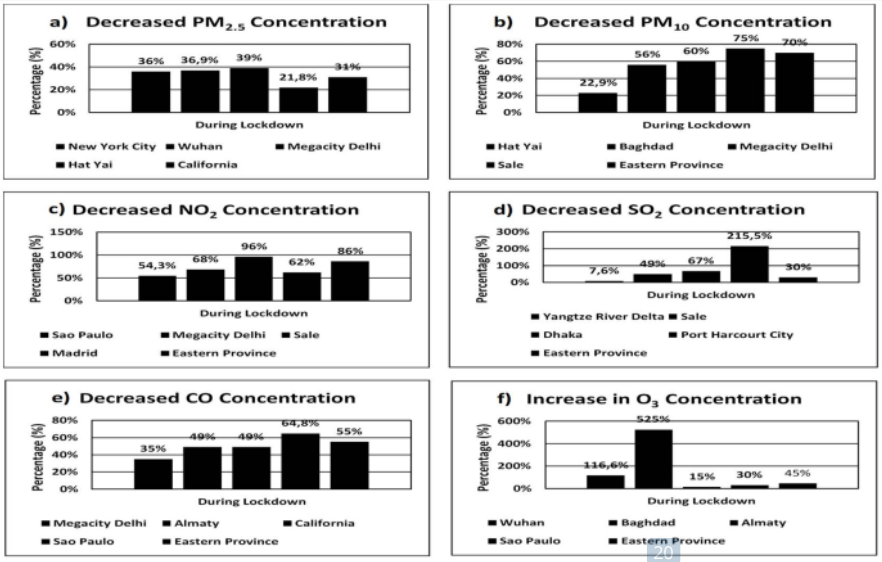
HASIL

Dampak Lockdown terhadap Polutan Udara di Era Pandemi COVID-19

Rincian penelitian yang meneliti dampak lockdown terhadap kualitas udara di berbagai kota disajikan pada Tabel 1. Dari 22 manuskrip yang digunakan untuk kajian ini, satu penelitian mencatat kualitas udara di Bangladesh[30], dua penelitian dilakukan di Brasil[31,32], empat studi yang dilakukan di China[33,34,35,36], tiga studi yang dilakukan di India[6,37,38], tiga studi yang dilakukan di Amerika Serikat[39,40,41]; dan masing-masing satu studi di Irak[42], Kazakhstan[43], Maroko[44], Spanyol[45], Korea Selatan[46], Amerika Selatan Utara (NSA)[7], Nigeria[47], Arab Saudi[48] dan Thailand[8]. Telah banyak penelitian yang membahas dampak lockdown terhadap parameter udara diantaranya $PM_{2.5}$, PM_{10}, NO_2, SO_2, CO, dan O_3.

Tabel 1. Ringkasan lokasi penelitian yang dilaporkan dalam literatur

Penulis, tahun	Negara	Judul	Lokasi	Polutan
Islam et al., 2020	Bangladesh	Impacts of nationwide lockdown due to COVID-19 outbreak on air quality in Bangladesh: a spatiotemporal analysis	Dhaka, Gazipur, Chattogram,Narayanganj	NO_2, SO_2, CO, O_3
Dantas et al., 2020	Brazil	The impact of COVID-19 partial lockdown on the air quality of the city of Rio de Janeiro, Brazil	Rio de Janeiro	NO_2, CO, PM_{10}
Kondoet al., 2020	Brazil	COVID-19 pandemic: Impacts on the air quality during the partial lockdown in São Paulo state, Brazil	Sao Paulo	NO_2, CO, O_3
Chu et., 2021	China	Significant concurrent decrease in $PM_{2.5}$ and NO_2 concentrations in China during COVID-19 epidemic	Wuhan	$PM_{2.5}, NO_2$
Li et al., 2020	China	Air quality changes during the COVID-19 lockdown over the Yangtze River Delta Region: An insight into the impact of human activity pattern changes on air pollution variation	Yangtze River Delta	$NO_2, SO_2, PM_{2.5}, O_3$
Filonchyk et al., 2020	China	Impact Assessment of COVID-19 on Variations of SO_2, NO_2, CO and AOD over East China	East China	NO_2, CO
Lian et al., 2020	China	Impact of city lockdown on the air quality of COVID-19-hit of Wuhan city	Wuhan	$PM_{2.5}, NO_2, O_3$
Sharma et al., 2020	India	Effect of restricted emissions during COVID-19 on air quality in India	India	$NO_2, SO_2, CO, PM_{2.5}, PM_{10}, O_3$
Mor et al, 2021	India	Impact of COVID-19 lockdown on air quality in Chandigarh, India	Chandigarh	$PM_{10}, PM_{2.5}$
Mahato et al., 2020	India	Effect of lockdown amid COVID-19 pandemic on air quality of the megacity Delhi, India	Megacity Delhi	$PM_{2.5}, PM_{10}, NO_2, CO$
Zangari et al., 2020	United State	Air quality changes in New York City during the COVID-19 pandemic	New York City	$PM_{2.5}, NO_2$
Son et al., 2020	United State	Reductions in mortality resulting from reduced air pollution levels due to COVID-19 mitigation measures	10 US states and the District of Columbia	$PM_{2.5}$
Liu et al., 2021	United State	Spatiotemporal impacts of COVID-19 on air pollution in California, USA	California	$CO, PM_{2.5}, NO_2$
Hashim et al., 2021	Iraq	Impact of COVID-19 lockdown on NO_2, O_3, PM2.5 and PM_{10} concentrations and assessing air quality changes in Baghdad	Baghdad	$NO_2, O_3, PM_{2.5}, PM_{10}$
Kerimray et al., 2020	Kazakhstan	Air quality changes in large cities during COVID-19 lockdowns: The impacts of traffic-free urban conditions in Almaty	Almaty	$NO_2, PM_{2.5}, O_3, CO$
Otmani et al., 2020	Marocco	Impact of Covid-19 lockdown on PM_{10}, SO_2 and NO_2 concentrations in Sale City (Morocco)	Sale	PM_{10}, SO_2, NO_2
Baldasano., 2020	Spain	COVID-19 lockdown effects on air quality by NO_2 in the cities of Barcelona and Madrid (Spain)	Barcelona and Madrid	NO_2
Han et al., 2020	South Korea	Air Quality Change in Seoul, South Korea under COVID-19 Social Distancing: Focusing on $PM_{2.5}$	Seoul	$PM_{2.5}, CO, NO_2$
Mendez-Espinosa et al., 2020	Northern South America	Air quality variations in Northern South America during the COVID-19 lockdown	Bogota and Medellin	$NO_2, PM_{2.5}, PM_{10}$
Fuwape et al., 2020	Nigeria	Impact of COVID -19 pandemic lockdown on distribution of inorganic pollutants in selected cities of Nigeria	Lagos, Kaduna	NO_2, SO_2, O_3
Anil and Alagha, 2020	Saudi Arabia	The impact of COVID-19 lockdown on the air quality of Eastern Province, Saudi Arabia	Eastern Province	PM_{10}, NO_2, SO_2, O_3
Stratoulias et al., 2020	Thailand	Air quality development during the COVID-19 pandemic over a medium-sized urban area in Thailand	Hat Yai	$NO_2, PM_{2.5}, PM_{10}, O_3$



Gambar 2. Persentase perubahan konsentrasi polutan. a) Penurunan konsentrasi $PM_{2.5}$, b) Penurunan konsentrasi PM_{10}, c) Penurunan konsentrasi NO_2, d) Penurunan konsentrasi SO_2, e) Penurunan konsentrasi CO, dan f) Peningkatan konsentrasi O_3 selama periode lockdown COVID-19

Kebijakan lockdown di era pandemi COVID-19 mengurangi aktivitas industri, transportasi dan sosial. Kondisi ini mengakibatkan terjadinya perubahan konsentrasi $PM_{2.5}$, PM_{10}, NO_2, SO_2, CO, dan O_3 di beberapa kota selama periode lockdown. Data yang disajikan berupa penurunan konsentrasi pencemar di lima kota yang mengalami perubahan signifikan untuk setiap pencemar selama periode lockdown. Persentase perubahan konsentrasi pencemar $PM_{2.5}$, PM_{10}, NO_2, SO_2, CO, dan O_3 disajikan pada Gambar 2.

PEMBAHASAN

COVID-19 adalah penyakit pernapasan akut yang dapat menyebabkan pneumonia dengan gejala seperti demam, batuk, dan dispnea[49] dan memiliki perkiraan tingkat kematian 2-3%[50]. COVID-19 memiliki tingkat keagresifan yang lebih tinggi ketika udara tercemar. Paparan jangka panjang $PM_{2.5}$ mengarah pada peningkatan tingkat kematian COVID-19, dengan besaran peningkatan yang 20 kali lebih besar[51]. Penelitian 120 kota di China menunjukkan bahwa terdapat hubungan yang signifikan antara polusi udara dan infeksi COVID-19[52].

Sars-CoV-2 menyebar dengan cepat pada manusia yang memiliki kontak dekat dengan orang yang sudah terinfeksi[53]. Sebagian besar negara menerapkan pembatasan pada transportasi, perdagangan dan kegiatan budaya, sekolah dan universitas ditutup, dan jarak sosial diberlakukan[30]. Efek lockdown cukup jelas dalam hal penurunan yang cukup besar pada tingkat pertumbuhan penyakit[54]. Efeknya juga terlihat pada faktor lingkungan di seluruh dunia dalam hal penurunan kabut asap, peningkatan kualitas udara dan air. Akibat aktivitas antropogenik yang terbatas di sektor transportasi, industri dan domestik[5].

Kegiatan antropogenik merupakan penyebab utama terjadinya pencemaran udara ambien, karena banyaknya emisi polutan berbahaya dalam konsentrasi tinggi yang merugikan kesehatan[55,56]. Penyebab utama pencemaran udara antara lain pembangunan ekonomi, urbanisasi, konsumsi energi, transportasi dan motorisasi, serta pertambahan penduduk perkotaan yang pesat[57]. Udara merupakan elemen penting untuk kelangsungan hidup semua makhluk hidup. Oleh karena itu, perlu dijaga kebersihan dan keamanannya.

$PM_{2.5}$ merupakan partikel dengan diameter <2.5 μm yang berupa partikel hasil pembakaran, senyawa organik, dan logam[58]. Gambar 2 (a) menunjukkan penurunan konsentrasi $PM_{2.5}$ selama periode lockdown di lima kota, yaitu Megacity Delhi, Wuhan, New York City, California, dan Hat Yai. Persentase penurunan konsentrasi $PM_{2.5}$ yang tinggi ditemukan di Megacity Delhi yaitu 39% selama fase lockdown. Ini meningkatkan kualitas udara sekitar 40% hingga 50%[38]. Penerapan lockdown di Wuhan, konsentrasi $PM_{2.5}$ mengalami penurunan sebesar 36.9% dan tetap menjadi pencemar utama[36]. Penurunan konsentrasi $PM_{2.5}$ dengan persentase 36% diamati di New York City setelah penguncian terjadi[39]. Pengamatan yang dilakukan di California menunjukkan penurunan 31% konsentrasi $PM_{2.5}$ selama lockdown (19 Maret - 7 Mei 2020)[41]. Konsentrasi $PM_{2.5}$ juga menurun sebesar 21,8% di Hat Yai[8]. Penelitian lain juga melaporkan penurunan $PM_{2.5}$ di Delta Sungai Yangtze[34], Chandigarh[37], Seoul[46] dan Baghdad[42].

PM_{10} adalah partikel berdiameter <10 μm yang berupa debu, serbuk, dan kapang[58]. Gambar 2 (b) menunjukkan bahwa konsentrasi PM_{10} menurun selama periode lockdown di lima kota, yaitu Sale, Eastern Province, Megacity Delhi, Baghdad, dan Chandigarh. Pengurangan aktivitas kendaraan selama lockdown mengakibatkan penurunan 75% konsentrasi PM_{10} tertinggi di Sale, Maroko[44]. Provinsi Timur juga mengalami penurunan konsentrasi yang signifikan pada berbagai tingkat PM_{10} (21-70%)[48]. Kondisi ini juga terjadi pada fase lockdown di Megacity Delhi, konsentrasi PM_{10} menurun sekitar 60%[38]. Penguncian parsial yang diterapkan di Baghdad mengurangi konsentrasi PM_{10} sebesar 56%[42]. Konsentrasi PM_{10} menurun sebesar 22,9% dalam 3 minggu pertama penutupan di Hat Yai, Thailand[8]. Penelitian lain juga melaporkan penurunan konsentrasi PM_{10} selama periode lockdown, masing-masing 36,8%, 22,8% dan 2,4% di Chandigarh[37].

NO_2 adalah gas yang sangat reaktif yang dikenal sebagai nitrogen oksida (NOx). NO_2 terbentuk dari emisi kendaraan bermotor, pembangkit listrik, dan peralatan off-road[59]. Gambar 2 (c) menunjukkan bahwa konsentrasi NO_2 telah menurun secara signifikan di lima kota, yaitu Sale, Eastern Province, Megacity Delhi, Madrid, dan Sao Paulo. Penurunan emisi karena berkurangnya aktivitas antropogenik, terutama di bidang transportasi dan industri selama lockdown COVID-19. Penurunan konsentrasi NO_2 sebesar 96% di Sale, Maroko[44]. NO_2 sebagai penanda polutan yang merespon tindakan lockdown karena konsentrasinya mengalami penurunan, berkisar antara 12-86% di Provinsi Bagian Timur[48]. Penurunan terjadi pada konsentrasi NO_2 sekitar 68% selama fase lockdown di Megacity Delhi, India[38]. Konsentrasi NO_2 juga menurun di Madrid selama lockdown sebesar 62%[45]. Penurunan konsentrasi NO_2 sebesar 54,3% diamati di daerah perkotaan selama penutupan sebagian[32]. Penelitian lain juga melaporkan penurunan konsentrasi NO_2 di Wuhan[36], New York City[39], Yangtze River Delta[34], California[41], Almaty[43], dan Hat Yai[8]. Adanya pembatasan kegiatan transportasi telah menurunkan konsentrasi NO_2.

SO_2 adalah indikator kelompok gas sulfur oksida (SO_X). Sumber SO_2 di atmosfer adalah hasil pembakaran bahan bakar fosil oleh pembangkit listrik dan fasilitas industri lainnya[60]. Gambar 2 (d) menunjukkan penurunan konsentrasi SO_2 selama fase lockdown COVID-19 di lima kota, yaitu Port Harcourt City, Dhaka, Sale, Eastern Province, dan Yangtze River Delta. Penurunan konsentrasi SO_2 tertinggi terjadi di Port Harcourt City sebesar 215,5%[47]. Di Dhaka, konsentrasi SO_2 menurun sekitar 67%[30]. Hasil yang diperoleh di Sale menunjukkan bahwa konsentrasi SO_2 menurun sebesar 49%[44]. Provinsi Timur juga mengalami penurunan konsentrasi yang signifikan pada tingkat variasi SO_2 antara 8,7 dan 30%[48]. Konsentrasi SO_2 menurun 7,6% selama penguncian di Delta Sungai Yangtze[34].

CO merupakan gas yang tidak berwarna, tidak berbau, dan sangat berbahaya jika terhirup dalam jumlah banyak. Sumber CO berasal dari kendaraan bermotor yang menggunakan bahan bakar fosil, cerobong asap[61]. Gambar 2 (e) menunjukkan bahwa konsentrasi CO mengalami penurunan selama lockdown COVID-19 di lima kota, yaitu Sao Paulo, Eastern Province, Almaty, California, dan Megacity Delhi. Penurunan drastis konsentrasi CO sebesar 64,8% di daerah perkotaan selama penguncian parsial[31]. Selama periode lockdown, konsentrasi CO menurun 55% di Provinsi Timur[48]. Konsentrasi CO telah menurun di Almaty dan California sebesar 49% (14,25), Sekitar 35% penurunan CO selama fase penguncian di Megacity Delhi[38]. Penelitian lain juga melaporkan penurunan konsentrasi CO di Rio De Janeiro[31], China Timur[35], dan Seoul[46].

O_3 atau ozon merupakan salah satu jenis polutan udara yang merupakan oksidator kuat dan berdampak negatif bagi kesehatan[62]. Gambar 2 (f) menunjukkan bahwa O_3 tidak mengalami penurunan tetapi mengalami peningkatan konsentrasinya di lima kota yaitu Wuhan, Provinsi Bagian Timur, Sao Paulo, Almaty, dan Baghdad. Peningkatan konsentrasi O_3 tertinggi ditemukan di Baghdad sebesar 525%[42]. Konsentrasi O_3 telah meningkat di Wuhan sebesar 116,6%[36]. Provinsi Timur juga mengalami peningkatan konsentrasi yang signifikan pada berbagai tingkat O_3 sebesar 45%[48]. Peningkatan sekitar 30% konsentrasi O_3 diamati di daerah perkotaan Sao Paulo, Brazil. Hal ini dipengaruhi oleh kondisi lalu lintas kendaraan, karena nitrogen monoksida mengalami penurunan[32]. Konsentrasi O_3 meningkat sebesar 15% selama periode penguncian di Almaty[43]. Pembentukan O_3 dipengaruhi oleh reaksi fotokimia. Konsentrasi NO dan NO_2 menurun karena lockdown yang membatasi aktivitas kendaraan bermotor. Penurunan konsentrasi NO mengurangi proses tritrasi O_3 yang biasanya menurunkan konsentrasi O_3 terutama di wilayah kota. Proses titrasi yang lebih rendah sekaligus meningkatkan konsentrasi O_3 di udara ambien[63].

KESIMPULAN

Kebijakan lockdown sebagai upaya mencegah penyebaran COVID-19. Pembatasan kegiatan industri, transportasi, pendidikan, dan rutinitas masyarakat ditutup selama pandemi COVID-19. Penurunan konsentrasi polutan terlihat jelas, karena pembatasan aktivitas antropogenik. Penurunan konsentrasi $PM_{2.5}$, PM_{10}, NO_2, SO_2, CO terjadi di Megacity Delhi, Wuhan, New York City, California, Hat Yai, Sale, Eastern Province, Baghdad, Chandigarh, Madrid, Sao Paulo, Port Harcourt City, Dhaka, Sungai Delta Yangtze dan Almaty. Berkurangnya konsentrasi pencemar sebagian besar disebabkan oleh berkurangnya jumlah kendaraan bermotor dan berkurangnya kegiatan industri. Konsentrasi NO_2 yang rendah yang biasanya disebabkan oleh konsentrasi NO yang lebih rendah seperti yang ditunjukkan di beberapa kota seperti Wuhan, Provinsi Timur, Sao Paulo, Almaty, dan Baghdad menurunkan proses titrasi O_3 dan pada saat yang sama meningkatkan konsentrasi di udara ambien. Kebijakan lockdown menjadi opsi terbaik dalam menekan penyebaran COVID-19. Selain itu, perilaku memakai masker, mencuci tangan, dan menjaga jarak perlu diterapkan.

DAFTAR PUSTAKA

1. Huang C, Wang Y, Li X, Ren L, Zhao J, Hu Y, Cheng, Z. Clinical Features of Patients Infected with 2019 Novel Coronavirus in Wuhan, China. Lancet. 2020;497–506.
2. World Health Organization (WHO). Coronavirus disease (p. 2633). Geneva: World Health Organization; 2020.
3. Qun L, Xuhua G, Peng W, Xiaoye W, Lei Z, Yeqing T, Chuding C. Early Transmission Dynamics in Wuhan, China, of Novel Coronavirus–Infected Pneumonia. The New England Journal of Medicine. 2020;1199–1207.
4. Cucinotta D, Vanelli M. WHO Declares COVID-19 a Pandemic. Acta Biomed. 2020;157–60.
5. Muhammad S, Long X, Salman M. 2020. COVID-19 pandemic and environmental pollution: A blessing in disguise? Sci Total Environ. 2020;28:138820. Available from: https://doi.org/10.1016/j.scitotenv.2020.138820
6. Sharma, Shubham, Mengyuan Z, Anshika, Jingsi G, Hongliang Z, and Sri HK. Effect of Restricted Emissions during COVID-19 on Air Quality in India. Science of The Total Environment. 2020;728:138878.
7. Mendez-Espinosa JF, Rojas NY, Vargas J, Pachón JE, Belalcazar LC, Ramírez O. Air quality variations in Northern South America during the COVID-19 lockdown. Sci Total Environ. 2020;749:141621.
8. Stratoulias, Dimitris, and Narissara N. Air Quality Development during the COVID-19 Pandemic over a Medium-Sized Urban Area in Thailand. Science of The Total Environment. 2020;746:141320.
9. Wu JTL, Leung K, Gabriel M. Nowcasting and Forecasting the Potential Domestic and International Spread of the 2019-NCoV Outbreak Originating in Wuhan, China: A Modelling Study. Lancet. 2020;689–97.
10. Coccia M. Factors Determining the Diffusion of COVID-19 and Suggested Strategy to Prevent Future Accelerated Viral Infectivity Similar to COVID. Science of the Total Environment. 2020.
11. Ma Y, Zhao Y, Liu J, He X, Wang B, Fu S, Yan J, Niu J, Zhou J, Luo B. Effects of temperature variation and humidity on the death of COVID-19 in Wuhan, China. Science of the Total Environment. 2020.
12. Lau H, Khosrawipour V, Kocbach P, Mikolajczyk A, Schubert J, Bania, J., Khosrawipour, T. 2020. The Positive Impact of Lockdown in Wuhan on Containing the COVID-19 Outbreak in China. J Travel Med.
13. Wilder-Smith A, Freedman DO. Isolation, Quarantine, Social Distancing and Community Containment: Pivotal Role for Old-Style Public Health Measures in the Novel Coronavirus (2019-NCoV) Outbreak. J Travel Med. 2020;1–4.
14. Dutheil F, Baker JS, Navel V. COVID-19 as a Factor Influencing Air Pollution? Environmental Pollution. 2020.
15. Ogen Y. Assessing Nitrogen Dioxide (NO2) Levels as a Contributing Factor to Coronavirus (COVID-19) Fatality. Science of the Total Environment. 2020.

16. Tobías A, Carnerero C, Reche C, Massagué J, Via M, Minguillón MC, Alastuey A, Querol X. Changes in Air Quality during the Lockdown in Barcelona (Spain) One Month into the SARS-CoV-2 Epidemic. Science of the Total Environment. 2020. Available from:https://doi.org/https://doi.org/10.1016/j.scitotenv.2020.138540.
17. Wang C, Horby PW, Hayden FG, Gao GF. A Novel Coronavirus Outbreak of Global Health Concern. Lancet. 2020;470–73.
18. Pacheco H, Díaz-López S, Jarre E, Méndez W, & Zamora-Ledezma E. NO2 Levels after the COVID-19 Lockdown in Ecuador: A Trade-off between Environment and Human Health. Urban Climate. 2020.
19. Cai J, Ge Y, Li H, Yang C, Liu C, Meng X, Wang W, Niu C, Kan L, Schikowski T, Yan B, Chillrud SN, Kan H, Jin L. Application of Land Use Regression to Assess Exposure and Identify Potential Sources in PM2.5, BC, NO2 Concentrations. Atmos. Environ. 2020.
20. Liu Z, Guan Q, Luo H, Wang N, Pan N, Yang L, Xiao S, Lin J. Development of Land Use Regression Model and Health Risk Assessment for NO2 in Different Functional Areas: A Case Study of Xi'an, China. Atmos. Environ. 2020;515–25. Available from:https://doi.org/https://doi.org/10.1016/j.atmosenv.2019.06.044.
21. Rovira J, Domingo JL, Schuhmacher M. Air Quality, Health Impacts and Burden of Disease Due to Air Pollution (PM10, PM2.5, NO2 and O3): Application of AirQ+ Model to the Camp de Tarragona County (Catalonia, Spain). Science of the Total Environment. 2020.
22. Singh V, Singh S, Biswal A, Kesarkar AP, Mor S, & Ravindra K. Diurnal and Temporal Changes in Air Pollution during COVID-19 Strict Lockdown over Different Regions of India. Environmental Pollution. 2020.
23. Siddiqui A, Suvankar H, Prakash C, and Pramod K. COVID-19 Pandemic and City-Level Nitrogen Dioxide (NO2) Reduction for Urban Centres of India. Journal of the Indian Society of Remote Sensing. 2020;48 (7): 999–1006.
24. Zoran MA, Roxana SS, Dan MS, and Marina NT. Assessing the Relationship between Surface Levels of PM2.5 and PM10 Particulate Matter Impact on COVID-19 in Milan, Italy. Science of the Total Environment. 2020;738: 139825.
25. Chen Y, Shumin Z, Chao P, Guangming S, Mi T, Ru JH, Dongmei G, Huanbo W, Xiaojiang Y, and Fumo Y. Impact of the COVID-19 Pandemic and Control Measures on Air Quality and Aerosol Light Absorption in Southwestern China. Science of the Total Environment. 2020;749:141419.
26. Chen L, Antony W, Lung CC, Yi L, and Ge L. Nonuniform Impacts of COVID-19 Lockdown on Air Quality over the United States. Science of the Total Environment. 2020;745:141105.
27. Ju MJ, Jaehyun O, and Yoon HC. Changes in Air Pollution Levels after COVID-19 Outbreak in Korea. Science of the Total Environment. 2021;750 (January): 141521. Available from:https://doi.org/10.1016/j.scitotenv.2020.141521.
28. Briz-Redón A, Carolina Belenguer-Sapiña, and Ángel Serrano-Aroca. Changes in Air Pollution during COVID-19 Lockdown in Spain: A Multi-City Study. Journal of Environmental Sciences (China). 2021;101:16–26.
29. Moher D, Liberati A, Tetzlaff J, Altman DG, The PRISMA Group. Preferred Reporting Items for Systematic Reviews and Meta-Analyses: The PRISMA Statement. PLoS Med. 2009;6(7): e1000097. doi:10.1371/journal.pmed1000097
30. Islam MS, Tanmoy RT, Shimul R, and Mizanur R. Impacts of Nationwide Lockdown Due to COVID-19 Outbreak on Air Quality in Bangladesh: A Spatiotemporal Analysis. Air Quality, Atmosphere and Health. 2020;1–13.
31. Dantas G, Bruno S, Bruno BF, Cleyton MDS, and Graciela A. The Impact of COVID-19 Partial Lockdown on the Air Quality of the City of Rio de Janeiro, Brazil. Science of The Total Environment. 2020;729:139085.
32. Nakada LYK, and Rodrigo CU. COVID-19 Pandemic: Impacts on the Air Quality during the Partial Lockdown in São Paulo State, Brazil. Science of The Total Environment. 2020;730:139087.
33. Chu B, Shuping Z, Jun L, Qingxin M, and Hong H. Significant Concurrent Decrease in PM2.5 and NO2 Concentrations in China during COVID-19 Epidemic. Journal of Environmental Sciences (China) 2020;99:346–53.
34. Li L, Qing L, Ling H, Qian W, Ansheng Z, Jian X, Ziyi L. Air Quality Changes during the COVID-19 Lockdown over the Yangtze River Delta Region: An Insight into the Impact of Human Activity Pattern Changes on Air Pollution Variation. Science of The Total Environment. 2020;732:139282.
35. Filonchyk M, Volha H, Haowen Y, Andrei G, and Natallia S. Impact Assessment of COVID-19 on Variations of SO2, NO2, CO and AOD over East China. Aerosol and Air Quality Research. 2020;20(7):1530–40.
36. Lian X, Jianping H, Rujin H, Chuwei L, Lina W, and Tinghan Z. Impact of City Lockdown on the Air Quality of COVID-19-Hit of Wuhan City. Science of the Total Environment. 2020;742:140556.
37. Mor S, Sahil K, Tanbir S, Sushil D, Vivek P, and Khaiwal R. Impact of COVID-19 Lockdown on Air Quality in Chandigarh, India: Understanding the Emission Sources during Controlled Anthropogenic Activities. Chemosphere. 2021;263: 127978. Available from:https://doi.org/https://doi.org/10.1016/j.chemosphere.2020.127978.
38. Mahato S, Swades P, and Krishna GG. Effect of Lockdown amid COVID-19 Pandemic on Air Quality of the Megacity Delhi, India.Science of the Total Environment. 2020;730:139086.
39. Zangari S, Dustin TH, Amanda TC, and Jaime EM. Air Quality Changes in New York City during the COVID-19 Pandemic. Science of the Total Environment 2020;742:140496.
40. So JY, Kelvin CF, Seulkee H, Honghyok K, Chris CL, and Michelle LB. Reductions in Mortality Resulting from Reduced Air Pollution Levels Due to COVID-19 Mitigation Measures. Science of The Total Environment. 2020;744: 141012. Available from:https://doi.org/https://doi.org/10.1016/j.scitotenv.2020.141012.
41. Liu Q, Jackson TH, Long SC, Donglian S, Paul RH, Manzhu Y, Daniel QD, Michael ML, and Chaowei Y. Spatiotemporal Impacts of COVID-19 on Air Pollution in California, USA. Science of The Total Environment. 2021;750: 141592. Available from:https://doi.org/https://doi.org/10.1016/j.scitotenv.2020.141592.
42. Hashim BM, Saadi KA, Ali A, and Nadhir A. Impact of COVID-19 Lockdown on NO2, O3, PM2.5 and PM10

Concentrations and Assessing Air Quality Changes in Baghdad, Iraq. Science of the Total Environment. 2021;754:141978.
43. Kerimray A, Nassiba B, Olga PI, Bauyrzhan B, Bulat K, Pavel P, and Ferhat K. Assessing Air Quality Changes in Large Cities during COVID-19 Lockdowns: The Impacts of Traffic-Free Urban Conditions in Almaty, Kazakhstan. Science of The Total Environment. 2020;730:139179.
44. Otmani A, Abdelfettah B, Mounia T, Moussa B, El MC, Mohammed EB, and Mohamed K. Impact of Covid-19 Lockdown on PM10, SO2 and NO2 Concentrations in Salé City (Morocco). Science of the Total Environment. 2020;735:139541. Available from:https://doi.org/10.1016/j.scitotenv.2020.139541.
45. Baldasano JM. COVID-19 Lockdown Effects on Air Quality by NO2 in the Cities of Barcelona and Madrid (Spain). Science of the Total Environment. 2020;741:140353.
46. Han BS, Kyeongjoo P, Kyung-Hwan K, Seung-Bu P, Han-Gyul J, Sungju M, Jong-Won K, and Jong-Jin B. Air Quality Change in Seoul, South Korea under COVID-19 Social Distancing: Focusing on PM2.5. International Journal of Environmental Research and Public Health. 2020;(17):6208.
47. Fuwape IA, Okpalaonwuka CT, and Ogunjo ST. Impact of COVID -19 Pandemic Lockdown on Distribution of Inorganic Pollutants in Selected Cities of Nigeria. Air Quality, Atmosphere and Health. 2020;1–7.
48. Anil I and Omar A. The Impact of COVID-19 Lockdown on the Air Quality of Eastern Province, Saudi Arabia.Air Quality, Atmosphere and Health. 2020;August, 1–12. Available from:https://doi.org/10.1007/s11869-020-00918-3.
49. Jiang F, Deng L, Zhang L, Cai Y, Cheung CW, Xia Z. Review of the clinical characteristics of coronavirus disease 2019 (COVID-19). Journal of General Internal Medicine. 2020.
50. Rodriguez-Morales AJ, Katterine Bonilla-Aldana D, Tiwari R, Sah R, Rabaan AA, Dhama K. Covid-19, an emerging coronavirus infection: Current scenario and recent developments—An overview. Journal of Pure and Applied Microbiology. 2020.
51. Wu X, Nethery RC, Sabath BM, Braun D, Dominici F. Exposure to air pollution and COVID-19 mortality in the United States: a nationwide cross-sectional study. medRxiv. 2020.
52. Zhu Y, Xie J, Huang F, Cao L. Association between short-term exposure to air pollution and COVID-19 infection: evidence from China. Sci. Total Environ. 2020;727:138704.
53. Bherwani H, Gupta A, Anjum S, Anshul A, Kumar R. Exploring dependence of COVID-19 on environmental factors and spread prediction in India. Res. Square. 2020. Available from: https://doi.org/10.21203/rs.3.rs-25644/v1.
54. Myllyvirta L, Dahiya S. Air quality improvements due to COVID 19 lock-down in India. 2020. Available from: https://energyandcleanair.org/.
55. Gautam S, Hens L. SARS-CoV-2 pandemic in India: what might we expect?. Environ Dev Sustain 22.2020;3867–3869. Available from: https://doi.org/10.1007/s10668-020-00739-5
56. Ghorani-Azam A, Riahi-Zanjani B, Balali-Mood M. Effects of air pollution on human health and practical measures for prevention in Iran. J. Res. Med. Sci. 2016;21, 65. Available from: https://dx.doi.org/10.4103%2F1735-1995.189646
57. Kaplan G, Avdan ZY, Avdan U. Spaceborne Nitrogen Dioxide Observations from the Sentinel-5P TROPOMI over Turkey. Multidisciplinary Digital Publishing Institute, Proceedings, MDPI. 2019. Available from: https://doi.org/10.3390/ECRS-3-06181.
58. U.S. Environmental Protection Agency. Particulate Matter (PM) Pollution [Internet]. 2020 [cited 2020 Oct 13]. Available from: https://www.epa.gov/pm-pollution/particulate-matter-pm-basics#PM
59. U.S. Environmental Protection Agency. Nitrogen Dioxide (NO_2) Pollution. 2020a [cited 2020 Oct 13]. Available from: https://www.epa.gov/no2-pollution/basic-information-about-no2#What is NO2
60. U.S. Environmental Protection Agency. Sulfur Dioxide (SO_2) Pollution. 2020b [cited 2020 Oct 13]. Available from: https://www.epa.gov/so2-pollution/sulfur-dioxide-basics#what is so2
61. U.S. Environmental Protection Agency. Carbon Monoxide (CO) Pollution in Outdoor Air. p. 2020c [cited 2020 Oct 13]. Available from: https://www.epa.gov/co-pollution/basic-information-about-carbon-monoxide-co-outdoor-air-pollution#What is CO
62. Bernardini FL, Attademo RT, Gobbicchi C, Balducci PM, Del BV, Menculini G. Air Pollutants and Daily Number of Admissions to Psychiatric Emergency Services: Evidence for Detrimental Mental Health Effects of Ozone. Epidemiology and Psychiatric Sciences. 2019;29:e66.
63. Xu K, Kangping C, Li-Hao Y, Ya-Fen W, Yen-Kung H, Shun W, and Jiajia Z. Air Quality Index, Indicatory Air Pollutants and Impact of COVID-19 Event on the Air Quality near Central China. Aerosol and Air Quality Research. 2020;20(6):1204–21.

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