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# THE EFFECT OF LARGE-SCALE PHYSICAL DISTANCING ON THE AIR POLLUTANT STANDARD INDEX IN DKI JAKARTA

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**Abstract:**
Based on a number of indicators and calculations, various parties stated that motorized vehicles and industrial activities affect air quality in DKI Jakarta Province. The implementation of activities at home and large-scale physical distancing has more or less affected air quality in DKI Jakarta Province. The purpose of this study was to determine the effectiveness of large-scale in improving air quality in DKI Jakarta Province. The research method used is a combination of literature review and secondary data analysis. Secondary data comes from the official website of the DKI Jakarta Provincial Government's Integrated Data Portal. The data analyzed in the form of air pollutant standard index from five parameters of air pollution sources, namely $PM_{10}$, $SO_2$, CO, $O_3$ and $NO_2$. The results showed that large-scale physical distancing during the COVID-19 pandemic in DKI Jakarta Province could reduce the CO and $NO_2$ index by 47.34% and 45.68%, respectively, while the $PM_{10}$, $SO_2$ and $O_3$ parameters did not show any differences between before or during PSBB. The conclusion is that large-scale physical distancing in DKI Jakarta Province were effective in having a good effect on air quality, although not all parameters show a significant difference.

**Keywords:** DKI Jakarta Province, physical distancing, air pollution, COVID-19

## INTRODUCTION

Coronavirus disease (COVID-19) caused by Severe Acute Respiratory Syndrome Coronavirus 2 (SARS-CoV-2) which is currently endemic, spread rapidly throughout the world after being reported from China at the end of December 2019 (Huang, et al., 2020). Soon after, a pandemic was announced by the World Health Organization (WHO). SARS-CoV-2 is an RNA virus, that has a high mutation rate and is adaptable so that it is easily transmitted (Wang et al., 2020). Until now, when this article was written the vaccine had been given to the public, but the virus continued to mutate resulting in new variants such as Alpha, Beta, Delta, Gamma, Lambda to Omicron variants (Wolfe, et al, 2022; Zhang, et al, 2022). The rapid geographic spread of the coronavirus, mainly associated with a high percentage of infections, is not well documented. As a result, extraordinary and unprecedented public health measures have been taken by most countries by imposing strict measures at the local and national levels to slow down the spread of the virus in their respective regions including Indonesia. Policies that are often carried out are regional quarantine (lockdown) or large-scale physical distancing (Suraya, et al, 2020). Therefore, industrial activities, and commercial, as well as the transportation of people and goods, shrank suddenly.

This reduction in anthropogenic activity has a positive impact on the natural environment and leads to improvements in air quality as reported worldwide in public broadcasting such as in the ESA application (ESA, 2020) and similar scientific literature. In response to the outbreak, several studies have been carried out to determine the effect of lockdown on air quality, especially in big cities, because air pollution has an impact on human health such as affecting the respiratory system. Several studies have emphasized the important health benefits during the pandemic transition. Chen et al. (2020) claim that aggressive control measures to contain the outbreak led to significant improvements in air quality and reductions of ground-level air pollution in 27 countries in terms of health benefits.

Although it has been reported that some countries have experienced improvements in air quality during the large-scale physical distancing, some previous studies have focused on measuring the concentration of pollutant substances (pollutants) without paying attention to the pollutant standard index. Therefore, in this study, the effect of large-scale physical distancing due to the COVID-19 pandemic was analyzed by analyzing the air pollutant standard index, both before large-scale physical distancing and during large-scale physical distancing with a case study in DKI Jakarta province as the center of state administration (Indraprahasta and Derudder, 2019; Caraka, et al, 2020). So, the main objective of this study is to determine the effectiveness of large-scale physical distancing on improving air quality in DKI Jakarta Province.

## METHODS

### Data Collection Study Area

The location for data collection is in the DKI Jakarta Province (Figure 1). DKI Jakarta is the capital city of Indonesia and the largest city in Indonesia. Geographically, Jakarta is located between 06º 10' latitude 106º 49' east longitude. It is bordered by Banten Province in the west and east and south by West Java Province. To the north it is bordered by the Java Sea. Jakarta has an area of approximately 664.01 km² (ocean: 6,977.5 km²), with a population of 10,557,810 people in 2019 (http://jakarta.go.id/). As the center of business, politics, and culture, Jakarta is home to the headquarters of state-owned enterprises, private companies, and foreign companies. The city is also the seat of government institutions and the ASEAN secretariat office. Jakarta is served by two airports, namely Soekarno-Hatta Airport and Halim Perdanakusuma Airport, as well as three seaports at Tanjung Priok, Sunda Kelapa and Ancol (Martinez, et al., 2020; Laboratorium Lingkungan Hidup Daerah DKI Jakarta).

The first case of COVID-19 started from an activity that took place in Jakarta. At that time, patient Case 01 was at a dance event at the Amigos Club, South Jakarta, on February 14, 2020. He contacted a Japanese citizen domiciled in Malaysia during the event. Apparently, the Japanese citizen contracted COVID-19 and transmitted it to Case 01 patients. The spread of the Coronavirus type 2 (SARS-CoV-2) which causes COVID-19 disease continues to spread to many areas in Jakarta. DKI Jakarta Governor Anies Baswedan even named Jakarta as one of the epicenters (top points) of the spread of COVID-19. Therefore, the government took a firm stance by issuing a large-scale physical distancing policy, namely closing offices, working from home, closing school buildings, closing entertainment venues, and restricting transportation.

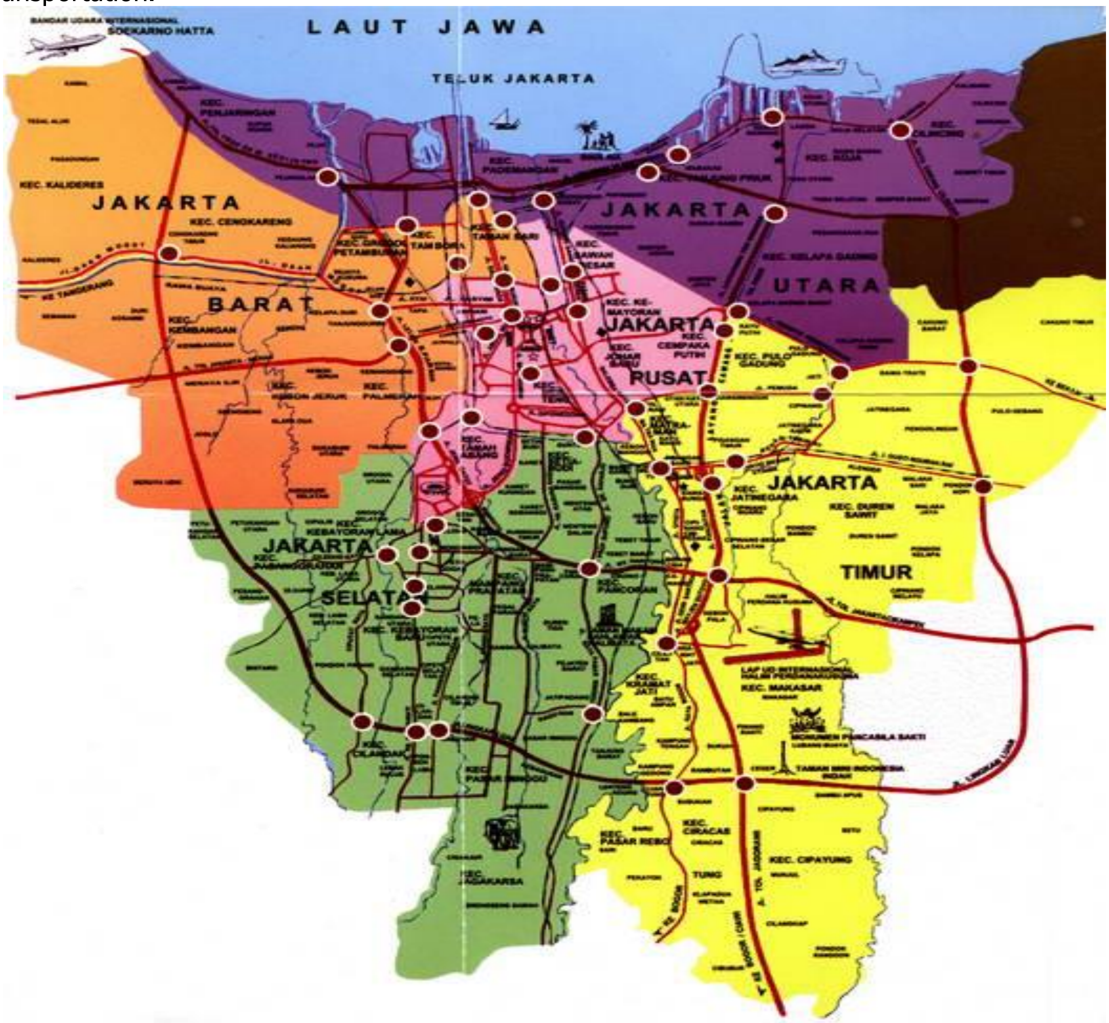


Figure 1. Study area that describes the DKI Jakarta Province and 5 areas of air quality monitoring stations (http://jakarta.go.id/).

## DATA SOURCE

The air pollutant parameters measured are the standard air pollutant indexes from 5 sources of air pollutants in the form of $PM_{10}$, $SO_2$, CO, $O_3$, and $NO_2$. Air pollution data were analyzed from January 2020 to June 2020. The secondary data analyzed came from the official website of the DKI Jakarta Provincial Government Integrated Data Portal which is data from the results of real-time air quality index measurements (every time) from 5 locations of Air Quality Monitoring Stations in DKI Jakarta, namely DKI 1 Bundaran HI-Central Jakarta; DKI 2 Kelapa Gading-North Jakarta; DKI 3 Jagakarsa-South Jakarta; DKI 4 Crocodile Hole Museum-East Jakarta; and DKI 5 Housing Kebon Jeruk, Central Jakarta.

## RESEARCH METHODS

The research method used is a combination of literature review and secondary data analysis. The literature review analyzed five parameters of air pollution sources to find out whether there was a trend in the standard index of ground air pollutants due to large-scale physical distancing during the COVID-19 pandemic.

To obtain data that can represent an overview of changes in the air pollutant standard index, statistical data was selected from the air pollutant standard index daily data for 6 months, starting from January to June 2020. The average value and standard deviation were used to discuss the air pollutant standard index value before and during the large-scale physical distancing, and the relative difference from the mean value in percentage is used as a proxy for the air pollutant standard index.

## STATISTICAL ANALYSIS

We used an independent t-test to analyze the air pollutant standard index values. The t-test was used to compare the measured parameters ($PM_{10}$, $SO_2$, CO, $O_3$, and $NO_2$) between one month and another, as well as to compare the air pollutant standard index values before and during the large-scale physical distancing. All data were analyzed using Microsoft Excel 2010. P-value $<0.05$ was significantly different.

## RESULTS

Currently, the air quality standard index that is officially used in Indonesia is the Air Pollutant Standard Index, which is by the Decree of the State Minister of the Environment Number: KEP 45/MENLH/1997 concerning the Air Pollutant Standard Index. The decision used as consideration material, among others, is to provide the convenience of uniformity of ambient air quality information to the public at a certain location and time as well as consideration in carrying out air pollution control efforts.

Figure 2 shows that the air pollutant standard index of particulates ($PM_{10}$) for 6 months from January to June 2020 seems to fluctuate. During this period, the DKI Jakarta Provincial Government has implemented large-scale physical distancing for 3 times, namely large-scale physical distancing volume 1 on 10-23 April 2020, large-scale physical distancing volume 2 on 24 April - 22 May 2020, and large-scale physical distancing volume 3 on 22 May – June 4, 2020. From 6 months of observation, there is the highest peak value, namely on April 22, 2020, with an air pollutant standard index value of 111, this value according to the ministry of environment is in the unhealthy category (ISPU, 2016). At this value, the level of air quality will be detrimental to humans or sensitive animal groups, it can even cause damage to plants and aesthetic value. On that date, there was a transition from large-scale physical distancing volume 2 to volume 3. This could happen because people were already fed up with PSBB volume 1 and volume 2, resulting in a spike in the transition from large-scale physical distancing volume 2 to volume 3, this condition also shows that large-scale physical distancing does not affect the reduction of $PM_{10}$ particulates in DKI Jakarta.

The standard air pollutant index of sulfide compounds ($SO_2$) is shown in Figure 3. The curve shown in March has a broken part, this is because at the beginning of the month, namely the 1st to 5th, and between the 20th to the 28th, no air pollutant standard index data was found. $SO_2$. However, until the end of March, the trend tends to decrease. The average air pollutant standard index score in March was the lowest among the other 5 months. Likewise in April, the curve is relatively constant with the standard air pollutant index lower than in January or February. In May and June, it did not show a significant difference to April, only at the end of May a fluctuating curve was formed. It is possible that at the end of May, the average community began to get tired of staying at home all the time. On a monthly average, large-scale physical distancing has no significant effect on decreasing the standard index of air pollutant sulfide compounds, however, in March, which is the month when a positive case of COVID-19 was announced, there was a decrease in standard air pollutant index for sulfide compounds as shown in Table 1.

Table 1. Average monthly air pollutant standard index

| Month | $PM_{10}$ | $SO_2$ | CO | $O_3$ | $NO_2$ |
|---|---|---|---|---|---|
| Jan | 56.42±14.05$^a$ | 34.97±5.87$^a$ | 32.06±12.94$^a$ | 70.52±19.61$^a$ | 11.97±3.97$^a$ |
| Feb | 56.17±12.59$^a$ | 25.72±5.76$^b$ | 35.62±13.55$^a$ | 90.66±39.85$^b$ | 14.13±2.71$^a$ |
| Mar | 44.03±14.31$^b$ | 18.71±4.38$^c$ | 31.72±18.51$^a$ | 98.90±46.86$^b$ | 7.10±2.77$^b$ |
| Apr | 64.63±16.40$^c$ | 26.53±2.03$^b$ | 22.03±5.67$^b$ | 93.30±26.24$^b$ | 9.90±2.47$^b$ |
| May | 58.29±12.53$^a$ | 25.00±5.35$^b$ | 18.71±5.94$^b$ | 80.65±23.22$^c$ | 10.29±2.42$^b$ |
| Jun | 67.53±9.36$^c$ | 23.87±2.19$^b$ | 20.17±7.74$^b$ | 79.63±18.55$^c$ | 13.07±3.24$^a$ |

Note: Significant differences (P<0.05) were indicated by writing different lowercase superscripts in the same column.

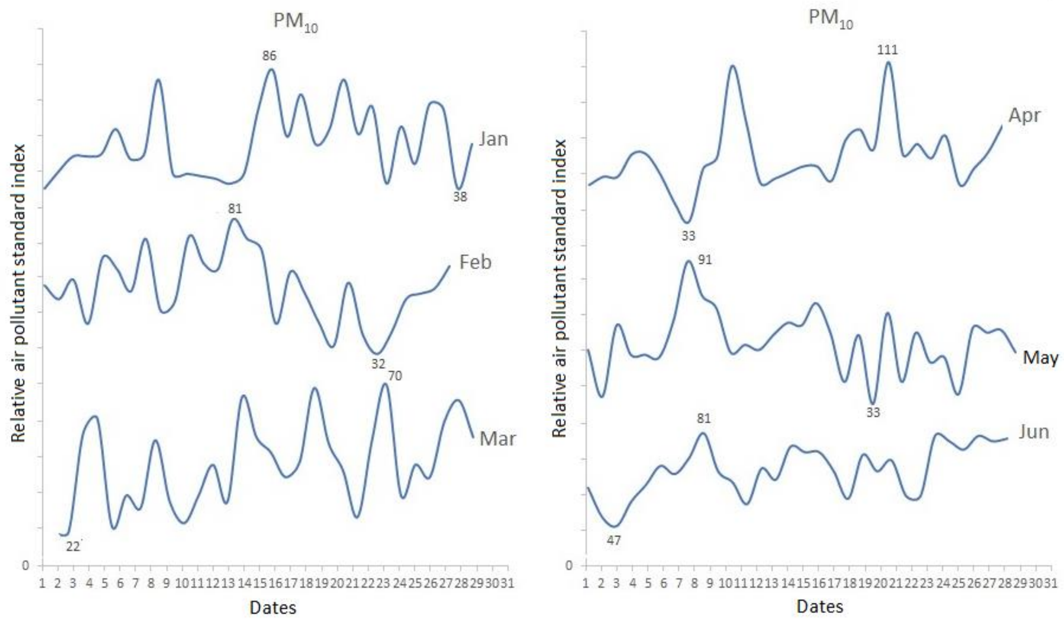


Figure 2. The air pollutant standard index of particulates ($PM_{10}$) in DKI Jakarta Province from January - June 2020.

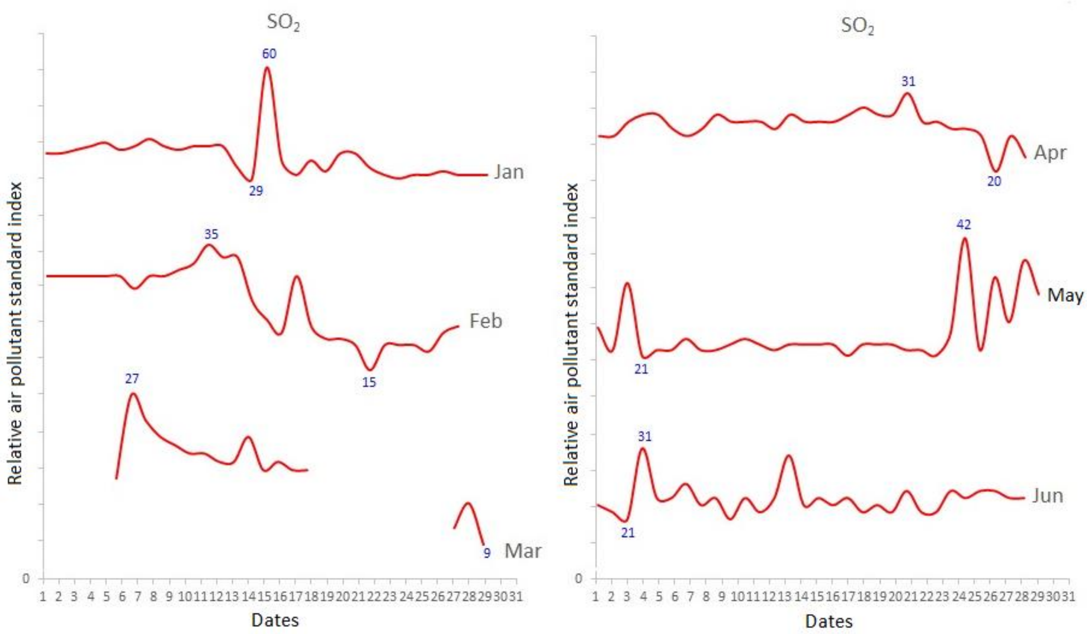


Figure 3. Air pollutant standard index of sulfide ($SO_2$) in DKI Jakarta Province from January - June 2020.

In contrast to the standard air pollutant index of carbon monoxide (CO), the implementation of the large-scale physical distancing (in April – June) had a positive effect in reducing the CO index significantly compared to before the large-scale physical distancing was enacted (January – March) as shown in Figure 4. The lowest percentage decline namely in April of 47.34% compared to February which had the highest CO index. In everyday life, CO gas can come from motor vehicle fumes or from factory chimneys (Nandi, et al., 2020).

Ozone ($O_3$) has the highest standard air pollutant index among other pollutant sources, as shown in Figure 5 and Table 1. Ozone can occur naturally in smog (fog). $NO_x$ gas and hydrocarbons from exhaust fumes from motor vehicles and various industrial activities can be a source of ozone formation. During 6 months of observation, the highest average ozone index occurred in March and the lowest average occurred in January. This shows that the large-scale physical distancing does not have a significant effect on ozone depletion. As stated by Kumar, et al. (2016), that this ozone can be produced by mixing ultraviolet light with the earth's atmosphere and forming the ozone layer at a certain height.

Figure 6 shows the standard air pollutant index of nitrite ($NO_2$) compounds. From the figure the lowest nitrite index is shown in March and followed by April and May. Table 1 also shows that the average nitrite index in the first month of the emergence of COVID-19 in Indonesia and during large-scale physical distancing volumes 1 and 2 shows a significant difference at $P<0.05$ compared to the nitrite index before large-scale physical distancing. The percentage of nitrite reduction was 45.68%. Nevertheless, the overall nitrite index is still in the range of 0 to 50. This means that the air quality is in the good category. This level of air quality will not have a negative effect on health, both for humans, animals, and plants (Dionova, et al., 2020).

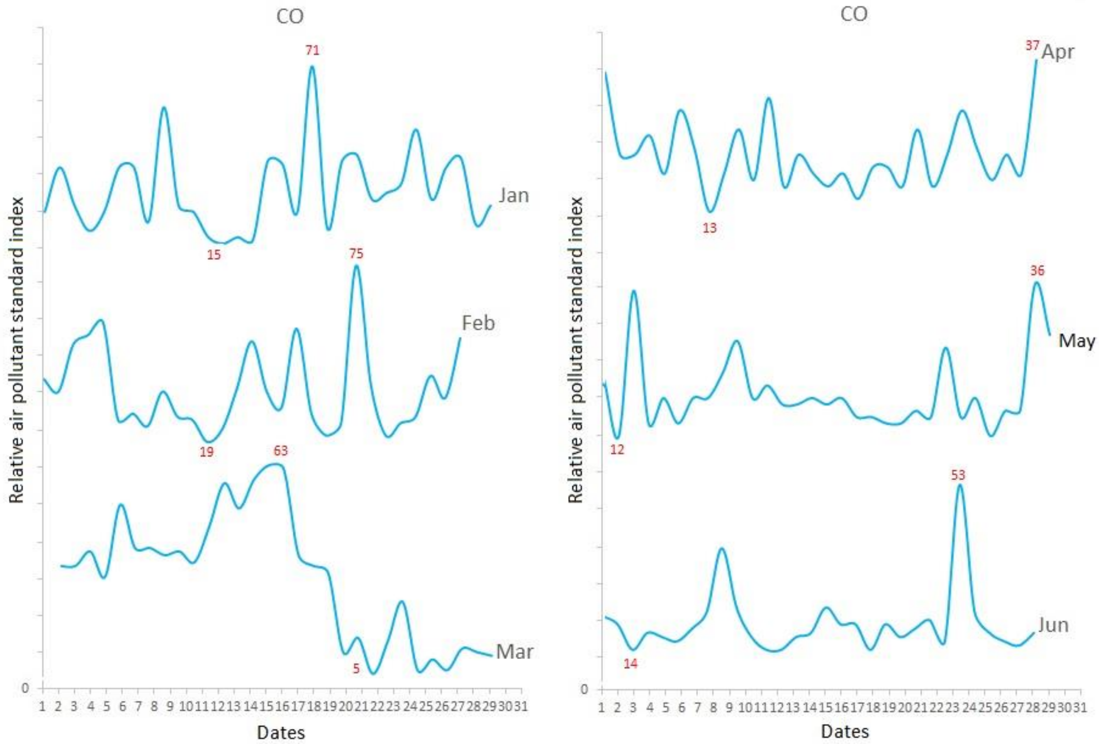


Figure 4. Air pollutant standard index of carbon monoxide (CO) in DKI Jakarta Province from January - June 2020.

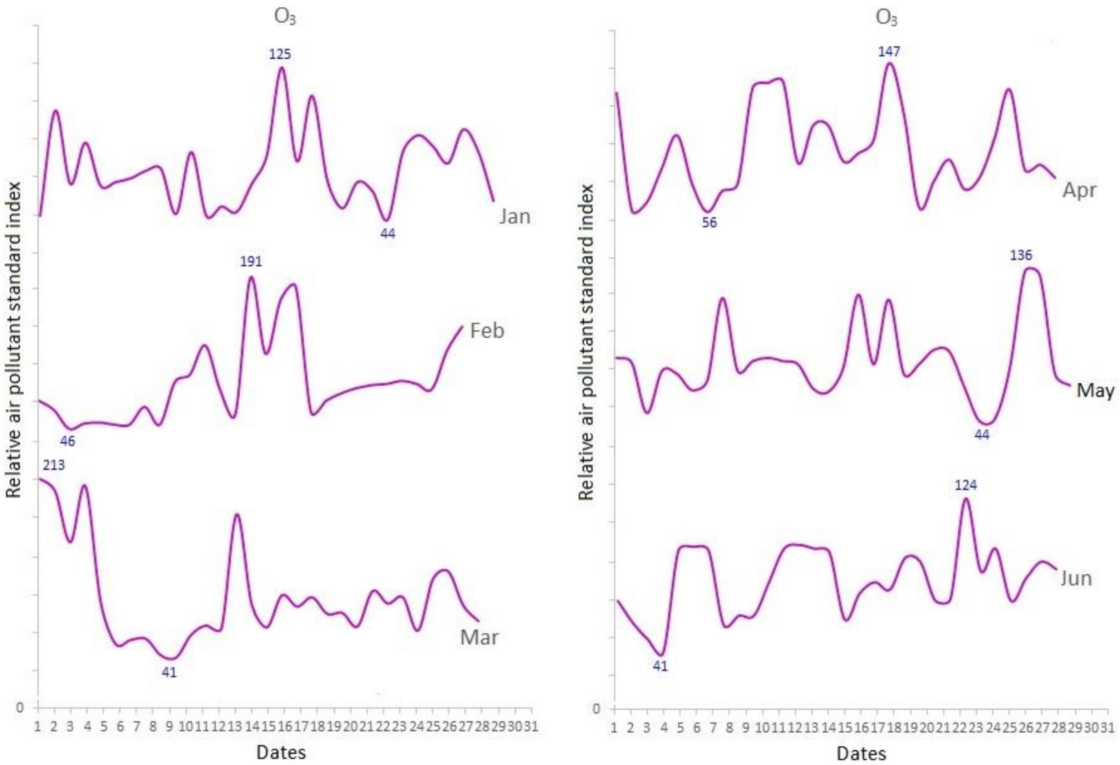


Figure 5. Air pollutant standard index of ozone ($O_3$) in DKI Jakarta Province from January - June 2020.

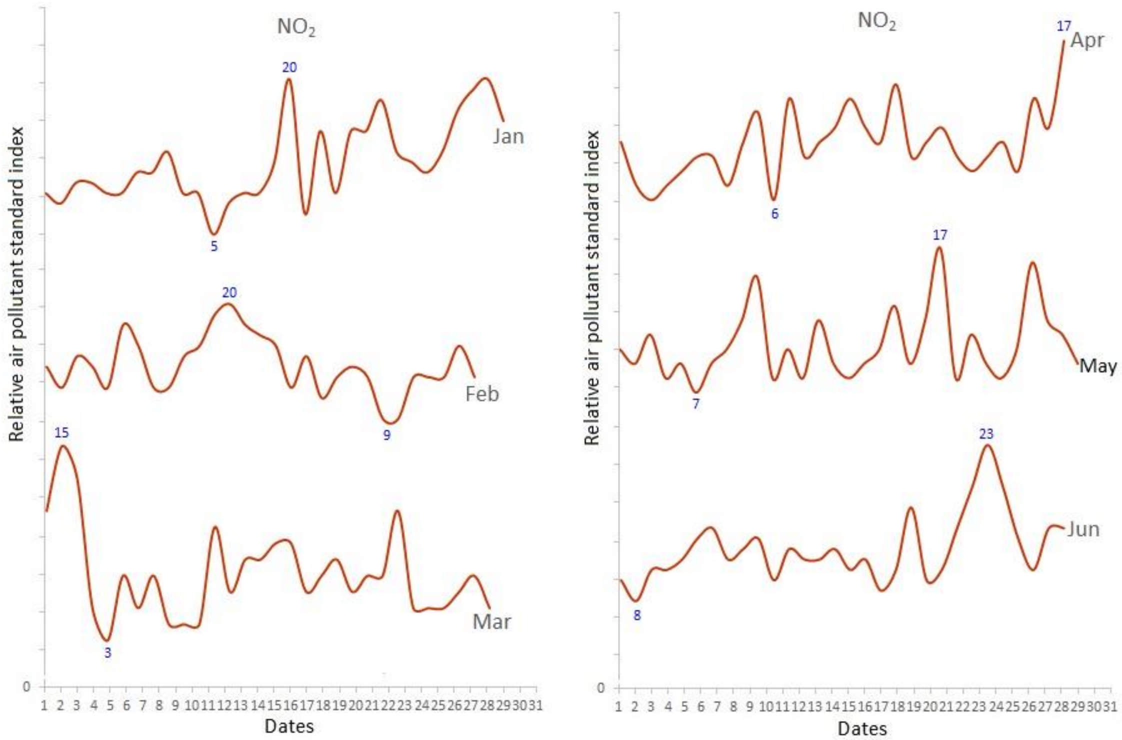


Figure 6. Air pollutant standard index of nitrite ($NO_2$) in DKI Jakarta Province from January - June 2020.

The results of the analysis of the air pollutant standard index clearly show that large-scale physical distancing during the COVID-19 pandemic in DKI Jakarta can improve air quality but are not 100% effective in reducing the five main sources of air pollution. One of the contributing factors is that the community does not really obey the large-scale physical distancing rules. The lowest average air pollutant standard index occurred in March, namely in the $PM_{10}$, $SO_2$ and $NO_2$ parameters. In the first month that a positive case of COVID-19 was announced, people were more alert and careful, even though in that month there were no large-scale physical distancing regulations from the government. Therefore, to achieve the goals of the large-scale physical distancing, it is necessary to have awareness from within the community itself.

## CONCLUSION

Based on the results of an analysis of the air pollutant standard index in DKI Jakarta Province, it was found that large-scale physical distancing during the COVID-19 pandemic caused Jakarta's air quality to be better. The effective carbon monoxide (CO) and nitrite ($NO_2$) compounds decreased by 47.34% and 45.68%, respectively. While particulates ($PM_{10}$), sulfide compounds ($SO_2$) and ozone ($O_3$) did not show significant differences between before and during large-scale physical distancing.

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