Implications of COVID-19 on The of Fine Particulate Matter (PM2.5) in Ethiopia

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Abstract

Background: The novel coronavirus pandemic, namely COVID-19, has become a global public health problem. COVID-19 was first reported in Ethiopia on 14 March 2020 by WHO. This paper is aimed at identifying the implication of COVID-19 on the concentration of $PM_{2.5}$ from March 14, 2020 to July 31, 2020 in Ethiopia.

Methods: The study gathered the environmental data released by Addis Ababa Central monitoring station before and during the coronavirus pandemic and discusses its impact on air quality. Daily concentrations of $PM_{2.5}$ were compared before and during the COVId-19 for 280 days. The study compared the daily concentration of $PM_{2.5}$ before COVID-19 from October 25, 2019 to March 13, 2020 and during COVID-19 from March 14, 2020 to July 31, 2020. The summary of the particulate matter, number of cases and deaths from March 14, 2020 to July 31, 2020 were analyzed in Ethiopia.

Results: The results show that, the concentration of $PM_{2.5}$ during COVID-19 was higher than before COVID-19. As air pollution increased the number of deaths was increased during coronavirus pandemic. There were 16,615 confirmed cases and 263 number of deaths from March 14, 2020 to July 31, 2020 in Ethiopia.

Conclusion: We found that the concentration of $PM_{2.5}$ during COVID-19 was higher than before COVID-19. COVID-19 has implications for the fine particulate matter ($PM_{2.5}$) pollution in metropolitan city.

Background

The novel coronavirus pneumonia, namely COVID-19, has become a global public health problem [1]. The outbreak of COVID-19 has spread rapidly across the world [2]. COVID-19 was initially reported in December 2019 in a small cluster in Wuhan (Hubei Province, China), it then successively spread all over the world [3–5]. The WHO declared COVID-19 a Public Health Emergency of International Concern [4]. Human and animal health threats from coronaviruses have been present over time [6]. A massive transformation of the world's COVID-19 pandemic has brought immense environmental effects [7]. A fast-rising number of confirmed cases has been observed in all continents, with Europe at the epicenter of the outbreak at this moment [8]. The case, which was announced on the 14th of March 2020, is the first one to be reported in Ethiopia since the beginning of the outbreak in China. The dramatic experience of the global Covid-19 pandemic has the great difficulty of effectively monitoring patients [9].

The COVID-19 global pandemic has likely affected air quality due to extreme changes in human behavior [10]. Urban air pollution has been associated with morbidity but little information exists on how it affects diurnal variation of lung function in children with asthma [11]. Similarly, high vehicle traffic was associated with asthma, cough and wheeze, and in children additionally exposed to environmental tobacco smoke, with allergic sensitization [12]. People living in an area with high levels of pollutant are more prone to develop chronic respiratory conditions and suitable to any infective agent [13]. A number of

cities worldwide experienced air quality improvements during COVID-19 lockdowns; however, such changes may have been different in places with major contributions from nontraffic related sources [14].

Furthermore, the coronavirus outbreak has led to a significant drop in worldwide air pollution [7]. As study shown that substantial human health benefits related to cardiovascular disease morbidity and mortality that can be achieved when aggressive control measures for air pollution are taken to reduce emissions from vehicles [15]. The number of confirmed cases of coronavirus infection is higher in countries with lower yearly average temperatures, higher economic openness and stronger political democracy [16]. Reinforced restrictive measures shall be considered in areas with higher air pollution, where the virus is more likely to find a fertile biological or environmental setting [17].

Atmospheric particulate matter with diameter less than 2.5 is a highly significant predictor of the number of confirmed COVID-19 cases and related hospital admissions [18]. Correspondingly, higher mortality was also correlated with poor air quality, namely with high $PM_{2.5}$, CO and NO_2 values [19]. In the same way, airborne particulate matter pollution likely increases the risk of getting COVID-19 in China [20]. COVID-19 held higher case fatality rate with increasing concentrations of $PM_{2.5}$ and PM_{10} in temporal scale, which may affect the process of patients developed from mild to severe and finally influence the prognosis of COVID-19 patients [21]. Air pollution is found to increase the risk of COVID-19 infection, therefore, use of mask and alcohols based standard sterilizers is significant [22]. As study conducted in Iran also shown that negative responses of the particulate matter pollution to positive shock in COVID-19 cases [23].

The coronavirus pandemic, which has numerous global implications, has led people to believe that nothing will be the same as before [24]. This paper identifying the association between $PM_{2.5}$ pollution and confirmed cases of COVID-19 in Ethiopia. Consequently, there is crucial need for the scientific community to explorer the experimental finding, or survey analysis between the association of COVID-19 and $PM_{2.5}$ pollution.

Materials And Methods

Study location

Addis Ababa has three $PM_{2.5}$ air quality monitoring stations at Black Lion Hospital, Addis Ababa Central, and Addis Ababa International Community School which is run by the United States Department of State in partnership with the United States of Environmental Protection Agency (USEPA). According to the WHO, 16615 confirmed cases and 263 deaths of COVID-19 have been identified in the whole of Ethiopia from March 14, 2020 to July 31, 2020. The researcher focused on $PM_{2.5}$, confirmed cases and deaths because of the limitation of the meteorological data and the others air pollution data. This study only included Addis Ababa Central air quality monitoring station. For the reason that, Addis Ababa central monitoring (US Embassy monitoring) station of air concentration is available on the AirNow website. Level of concentration of $PM_{2.5}$ were compared between historical versus current periods. In this study, changes in the air quality before and during the period of COVID-19 lockdown in Addis Ababa were quantified.

Data collection

Daily confirmed new cases for each day between March 14, 2020 to July 31, 2020 were obtained from the reports released by local Ministry of Health Ethiopia and Ethiopia Public Health Institute, and by WHO on the official websites. We set March 14, 2020 (i.e. first day COVID-19 cases confirmed in Addis Ababa) as the starting point of our study period to minimize the potential inclusion of imported cases from Ethiopia. Air pollution data were collected from an online platform (https://*www.airnow.gov* website) monitoring and analyzing the air quality. The study was covered 140 days of confirmed cases and deaths. Daily $PM_{2.5}$ concentration levels were obtained from the "Addis Ababa central monitoring station" which is publicly available for communities. The hourly concentration data were downloaded from AirNow or www.airnow.gov website of USEPA. The concentration of $PM_{2.5}$ data were collected before and during COVID-19 for 280 days. $PM_{2.5}$ concentrations was compared for four consecutive years (2017 to 2020) from March 14 to July 31 months. Similarly, $PM_{2.5}$ concentration data from March 14, 2020 to July 31, 2020 was compared with confirmed cases of coronaviruses and deaths in each day. Furthermore, there were 25 days (8.9%) the total missing data of $PM_{2.5,}$ that means 19 days (13.6%) were before COVID-19 and 6 days (4.3%) were during COVID-19.

Statistical analysis

The data were downloaded and calculated from the online portal of Air Pollution Monitoring Station of Ethiopia. Moreover, the descriptive statics analysis of maximum, minimum, mean and standard deviation were analyzed, and association of the $PM_{2.5}$ and COVID-19 analyzed. All analyses in this study were conducted using the Origin Pro software (version 9). The difference concentration of fine particulate matter between the before and during the period of COVID-19 in Addis Ababa were analyzed. The mean concentration of fine particulate matter from 2017 to 2020 were calculated in study period.

Results

Concentration of fine particulate matter observations (hourly mean) were retrieved from one monitoring station and excluded the missing data. Between March 14 and July 31, 2020 for total 140 days, the number of new cases in the Ethiopia was 16,615 in Table 1. Whereas, the total number of deaths reported during this time were only 263. The highest number of new cases, deaths and particulate matter recorded were 805 (July 31, 2020), 14 (July 30, 2020) and 71.5 $\mu g/m^3$ at (July11, 2020) respectively.

Table 1
The summary of the particulate matter, number of cases and deaths from March 14, 2020 to July 31, 2020 in Ethiopia.

Descriptive	Conc. of $PM_{2.5}$ in $\mu g/m^3$	Number of Coronavirus cases	Number of deaths
Maximum	71.5	805	14
Mean	26.36	118.7	1.9
Minimum	9.5	0	0
Stand Dev	9.90	176.86	3.14
Summary		16615	263

As indicated in Fig. 1 and Table 2 below, the highest number of new deaths 160 (61.3%) in July, 2020. Correspondingly, the number new deaths were 3 (1.15%), 5 (1.92%) and 93 (35.6%) in April, May and June consecutively. Whereas, the lowest number of new deaths 0 (0%) in March Month. Both number of deaths were increased from March 14 to July 31, 2020. Besides, the highest $PM_{2.5}$ recorded was 37 $\mu g/m^3$ in June and the lowest $PM_{2.5}$ recorded was 19.8 $\mu g/m^3$ in April. In the first three months from March 14 the $PM_{2.5}$ recorded were lower than the June and July months.

As shown in Fig. 2 and Table 2 below, the highest number of new cases 10769 (64.8%) in July, 2020. Correspondingly, the number of new cases were 107 (0.6%), 933 (5.6%) and 4783 (28.8%) in April, May and June consecutively. Whereas, the lowest number of new cases 23 (0.1%) in March Month. The number of new cases was increased from March 14 to July 31, 2020.

As indicated in Table 2 also, from the total new cases of coronavirus were 16615 and 263 deaths. This implies that from total cases there was 1.58 percentage of deaths.

Table 2
The number of total cases and deaths with the percentages from March 14 to July 31, 2020

Items	Number of COVID-19 cases	Percent of cases	Number of deaths	Percent of death	Percent of deaths per total cases
March	23	0.1	0	0	1.58
April	107	0.6	3	1.14	
May	933	5.6	5	1.9	
June	4783	28.8	95	36.12	
July	10769	64.8	160	60.8	
total	16615	1	263	1	

As shown in Fig. 3, the mean of concentration $PM_{2.5}$ recorded were 27.7 μg/m^3, 30.5 μg/m^3, 25.2 μg/$m^3$and 26.3 μg/m^3 from 2017, 2018, 2019 and 2020 years respectively. The highest concentration $PM_{2.5}$ recorded were 42.8 μg/m^3 in June, 2018 and 39.2 μg/m^3 in July, 2017 and 2019.

As indicated in Fig. 4, the mean concentration of fine particulate matter recorded were 20.8 μg/m^3 and 26.4 μg/m^3 for before and during COVID-19 respectively. This implies that, the air pollution becomes increased during COVID-19 for 140 days as compared with before COVID-19 with 140 days consecutively. Besides, the total missing data of concentration of $PM_{2.5}$ were 25 days (19 days before and 6 days during COVID-19) respectively.

Discussion

Our study suggests that both daily concentration of fine particulate matter and the confirmed cases of COVID-19 in Ethiopia. COVID-19 outbreak has caused great health burden in both developed and developing countries. In this study, we examined the relationship between fine particulate matter and confirmed cases of COVID-19. The results showed that as air pollution increased the number of deaths cases due to coronavirus also increased Fig. 1. As study conducted by [25], increased ambient particulate matter from industrialization and urbanization is highly associated with morbidity and mortality in worldwide. Increasingly rigorous containment measures allowed to reduce the impact of the COVID-2019 pandemic on the Italian National Health System but at the same time these restriction measures gave also the opportunity to assess the effect of anthropogenic activities on air pollutants in an unprecedented way [26]. However, with reduced activities, severe air pollution events still occurred in the North China Plain, causing discussions regarding why severe air pollution was not avoided [27].

Number of cities worldwide experienced air quality improvements during COVID-19 lockdowns; however, such changes may have been different in places with major contributions from nontraffic related sources [14]. When we compared the concentration of $PM_{2.5}$ for 140 days before and 140 days during COVID-19 in Addis Ababa the mean concentration of $PM_{2.5}$ was increased 5.6 μg/m^3 during COVID-19 in Fig. 4. This might be due to no lockdown stated by government of Ethiopia, and there is movement of people, transportation cars and industries activities during COVID-19 emergency. Likewise, study conducted [28] in Ontario Canada, fine particulate matter did not show any significant reductions during the State of Emergency. Contrary, the mean excessive risks of particulate matter reduced by ~ 52% nationwide due to restricted activities in lockdown period in India [29]. Decline in $PM_{2.5}$ concentration due to lockdown, mainly due to less movement of people to keep “social distancing” to control the spread of COVID-19 [30].

In addition, there is a significant relationship between air pollution and COVID-19 infection, which could partially explain the effect of national lockdown and provide implications for the control and prevention of this novel disease [1]. Source contributions of $PM_{2.5}$ transported from potential geographical regions showed reductions with mean values ranging from 0.22 to 4.36 μg/m^3 [31]. The lockdown has made it

possible to quantify the limit of decrease in pollution in light of this drastic reduction in traffic, in Madrid and Barcelona showed a significant decrease of the order of 75% [32].

Table 2 presents the result, the total number confirmed cases of coronavirus was 16615 and 263 deaths from March 14 to July 31, 2020 in Ethiopia. There was 1.58% of deaths from total confirmed coronavirus cases. Due to movement of people from one city to other cities, one country to other countries, infection spreads and COVID- 19 became a pandemic [33]. The highest number of COVID-19 cases were recorded in the most polluted regions with patients presenting with more severe forms of the disease requiring ICU admission [34]. Areas with worse prior air quality, especially higher concentrations of diesel exhaust, may be at greater COVID-19 risk, although further studies are needed to confirm these relationships [35].

Conclusion

This is the first study to investigate the implication of COVID-19 on fine particulate matter in Ethiopia, the daily mortality and confirmed cases of COVID-19 were studied. Our finding shows that the daily mortality of COVID-19 is increased as fine particulate matter increased. The concentration of fine particulate matter during COVID-19 was higher than Before COVID-19. From time to time the confirmed cases by COVID-19 were increased in Ethiopia. In overall, this study recommends the fine particulate matter ($PM_{2.5}$) also be important factors affecting the COVID-19 mortality.

Declarations

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Authors' contributions: Tadesse and Asnake designed the study. Abdella and Birhanu acquired the data. Tadesse, Abdella and Asnake analyzed and interpreted the data, and drafted the manuscript. All authors read and approved the final article.

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Availability of supporting data: The datasets of concentration of particulate matter ($PM_{2.5}$) and confirmed COVID-19 cases used or analyzed during the current study are available from the https://www.airnow.gov website and WHO reports.

Ethics approval and consent to participate: Not applicable

Consent for publication: Not applicable

Competing interests: None declared

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Figures

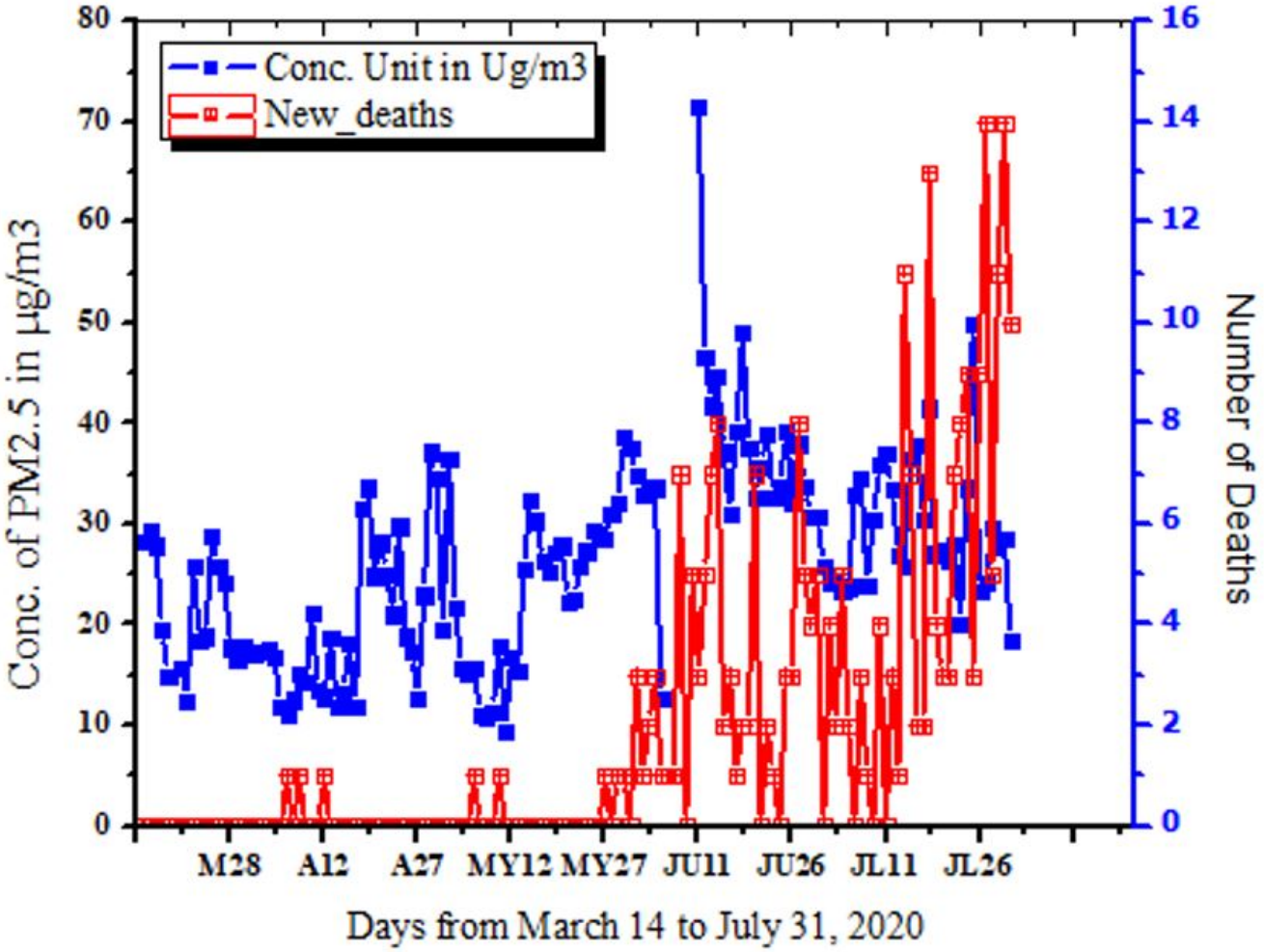

Figure 1

The relationship between PM2.5 and new deaths cases in Ethiopia

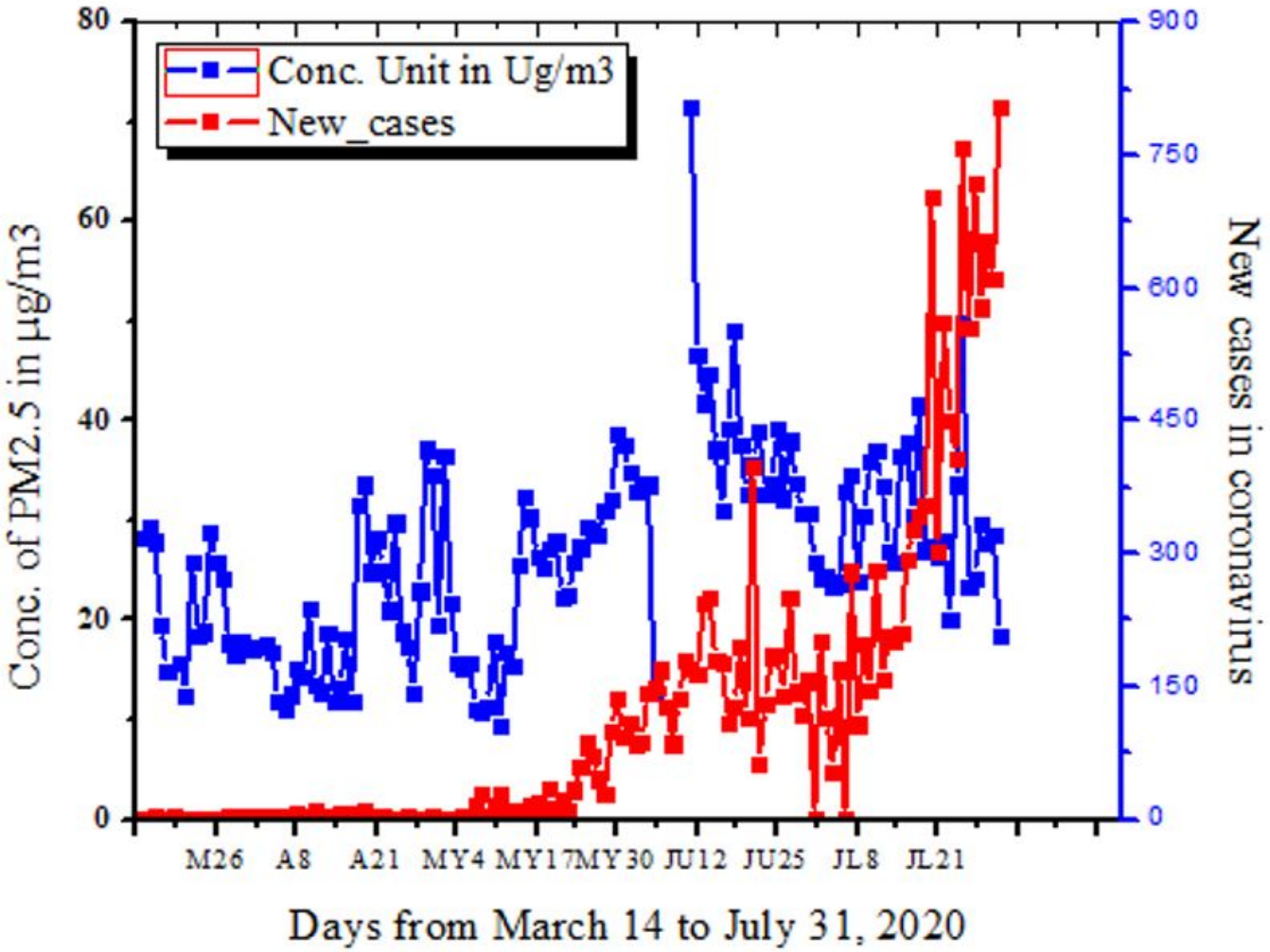

Figure 2

The relationship between the PM2.5 and new cases of coronavirus

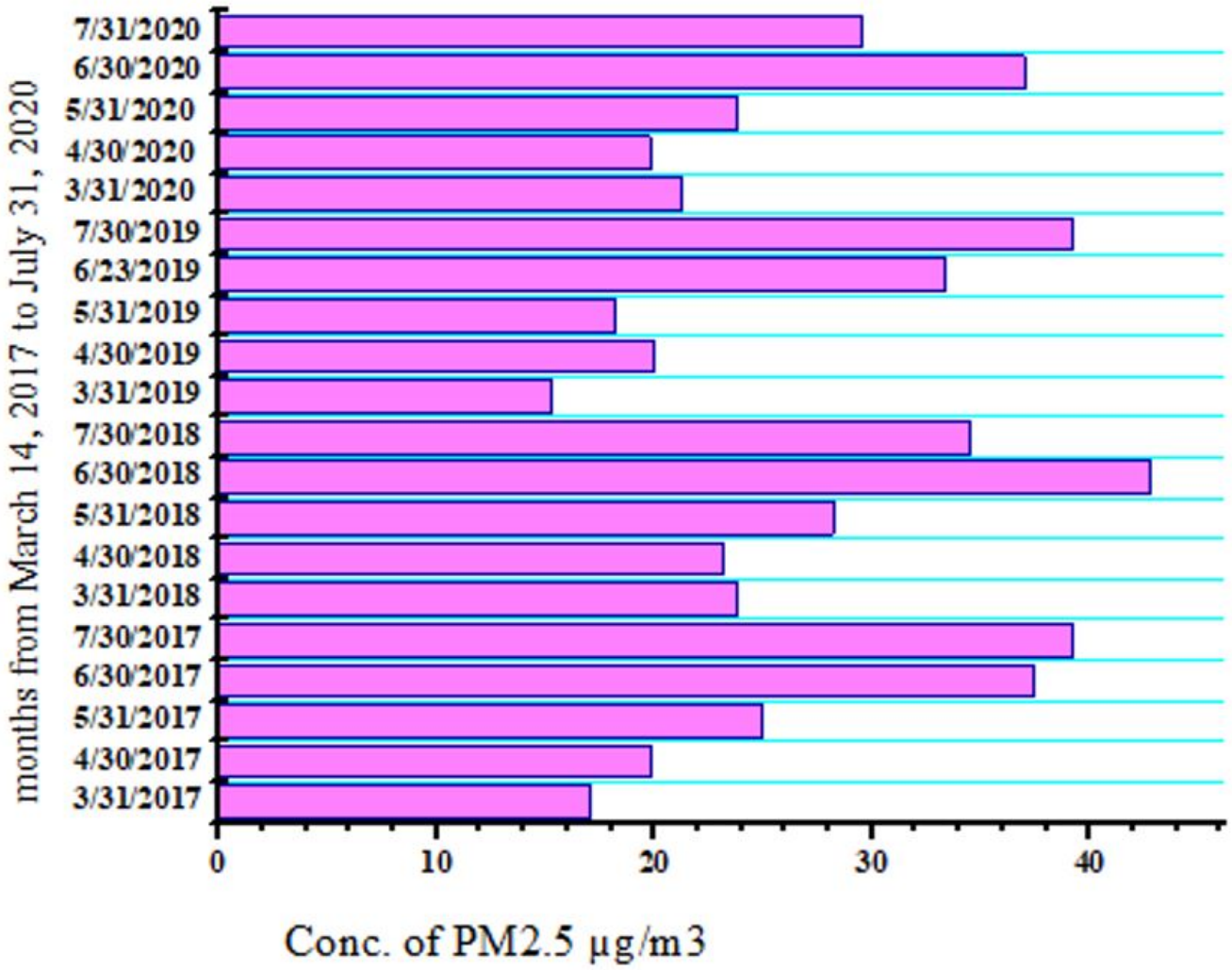

Figure 3

The trend mean concentration of PM2.5 from (March 14, 2017 to July 31, 2017) to (March 14 to July 31, 2020).

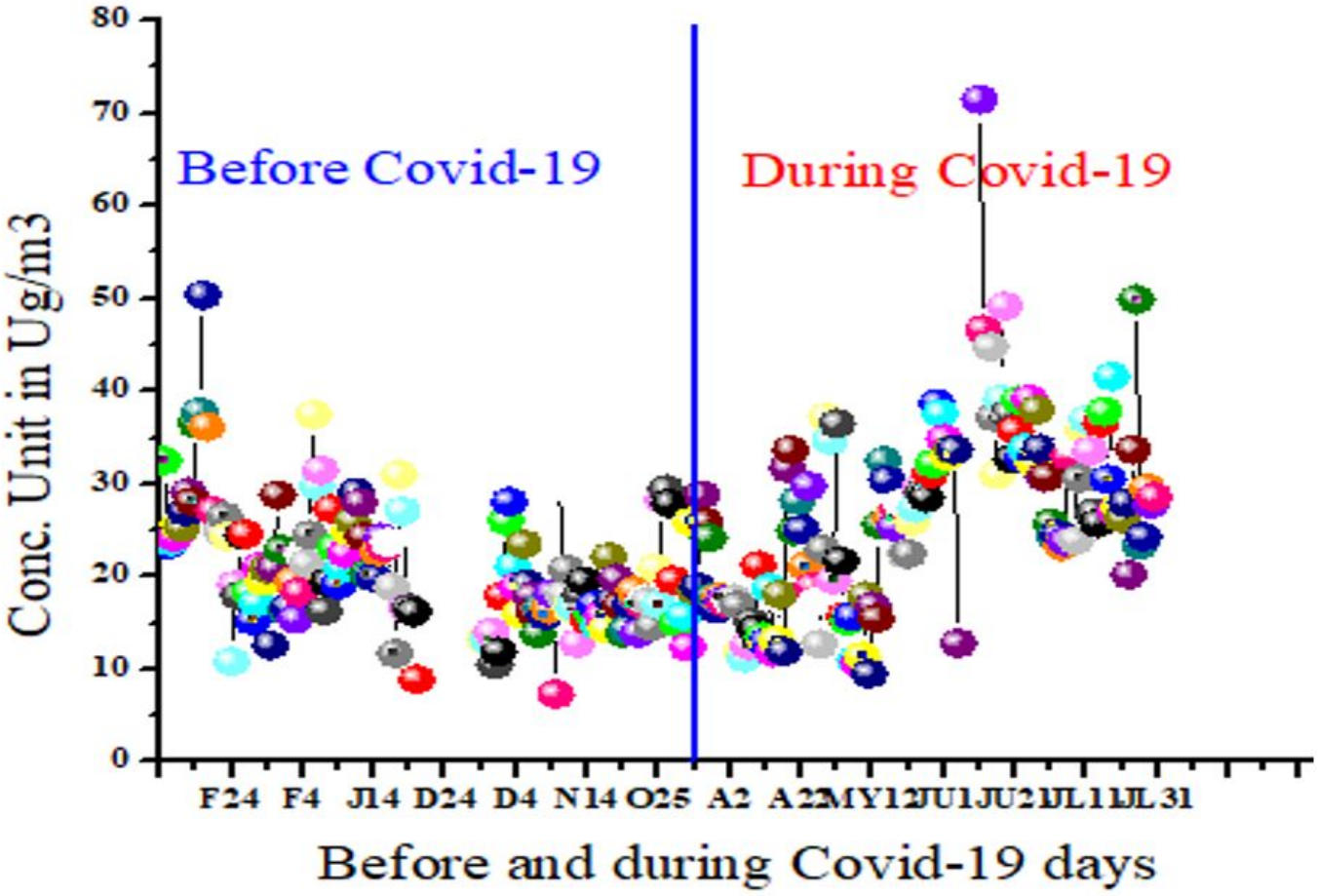

Figure 4

The concentration of PM2.5 before and during COVID-19 in Addis Ababa