Since January 2020 Elsevier has created a COVID-19 resource centre with free information in English and Mandarin on the novel coronavirus COVID-19. The COVID-19 resource centre is hosted on Elsevier Connect, the company's public news and information website.

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SARS-CoV-2 infection and air pollutants: Correlation or causation?

Keywords:
SARS-CoV-2 infection
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Dear Editor

We have recently read the reports from Zhu et al. (2020) and from Ogen (2020), suggesting a possible relationship between some air pollutants (i.e. $PM_{2.5}$, PM_{10}, CO, NO_2, and O_3) and SARS-CoV-2 infection rates. Such results are somewhat consistent with previous evidence that higher concentrations of air pollutants may be closely related to higher occurrence of respiratory infections caused by human pathogens, both as long-term and short-term exposures (Ciencewicki and Jaspers, 2007; Horne et al., 2018). Since COVID-19 endemic areas in China and in Italy are industrial areas being included among the most polluted in the developed countries, the plausibility of such a relationship may be particularly compelling, with subsequent significant implications for control and prevention of SARS-CoV-2 infection.

However, we think that a link between SARS-CoV-2 infection and pollution deserves some comments, as we believe that the proposal of such a link may be confounded by a number of factors. First of all, confirmed COVID-19 cases are only a proxy for the true SARS-CoV-2 infection incidence rate, as most asymptomatic cases or patients with very mild symptoms might not be tested and remains unidentified (Baud et al., 2020).

Second, as notification procedures may be complicated by a certain time lag, determined by the time requested to ascertain the true status of cases, it is possible that the notification day may fall well outside the real and more appropriate infection time lapse (i.e. onset of symptoms), with further consequences on the analyses (Hellewell et al., 2020).

Third, highly polluted areas in China and in Italy are characterized by higher rates of human interaction, particularly in the workplace, health and commercial facilities, and by a higher proportion of international travelers. Interestingly, the Italian region of Lombardy had common trading and industrial interests with the Wuhan area of China, being in its turn extensively interconnected with nearby regions of Emilia Romagna, Veneto and Piedmont, all of them from the highly polluted area

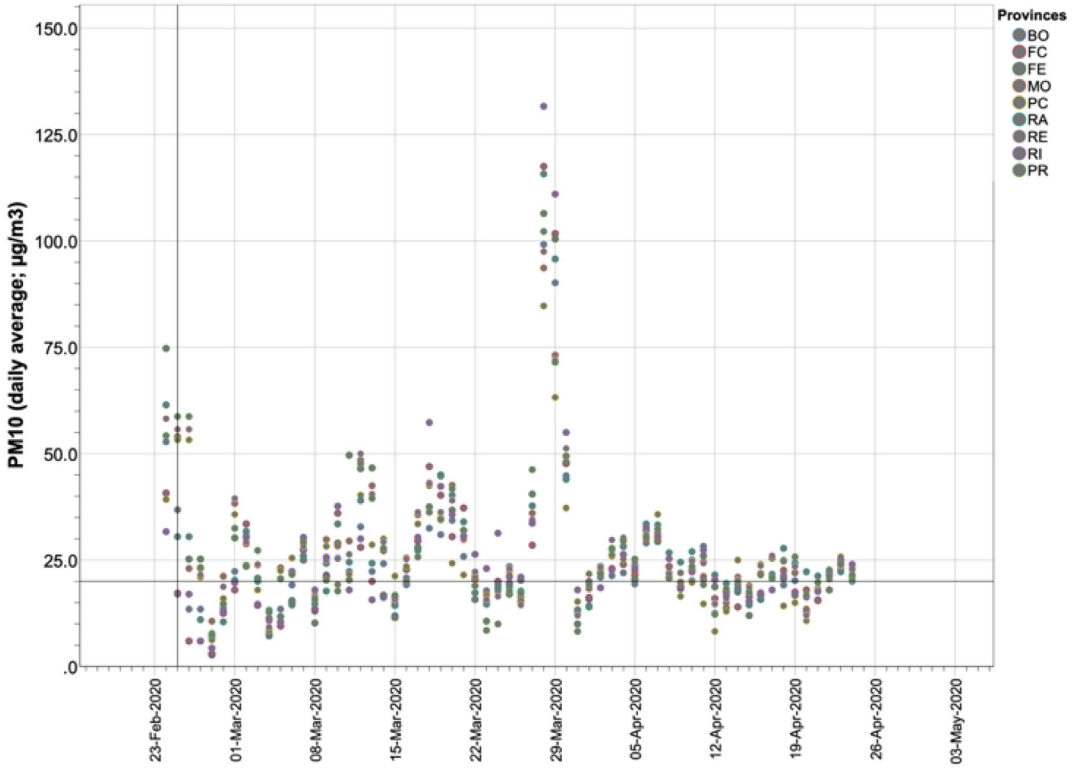

Fig. 1. Daily average PM_{10} concentration in Emilia Romagna Region during the lockdown (February 25th to April 24th, 2020). PM_{10} values decreased from 55.2 ± 1.4 µg/m^3 to 22.4 ± 0.7 µg/m^3 (Note: Bo = Bologna; FC = Forlì-Cesena; FE = Ferrara; MO = Modena; PC = Piacenza; RA = Ravenna; RE = Reggio Emilia; RI = Rimini; PR = Parma).

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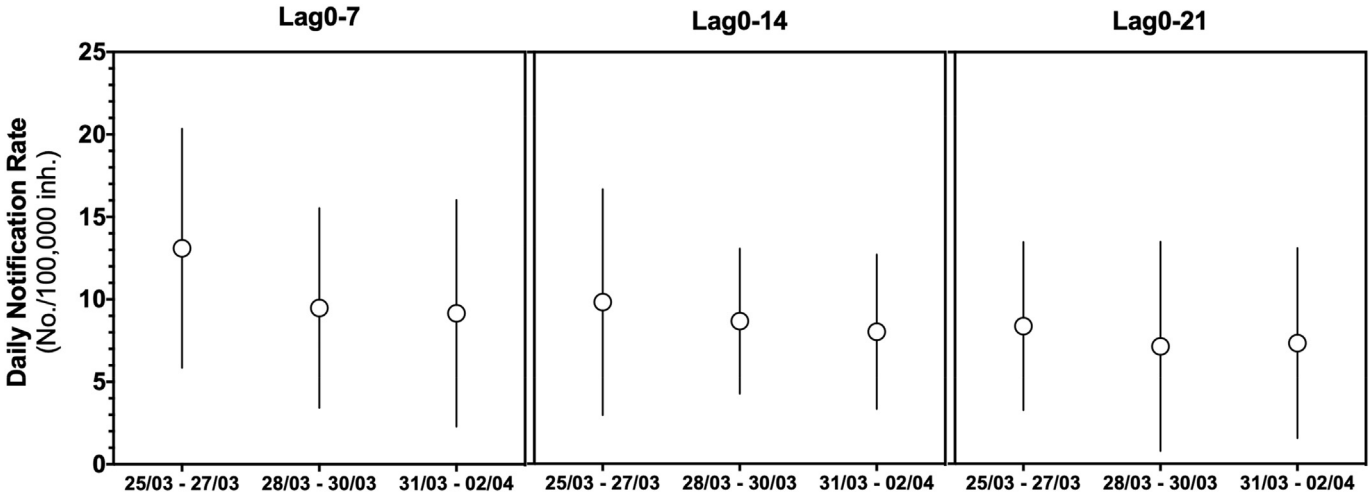

Fig. 2. Daily notification rates of COVID-19 confirmed cases, comparing in Lag0–7, 0–14, 0–21, the timeframe 28/03–30/03, characterized by a sudden surge of PM_{10} concentrations, with previous and following days.

of the Po river Valley, and all as well deeply involved in the SARS-CoV-2 epidemic (Guzzetta et al., 2020). As a consequence, the higher notification rates may have been simply due to an earlier and unnoticed spreading of the initial outbreak from mainland China, with a late diffusion to other Italian regions.

Last, but not least, it should be stressed that lockdown measures are significantly affecting air pollutants, reducing their daily concentrations. The clearance of air pollutants requires some time after the start of the lockdown (see actual data on PM_{10} from Emilia Romagna in Fig. 1) (Tobías et al., 2020); moreover, during the lockdown period the overall notification rate is similarly expected to fall (Guzzetta et al., 2020). We could therefore speculate that we are observing a correlation rather than a causation. Interestingly, during the lockdown phase (more precisely, between March 28th and March 30th), Emilia Romagna region showed a sudden surge of air particulate apparently unrelated with human activities. However, no increases in daily notification rates were clearly noticeable when comparing the suspected timeframe with the immediately previous (March 25th–27th) and subsequent (March 31st–April 2nd) timeframes, in lags 0–7, 0–14 days, and 0–21, as otherwise suggested by Zhu et al. (2020) (Fig. 2).

In conclusion, we suggest that a more appropriate way in dealing with and understanding the relationship between air pollution and SARS-CoV-2 infection incidence rates may occur comparing geographical areas characterized by similar socio-economic development, but strikingly different environmental status (e.g. highly polluted areas versus those with low pollution levels).

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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References

Baud, D., Qi, X., Nielsen-Saines, K., Musso, D., Pomar, L., Favre, G., 2020. Real estimates of mortality following COVID-19 infection. Lancet Infect. Dis. https://doi.org/10.1016/S1473-3099(20)30195-X S1473-3099(20)30195-X.

Ciencewicki, J., Jaspers, I., 2007. Air pollution and respiratory viral infection. Inhal. Toxicol. 19 (14), 1135–1146. https://doi.org/10.1080/08958370701665434.

Guzzetta, G., Poletti, P., Ajelli, M., Trentini, F., Marziano, V., Cereda, D., Tirani, M., Diurno, G., Bodina, A., Barone, A., Crottogini, L., Gramegna, M., Melegaro, A., Merler, S., 2020. Potential short-term outcome of an uncontrolled COVID-19 epidemic in Lombardy, Italy. February to March. Euro Surveill. 25 (12), 2000293. https://doi.org/10.2807/1560-7917.ES.2020.25.12.2000293.

Hellewell, J., Abbott, S., Gimma, A., Bosse, N.I., Jarvis, C.I., Russell, T.W., Munday, J.D., Kucharski, A.J., Edmunds, W.J., Centre for the Mathematical Modelling of Infectious Diseases COVID-19 Working Group, Funk, S., Eggo, R.M., 2020. Lancet Glob. Health 8, e488–e496. https://doi.org/10.1016/S2214-109X(20)30074-7.

Horne, B.D., Joy, E.A., Hofmann, M.G., Gesteland, P.H., Cannon, J.B., Lefler, J.S., Blagev, D.P., Korgenski, E.K., Torosyan, N., Hansen, G.I., Kartchner, D., Pope 3rd, C.A., 2018. Short-term elevation of fine particulate matter air pollution and acute lower respiratory infection. Am. J. Respir. Crit. Care Med. 198 (6), 759–766. https://doi.org/10.1164/rccm.201709-1883OC.

Ogen, Y., 2020. Assessing nitrogen dioxide (NO_2) levels as a contributing factor to coronavirus (COVID-19) fatality. Sci. Total Environ. 726, 138605. https://doi.org/10.1016/j.scitotenv.2020.138605.

Tobías, A., Carnerero, C., Reche, C., Massagué, J., Via, M., Minguillón, M.C., Alastuey, A., Querol, X., 2020. Changes in air quality during the lockdown in Barcelona (Spain) one month into the SARS-CoV-2 epidemic. Sci. Total Environ. 726, 138540. https://doi.org/10.1016/j.scitotenv.2020.138540.

Zhu, Y., Xie, J., Huang, F., Cao, L., 2020. Association between short-term exposure to air pollution and COVID-19 infection: evidence from China. Sci. Total Environ. 727, 138704. https://doi.org/10.1016/j.scitotenv.2020.138704.

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