*Letter to the Editor*

# Indoor Air Pollution was Nonnegligible during COVID-19 Lockdown

## Wei Du, Gehui Wang[*]

*Key Laboratory of Geographic Information Science of the Ministry of Education, School of Geographic Sciences, East China Normal University, Shanghai 200241, China*

## ABSTRACT

COVID-19 spread globally in the past months and caused hundreds of thousands of people dead. Many countries took lockdown policy to restrict human activities and industry to slow down the virus spread. The implementation of stringent lockdown resulted in less traffic and industrial emissions, thus reduction of various ambient air pollutants were observed in urban areas. Considering people stayed longer time in indoor, the indoor air pollution (IAP) might play a more important role for human health during lockdown. People suffered from high possibility of IAP exposure risk increase during lockdown as they almost stayed at home the whole day. Unfortunately, available studies on IAP and its health impact during this period were rare compared with those on ambient air. By this, more investigations should be performed to estimate the impact of global COVID-19 lockdown on human health in the future.

*Keywords:* COVID-19; Lockdown; Indoor air pollution.

As an infectious disease occurred once in a blue moon, COVID-19 was still in the pandemic. Till August 2, 2020, COVID-19 had caused more than 675,060 cases of death, and 17,396,943 cases infected around the world (WHO, 2020). To slow down the virus spread, China was the first country which decided to restrict human activities and industry (Xu *et al.*, 2020). The stringent lockdown was followed by many countries as it worked well (CNN, 2020; Kanniah *et al.*, 2020). The implementation of stringent lockdown resulted in less travel and less traffic and industrial emissions, and significant ambient air pollution reduction was observed both in China and other countries (Dutheil *et al.*, 2020; Myllyvirta, 2020; Earth Observatory, 2020; Safarian *et al.*, 2020; Xu *et al.*, 2020). Previous studies found apart from $O_3$, other air pollutants including $PM_{2.5}$, $PM_{10}$, $SO_2$, $NO_2$, and CO decreased significantly after lockdown in typical cities and areas such as Wuhan in China, Rome in Italy, Delhi in India, Salé City in Morocco, and southeast Asian area (Jain and Sharma., 2020; Kanniah *et al.*, 2020; Otmani *et al.*, 2020; Pierre *et al.*, 2020; Xu *et al.*, 2020). This huge drop of various ambient air pollutants was recognized as benefit on human health to a certain extent (Dutheil *et al.*, 2020; Jain and Sharma, 2020). It was well recognized that air pollution was associated with non communicable diseases such as respiratory allergies and lung cancer and could cause millions premature deaths around the world (Cohen *et al.*, 2017). The better ambient air quality, although not the reason for COVID-19 lockdown, was a co-benefit to the environment and human health. According to this, some points thought COVID-19 lockdown could save people' lives because better ambient air quality could have positive impact on human health during this period (Isaifan, 2020; Son *et al.*, 2020).

Apart from ambient air quality, the indoor air quality, which was often overlooked, should get more concern considering people almost stayed the whole day at home and mainly exposed to indoor air pollutants during the lockdown. IAP was usually higher than ambient air pollution, especially in rural homes burning solid fuels for cooking and heating (Qi *et al.*, 2017, 2019). Considering the main source of IAP was different from ambient air pollution, the reduction of ambient air pollution might fail to result in a similar drop in IAP. For example, in rural Shanxi, China, IAP was 6.3 times higher than ambient air pollution (Huang *et al.*, 2017) due to the internal emission source or other factors that could increase the IAP. In fact, IAP was getting increasing concern in recent years since people spent most of their time in indoor and the severe health outcome (Wang *et al.*, 2016; Du *et al.*, 2017a, b; Qi *et al.*, 2017; Du *et al.*, 2020). It was estimated that nearly 1.64 and 0.27 million premature deaths were due to household air pollution (IAP contributed most) globally and in China, accounting ~35.8% and 24.1% for the total premature deaths associated with $PM_{2.5}$ exposure, respectively, in 2017

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[*] Corresponding author.
 *E-mail address:* ghwang@geo.ecnu.edu.cn

(GBD, 2019). Compared with the numerous studies focused on ambient air pollution during COVID-19 lockdown, the studies on IAP was relatively rare (Amoatey *et al.*, 2020). A study conducted in Middle Eastern countries found the habitual indoor incense burning could increase indoor PMs, resulting in a favorable condition for the spread of the virus via inhalation (Amoatey *et al.*, 2020). Ching and Kajino (2020) also pointed out the air quality in some indoor environments such as toilets, hospitals, and clinics should be paid special concern to. Various factors could have impact on IAP, such as fuel type, cooking, and smoking behaviors (Huang *et al.*, 2017; Du *et al.*, 2020). The most important influence factors that could increase IAP are described below:

1) Cooking and/or heating fuel and household fuel consumption: the incomplete combustion of solid fuels (biomass, animal dung, and coals) could emit a lot of pollutants such as PMs, PAHs, $NO_x$, and so on (Shen *et al.*, 2015; Du *et al.*, 2018). Compared to solid fuels, gas fuels emitted less pollutants and electricity almost do not emit any pollutants (Shen *et al.*, 29017; Zhao *et al.*, 2020). The households using solid fuels usually had higher IAP than those using clean energies. Except fuel type, the consumption also influence the indoor air quality (Tao *et al.*, 2018). When China announced the lockdown, hundreds millions of people had travelled back to their rural hometowns for traditional spring festival, so the families in rural areas became bigger than the days before the lockdown (Fan *et al.*, 2020). In some developing countries such as India, poor workers walked back to rural areas because of the loss of job, also resulted in bigger family sizes in rural areas (CNN, 2020). Given this, the households in rural areas may need more fuels to prepare food or heating. Fig. 1 showed the photo of a typical kitchen when cooking with solid fuels, the air pollution was very severe during this period. For urban households, they might also need to prepare their food at home instead of eating out as normal, thus the emissions from cooking would be higher, which was stated in a previous study conducted in Wuhan, China (Pierre *et al.*, 2020).



**Fig. 1.** The photo of a typical kitchen when burning solid fuel for cooking.

2) Cooking oil: cooking oil also was an important contributor to IAP, especially in China where stir frying was a popular cooking style (Karimatu *et al.*, 2013; Zhao *et al.*, 2019). Cooking more frequently at home during lockdown might not only increase the emissions of cooking fuel, but also the emission of cooking oil.

3) Smoking: Smoking not only harmed the health of smoker, but also the people exposed to the second hand smoke (Kanchongkittiphon *et al.*, 2015). During lockdown, if there was a smoker in a household, his families might suffer from second-hand smoke more frequently, this was especially severe for babies (children), pregnant women, and elders since they were more sensitive to air pollution (Wang *et al.*, 2017; Pani *et al.*, 2020; Van der Zee *et al.*, 2020).

4) Human activities: playing at home or cleaning the floor up could also increase the indoor air pollution. The human activities would be more frequent during lockdown since the families stay together at home almost the whole day.

5) Air conditioning, use of home ventilation systems, and opening duration/frequency of doors and windows: it was found that the use of air cleaner and home ventilation could have positive impact on indoor air quality (Zhang *et al.*, 2011; Huang *et al.*, 2017). The opening duration/frequency of doors and windows also affected indoor air through indoor/outdoor air exchange (Liu *et al.*, 2018).

Based on the above discussion, people might suffer from high possibility of inhalation exposure risk increase, especially in rural homes burning solid fuels, thus leading to negative health outcome. Although the ambient air pollution drop significantly after the lockdown, it would be a little optimistic to consider the COVID-19 lockdown as a positive health impact because the IAP might be aggravated. In our point, the lockdown might fail to save people' lives by improving ambient air quality because when indoor air pollution was taken into consideration, the impact might turn to a negative one

(Pierre *et al.*, 2020). Given the fact that the IAP might be severer during lockdown, some suggestions were given below:
1) Try to use clean fuels and cook in a better way that emitted less pollutants.
2) Open the window frequently or use air cleaner, and use kitchen ventilator when cook if possible.
3) Try not to smoke at home.

In the future, more attention should be paid on the health impact of COVID-19 lockdown on human health caused by IAP. Investigations, both experimental and epidemiological investigations should be performed to estimate the impact of global COVID-19 lockdown on human health, especially for residents living in rural areas and using solid fuels as the routine fuels in the future.

## CONCLUSION

The implementation of COVID-19 lockdown resulted in less travel and traffic and less industrial emissions. Many previous studies found significant ambient air pollution reduction in both China and other countries. Although the better ambient air quality was not the reason for COVID-19 lockdown, it was a co-benefit both on environment and human health as a matter of fact. Considering people spent most of their time in indoor environments during the lockdown, the IAP might played a more crucial role, which was unfortunately overlooked. In this study, the factors affected indoor air quality were discussed and advice to reduce IAP was given. Theoretically, there was a high possibility of potential IAP increase, thus leading to negative health outcome on human during COVID-19 lockdown. Based on this, future investigations should be performed to estimate the impact of global COVID-19 lockdown on human health.

## COMPETING FINANCIAL INTEREST

The authors declare no competing financial interest.

## ACKNOWLEDGEMENT

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