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COMMENTARY

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Household air pollution during COVID-19 pandemic: A concern in India

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Household air pollution is a serious public health concern in India with more than half of the Indian households relying on solid fuel use. The long periods of lockdown related measures to control COVID-19 pandemic in India further aggravated the adverse health effects of household air pollution as millions Indians were exposed to high level of health-damaging air pollutants inside their homes. This commentary discusses the vulnerability of the socioeconomically disadvantaged population forced to stay indoors during the pandemic. Exposure to household air pollution has detrimental effects on health, which might put individuals at higher risk for complications related to COVID-19. A large proportion of socioeconomically disadvantaged section of the population were exposed to critical levels of household air pollution and more vulnerable to severe health effects of COVID-19. There is a pressing need to understand the aggravated health consequences of household air pollution in association with COVID-19.

1 | OVERVIEW

The global outbreak of the COVID-19 pandemic has affected millions of lives so far. The spread of pandemic has brought humongous challenges to the health and economy in high, low, and middle-income countries. Even the best of the healthcare system in high-income countries such as the United States of America, Italy, Spain, and the United Kingdom have been rendered precarious; the numbers of coronavirus cases and deaths in these countries are still daunting. With inadequate healthcare infrastructure, India as a more populous developing country faces more grave challenges. The World Health Organization (2020), reported 21,026,758 confirmed cases worldwide, out of which 2,526,192 confirmed cases and 49,036 deaths cases were recorded in India. India as a densely populated country with 17% of world's population in only 2.4% area faces an enhanced risk of spread of COVID-19. To constrain the spread of this highly contagious disease, a nationwide lockdown was implemented in India since March 25, 2020; which restricted people from unnecessary movement, urging them to stay indoors and limiting all nonessential travel activities. Besides, the government has issued various guidelines regarding social distancing, wearing a mask, and maintaining regular hand hygiene.

A tiny silver lining widely discussed and celebrated in the time of lockdown of the pandemic is a sudden improvement in the ambient air. Several studies (Chauhan & Singh, 2020; Gautam, 2020; Sharma et al., 2020) have confirmed that lockdown in India has led to a significant decline in air pollution due to lower emissions of ambient pollutants related to transport and commercial and industrial activities. However, much less is discussed about the increased exposure to other common and more menacing sources of air pollution in India from the use of biomass and coal, for cooking and heating purposes due to stay-at-home orders. The strict lockdown has exposed people to household air pollution like never before. This is a serious concern for a country like India, where more than half of the population is still exposed to household air pollution due to solid fuel use (Balakrishnan et al., 2019; Gupta, 2019). In India, around 6.7 lakhs deaths a year are attributable to outdoor air pollution and approximately 4.8 lakhs premature deaths a year are linked to household air pollution due to the use of solid fuel (Balakrishnan et al., 2019).

2 | AIR POLLUTION, HEALTH, AND COVID-19

Outdoor and household air pollution together account for over 14% of all noncommunicable diseases (Cohen et al., 2017). The Global Burden of Diseases, Injury, and Risk Factors Study, reported air pollution as the second largest contributing factor to disease burden in India after malnutrition (Mokdad et al., 2016). Furthermore, recent studies

(Guan et al., 2020; Kluge et al., 2020; Yang et al., 2020) report that individuals with co-morbid conditions are at higher risk of COVID-19 infection and deaths, and indoor air pollution may further add to co-morbid conditions. Therefore, COVID-19 may overstrain the existing health system in India, which already faces challenges from an escalating burden of noncommunicable diseases (Arokiasamy, 2018).

Exposure to ambient air pollution has detrimental effects on health (Brunekreef & Holgate, 2002; Mannucci et al., 2015; Pope 3rd, 2000), that might put individuals at higher risk for complications related to COVID-19, which is a notable concern. Whereas, several previous studies conducted in India have highlighted the influence of household air pollution on health (Balakrishnan et al., 2015; Elf et al., 2018; Sehgal et al., 2014). There is strong evidence linking household air pollution exposure with cardiovascular diseases (Dutta & Ray, 2012; Yamamoto et al., 2014), and respiratory diseases such as acute lower respiratory infections, chronic obstructive pulmonary disease and chronic bronchitis, lung cancer (Agrawal, 2012; Jindal et al., 2020; Mandal et al., 2020; Upadhyay et al., 2015). According to the Centers for Disease Control and Prevention (2021), pre-existing medical conditions like chronic lung diseases, diabetes, cancer, acute respiratory infection (ARI), CVDs, and so on, increases the severity of COVID-19 infection.

A study conducted in Delhi, which is one of the most polluted cities found that household air pollution during winters exceeds World Health Organisation standards by more than 20 times in households with both high and low socioeconomic status (Greenstone et al., 2021). Another study in South India documented the significant health impact of housing and SES characteristics on the burden of respiratory illness among women and children. A higher prevalence of respiratory problems was reported in low-income households exposed to indoor smoke (Rumchev et al., 2017). Maharana et al. (2018) showed that more than 60% of houses were overcrowded and poorly ventilated in a Kolkata slum. The study reported that irritation in the eye, suffocation, dry cough were significantly associated with the presence of IAP sources and their contributory factors. The present study found that majority of the households were exposed to IAP due to kerosene, neighborhood smoke while overcrowding, low income and ill-ventilation had a more worsening effect.

The poorest and the most vulnerable population are the most exposed to indoor air pollution. These households cannot afford alternative fuels or energy-efficient fuels such as kerosene, liquefied petroleum gas (LPG), and electricity or modern cookstoves because of poverty, which is one of the main barriers to the adoption of cleaner fuels (Agrawal, 2012; Duflo et al., 2008) exposing them to long-term adverse health effects.

There have been attempts to understand the association between exposure to air pollution or smoking and Severe Acute Respiratory Syndrome coronavirus 1 (SARS-CoV-1) and Severe Acute Respiratory Syndrome coronavirus 2 (SARS-CoV-2). Kan et al. (2005) study in Beijing, China found that daily mortality due to SARS might be associated with air pollutants like PM_{10}, SO_2, and NO_2. Another study from China while confirming a positive association between air pollution and SARS case fatality revealed that SARS patients from the highly polluted zones were twice as likely to die from the infection as compared to those from the low polluted region (Cui et al., 2003). A nationwide cross-sectional study conducted in the United States found that an increase of 1 $\mu g/m^3$ in $PM_{2.5}$ is associated with an 8% increase in the COVID-19 death rate (Wu et al., 2020). A recent study in China by Yongjian et al. (2020) showed a statistically significant link between air pollution and COVID-19 infection; short-term exposure to higher concentrations of $PM_{2.5}$, PM_{10}, CO, NO_2, and O_3 is associated with an increased risk of COVID-19 infection. Conticini et al. (2020) investigating the link between the high level of SARS-CoV-2 lethality and air pollution in Northern Italy concluded that a high level of atmospheric pollution can be related to higher prevalence and COVID-19 deaths. Several studies also reported smoking as a substantial risk factor of any viral infection and is most likely associated with adverse outcomes of COVID-19 (Berlin et al., 2020; Huang et al., 2020; Liu et al., 2019; Zhang et al., 2020). A systematic review by Vardavas and Nikitara (2020) revealed that smokers (current or former) were at higher risk of suffering from severe COVID-19 symptoms than nonsmokers as well as at greater risk of COVID-19 related mortality.

The scientific literature on the association between COVID-19 and air pollution as well as smoking suggests a potential linkage between household air pollution and COVID-19. The workers employed in the informal sector, staying in fragile settings were found more vulnerable to the severe effects of the pandemic (Ahmed et al., 2020). According to the latest round of National Family Health Survey (NFHS-4) report, around 76% of India's rural households and overall 56% of households rely on solid fuel use (IIPS, 2017), which implies that during this period of lockdown, millions of people in India are exposed to the high level of health-damaging air pollutants inside their homes, 20 times higher than accepted guidelines values (World Health Organization, 2016). Among households using solid fuel, almost 98% use chullah or open fire (IIPS, 2017). Exposure to indoor smoke can be up to 10 times hazardous than outdoor air pollution. This is because contained areas enable potential pollutants to build up more than open spaces (Kankaria et al., 2014).

Moreover, exposure to cooking smoke is aggravated in tiny, congested spaces, with poor ventilation without a chimney or hood. In India, such living conditions are generally found in slums of urban areas, where around 176 million people are estimated to live in extreme poverty (The World Bank, 2020). These slums are described to be unsuitable for human habitation due to poverty, overcrowding, perilous environmental, and social condition (Banerjee & Chattopadhyay, 2020; Corburn et al., 2020). Besides, the relatively high population density in slum areas may escalate COVID-19 infection and further exacerbate the current pathetic condition of slums. In poorer households, people use whatever is available for fuel such as plastic wastes, cloth rags, scrap tires, and other unconventional materials (Mbandi, 2020), which produces a hazardous level of pollutants. Almost 90% of Indian households do not have a chimney in the kitchen, and more than half of the households do not even have windows (IIPS, 2017). In addition to this, in around 29% of households, someone smokes inside the house on a daily basis, which may worsen

the effect of indoor smoke (IIPS, 2017). Smoking is more common among economically weak groups (Berlin et al., 2020). The Covid-19 lockdown measure of staying indoors in cramped settlements further increased the exposure to second-hand smoke at home.

Research shows that marginalized people, residing in fragile socioeconomic settings were most likely exposed to higher levels of air pollution because their houses and workplaces are in vicinity to industrial areas, waste dumps and roadways (Gouveia & Fletcher, 2000; O'Neill et al., 2003), augmented with poor access to health services and nutrition. According to a recent research literature (The Lancet, 2020), these immunocompromised populations are at higher risk to COVID-19, therefore this necessitates the need to understand the consequences of being exposed to household air pollution in association with COVID-19.

Further epidemiological research studies are needed to explore the association between household air pollution and COVID-19 risk in India. Future studies may consider studying various markers of household air pollution such as the use of incense sticks, mosquito coils, and so on along with the use of clean and unclean fuel and indoor smoking; personal exposure duration; presence of ventilation and separate kitchen; type of cooking stove; type of house; individual's activity pattern; health and socioeconomic conditions using case–control studies or exposure–response estimates.

3 | CONCLUSIONS

The COVID-19 pandemic had devastating health consequences, shattering the lives of a large majority of people in India. However, it has been evident from history that pandemic rarely affects everyone uniformly. Considering the dependency of a huge population on solid fuel use in India and the increasing severity of COVID-19 associated with air pollution, those belonging to the socioeconomically disadvantaged section of the society were the most vulnerable ones. People residing in these settings were the worst affected by both in terms of health impacts and economic turmoil. It is not feasible to prioritize specific actions for these vulnerable groups for the policymakers in the absence of readily available evidence. Thus, there is a pressing need for epidemiological studies to explore the association between household air pollution and COVID-19, especially during this lockdown period in India.

To encourage the use of clean fuel in the household, the Indian government has recently announced to provide up to three refills of LPG cylinders to 83 million poor households over the next 3 months as part of the relief package to minimize the effect of coronavirus outbreak lockdown. The refills will be available to users who are eligible for LPG supplies under the government's existing Pradhan Mantri Ujjwala Yojana (PMUY) subsidy scheme, which has been running since 2016. In addition to such measures, basic awareness about the harmful effects of household indoor air pollution, during the time of COVID-19 lockdown is important. Swift measures are necessary advising people to increase ventilation by opening windows and doors while cooking or heating for as long as possible and avoid smoking. It is pivotal to determine the extent of preparedness for vulnerable groups. The health system needs to adopt a more holistic approach by focusing more on rigorous testing, create more awareness, and take strong measures to control the spread. The vulnerable group of people need to be identified and treated with specific measures; else, the repercussions of this pandemic will be far more noxious.

AUTHORS CONTRIBUTIONS

All authors have contributed equally in the preparation of this paper.

DATA AVAILABILITY STATEMENT

Data sharing not applicable to this article as no datasets were generated or analysed during the current study.

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