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Review article

Impact of the COVID-19 pandemic on clean fuel programmes in India and ensuring sustainability for household energy needs

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ABSTRACT

Clean cooking energy strategies are critical for reducing air pollution, improving health, and achieving related Sustainable Development Goals. The recent COVID-19 lockdowns may impact the transition towards clean cooking fuels. The nationwide lockdown is likely to affect key factors such as energy access, income, transportation, etc., that play a role in decisions influencing household fuel use. The rural population already bears the burden of poverty and may not be able to afford and access clean cooking fuels during the lockdown. They are thus vulnerable to reversion to their traditional cooking methods using solid biomass fuels. The household air pollution caused due to the use of polluting fuels increases their susceptibility to non-communicable diseases, and thus may intensify the risk and severity of COVID-19 infection. Hence, there is an urgent need to expand sustainable energy solutions worldwide. The present study applies the DPSIR modeling framework to establish a set of comprehensive indicators for addressing the transition towards clean cooking fuels during the COVID-19 pandemic. The study also provides insights on various strategies adopted in India in response to the COVID-19 pandemic for maintaining continuity of delivering benefits under a clean cookstove program. The study offers future directions to ensure the transition towards cleaner fuels and sustainability.

1. Introduction

Clean cooking fuel is central to achieving specific Sustainable Development Goals (SDGs) and better health (Amegah and Jaakkola, 2016). The provision of clean cooking energy is related to at least ten SDGs (namely goals 1, 2, 3, 4, 5, 7, 8, 11, 13 and 15) that define a way to end poverty and inequality and to promote health, well-being, clean and affordable fuel, and sustainable growth to protect the environment (Rosenthal et al., 2018; Shankar et al., 2020). Access to clean cooking fuels is insufficient to provide benefits to health; sustained use is required. During disruptive events, like emergencies such as COVID-19, access to clean fuels must be a priority, as a necessary prerequisite to usage. Insufficient access to clean energy may accelerate the spread of COVID-19 contagion as the majority of the poor population lack access to essential energy requirements that are necessary to maintain health during pandemic (CastánBroto and Kirshner, 2020).

Solid biomass fuels are extensively used in low- and middle-income countries (LMICs, Rehfuess et al., 2017; Kaur-Sidhu et al., 2020). The use of these polluting solid biomass fuels in inefficient cookstoves leads to Household Air Pollution (HAP). HAP is considered one of the leading environmental and public health risk factors in the South Asian Region (Brabhukumr et al., 2020; Ravindra et al., 2020a,b; Smith et al., 2014; Landrigan et al., 2017). Recently, the World Health Organisation Global Action Plan for the Prevention and Control of Non-Communicable Diseases (NCDs) identified nine voluntary global targets; India became the first country to adopt an exceptional tenth target to address HAP through the promotion of clean fuels (WHO, 2015).

According to the Energy Progress Report, the global clean fuel rate increased from 57% in 2010 to 61% in 2017; only 0.5 percentage points have achieved access to clean cooking fuels annually (The Energy Progress Report, 2018). However, in contrast, Ravindra et al. (2019) show a significant transition towards the adoption of clean fuel in India. Despite these and other efforts, there are approximately three billion people globally who rely on solid fuels for household energy needs (State of Global Air 2019). There have been various initiatives facilitating clean energy access in LMICs, but progress has been slow. Despite some

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global progress, HAP remains a leading risk factor for ill-health, causing millions of premature deaths each year (Ravindra and Smith, 2018).

The transition to clean fuels has been hindered in recent months by COVID-19 and related lockdowns. In India, the countrywide lockdown began on 25th March 2020. The lockdown impacted the ability of households to get access to essential needs. This was accentuated in rural and remote areas already struggling for access to clean fuels. During this period, when movement is highly restricted, supporting households with the provision of clean cooking fuel becomes essential.

Moreover, the COVID-19 pandemic has been projected to hamper the uptake and sustained use of clean cooking fuels such as liquefied petroleum gas (LPG) that aim to bring direct health and environmental benefits (Thakur et al., 2020). The interconnectivity between demand and supply has been impacted due to an effect on sectors such as energy, economy, and transportation (Shupler et al., 2020). This paper examines various factors that could hamper the sustained use of clean fuels and the steps taken in response to the COVID-19 pandemic for maintaining the continuity of delivering benefits under a clean cookstove programme. The continued use of clean fuel will not only help to achieve the SDGs but also to improve the health of vulnerable populations.

2. Household air pollution and the transition to clean cooking fuels in India

Exposure to HAP is a major health risk factor usually associated with LMICs having low uptake of clean energy access (Schluger, 2014; Balakrishnan et al., 2002; Ravindra et al., 2019, 2020). Rural households without access to clean cooking fuels may face greater health problems that may aggravate COVID-19 symptoms (Schiffer, 2020; Singh et al., 2020). Exposure to solid biomass fuels is associated with respiratory problems such as reduced lung function and increased prevalence of respiratory symptoms that may lead to exacerbation of respiratory diseases (Kaur-Sidhu et al., 2019; Sharma et al., 2020). While the exact relationship between air pollution exposure and COVID-19 is unknown, some evidence indicates that areas of the US with higher air pollutant exposure have higher rates of COVID infection (Wu et al., 2020; Liang et al., 2020). Exposure to HAP may therefore be a risk factor for COVID-19 infection and severity.

Given this potential relationship, an expansion of access to clean fuels – with the goal of ensuring sustained use, even during economic and social shocks, like the current pandemic – is prudent. However, a lack of awareness about the health and environmental risk linked with traditional cookstoves acts as a barrier for a complete clean fuel transition (Arora and Jain, 2016; Sharma and Jain, 2019). Fig. 1 highlights the risk of using traditional cookstoves and the benefits of adopting clean cooking fuel use.

India is successfully moving towards a nationwide transition to clean cooking fuel. Government of India has taken various initiatives to streamline and promote LPG usage by reforming existing policies, and launching schemes for fostering connections and consumption such as Direct Benefit Transfer of LPG (DBTL)/PAHAL, Give It Up (GIU) campaigns that motivate well off LPG users to voluntarily surrender their subsidy for the poor who cannot afford LPG (Pillarisetti et al., 2019; Mani et al., 2020a, 2020b; Patnaik et al., 2018). Since 2016, a gradual upsurge has been witnessed in promotion of domestic LPG with the introduction of Pradhan Mantri Ujjwala Yojana (PMUY) targeting access to clean fuels and better health of women and children. Apart from this, various state level schemes are launched; among those is Himachal Grihini Suvidha Yojna, to support poor households that are not beneficiaries of any other existing LPG schemes. With this scheme, Himachal Pradesh has become first state to cover all households with LPG connections (Press Trust of India, 2020).

Despite various policies and programmes launched to promote clean fuel transition in India, the uptake of clean fuels largely remains low, as does the sustained use of these fuels, among the rural poor. The timeline for the clean cookstove interventions taken by the Indian Government are shown in Fig. 2. It has been depicted that since the launch of the flagship PMUY programme, more than 80 million households have obtained access to LPG (Giri and Aadil, 2018; Kar et al., 2019, Ravindra et al., 2019). Increased LPG coverage has driven demand for refills, especially in rural areas.

3. COVID-19 pandemic and clean fuel programmes

Sustained use of clean cooking energy and its continuous supply during emergencies such as COVID-19 must be kept on priority in rural areas. In urban areas, demand for increased LPG refills was observed during the first lockdown (25th March 2020), as people feared disrupted supply during the lockdown and pre-booked cylinders in panic (Verma et al., 2020; Mishra, 2020). However, cash-poor rural households may have struggled to access additional LPG cylinders and thus could reverse the transition that took place over the last few years. During "normal" periods, i.e., in the pre-COVID era, households practiced fuel stacking due to variations in fuel price, unreliable supply, preference, etc. rather than completely adopting clean fuels (Ravindra et al., 2019). Hence, the same households are at even more risk of relapsing to solid biomass fuel

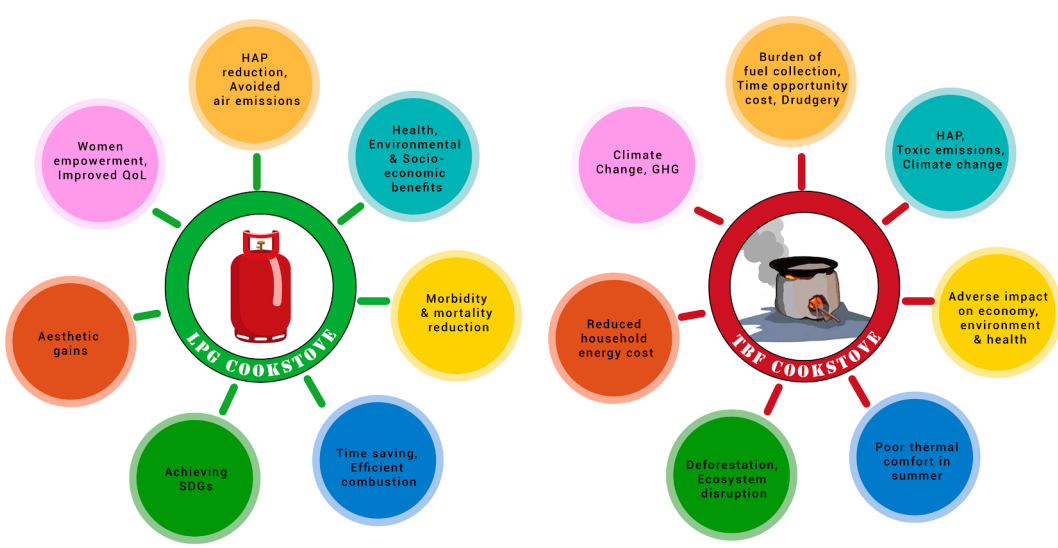

Fig. 1. Risk and benefits of traditional biomass fired (TBF) cookstoves and LPG fuel use. *HAP = Household Air Pollution; QoL = Quality of Life; SDGs = Sustainable Development Goals; LPG = liquefied petroleum gas; GHG = greenhouse gases.*

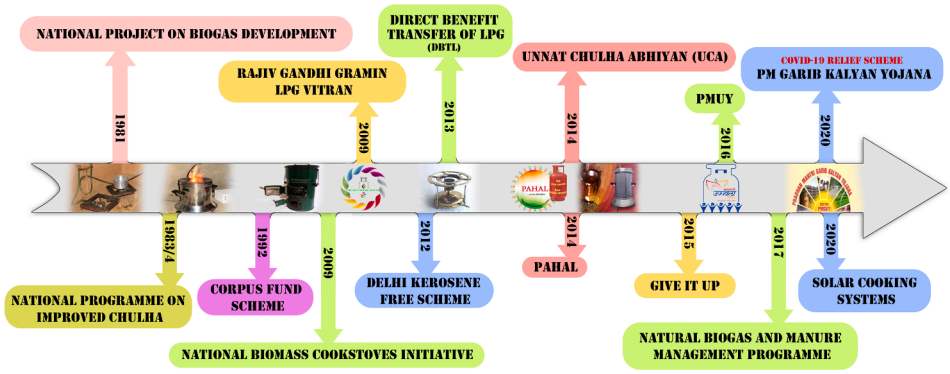

Fig. 2. Policies and programmes to promote a clean fuel transition in India.

use during critical situations such as COVID-19, which may impose economic constraints and do impose physical restrictions on free movement.

4. COVID-19 pandemic & sustained energy transition

To ensure the continuous supply of clean fuel and minimize the impact of COVID-19, Government of India responded quickly to maintain the transition towards clean fuel; the strategies discussed below were announced during the nationwide lockdown.

4.1. Ensure a reliable, uninterrupted supply

The major economic slowdown caused during the COVID-19 Pandemic has decreased the production rate of global gas companies (Belaid et al., 2020). The gaps in the supply chain are likely to affect access to clean cooking fuels. In comparison to urban areas, acquiring refills in rural areas may not be straightforward: doorstep delivery (i.e., transport of cylinders from central locations to directly outside customers' homes) is often not performed by distributors, which may act as a deterrent to clean fuel usage during the lockdown period. Further, the sporadic nature of refills among rural households results in fuel stacking, which is often a major constraint in clean fuel transitions (Puzzolo et al., 2016; Ravindra, 2019). For example, cooking food during the lockdown period can be extremely complex for low-income families, as they may not be able to afford clean fuel cylinders and may not be able to venture out to collect solid biomass fuels to prepare daily meals. Considering this, additional interventions are needed to support the sustained use of clean fuels amidst COVID-19. The Government has taken various initiatives to ensure a smooth supply of LPG cylinders to households during the countrywide lockdown due to the COVID-19 outbreak, as shown in Fig. 3. Among the most prominent of these is a direct cash transfer to households already participating in PMUY intended for use on LPG refills.

4.2. Energy prioritization

One way to ensure the use of clean fuels is to remove barriers to accessing the fuel. During the lockdowns, this can include (1) placing emphasis on increasing access to clean energy services in rural areas by reducing the overhead costs related to doorstep delivery and (2) further subsidizing costs for the poor, i.e., those who accessed LPG initially through the PMUY scheme. In June 2020, when the Government of India announced 'Unlock 1′ to restart the economy, LPG cylinder rates were hiked nationwide after a consecutive price cut for three months, as shown in Fig. 4. This likely will slow down the uptake of clean fuels. To promote the clean fuel transition, price hikes should not punish the poor, but rather be targeted at alternate fuels such as oil, turbine fuel, petrol, diesel, etc. (Stanistreet et al., 2019). Alternately, additional subsidies could be targeted specifically to the rural poor – an attempt to prevent blanket subsidies and support those who are most vulnerable. After COVID, depending on the economic situation, the level of subsidy may need to be adjusted to maintain fuel usage in both urban and rural areas.

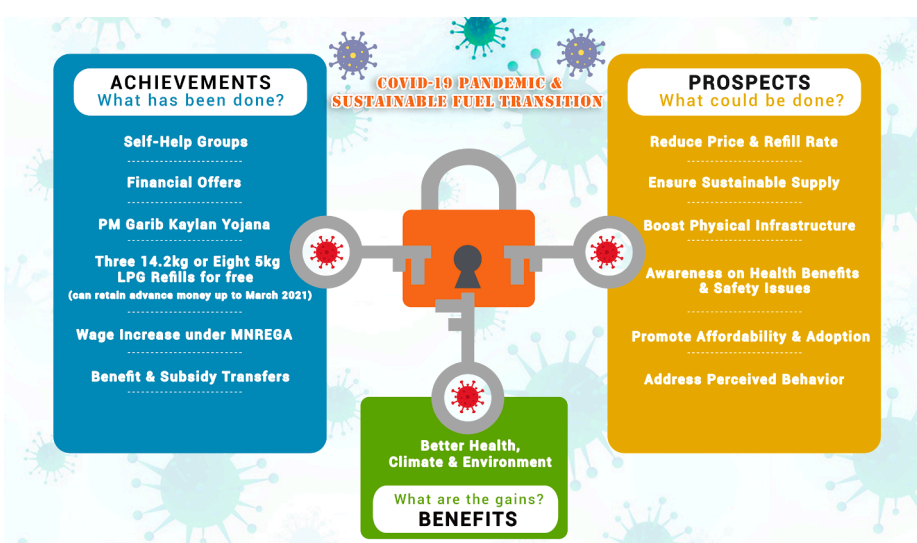

Fig. 3. Ensuring fuel transition sustainability in response to COVID-19 pandemic.

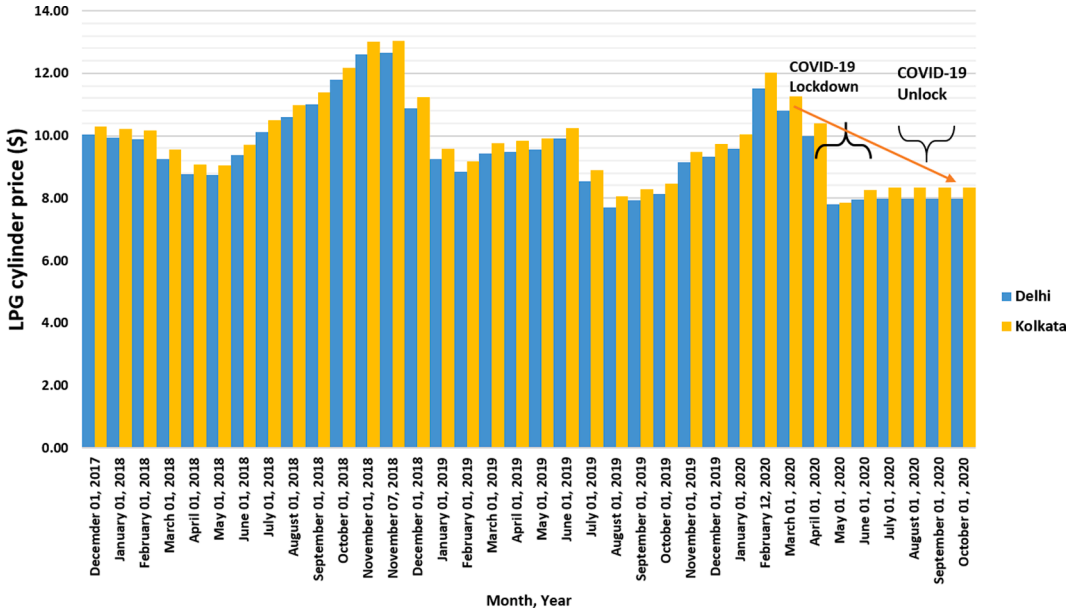

Fig. 4. Comparison of LPG pricing before and during COVID-19 lockdown.

4.3. Identify solutions for sustainable LPG use in below poverty line (BPL) households

Due to the significant financial and economic impact of the coronavirus pandemic, the losses suffered by marginal and poor populations slows the purchase of clean fuels for cooking purposes. To financially support low-income families, Government of India announced the Pradhan Mantri Garib Kalyan Yojana (PMGKY) to increase wages of those registered under the Mahatma Gandhi National Rural Employment Guarantee Act (MGNREGA) scheme, which guarantees wages for rural households for 100 days of unskilled manual work. To prevent employment disruption under PMGKY, MNREGA wages were hiked by ₹ 20 (0.27 USD; ₹ 182 to ₹ 202 – 2.44 to 2.71 USD) daily, benefitting about 140 million families. Additionally, the limit of providing collateral-free loans has been doubled (₹10 lac–₹ 20 lac; 13,400 to 26,800 USD) for women self-help groups in the country (Fig. 3). PMGKY also offered to provide ex-gratia payment of ₹500 (6.72 USD) monthly for three months to women holding accounts under Pradhan Mantri Jan Dhan Yojana (PMJDY). The government has also proposed to support vulnerable groups, consisting of low wage earners, widows, senior citizens, and differently-abled, by providing unconditional cash transfers to prevent employment disruption.

Related to fuel use, Governement of India has provided an additional relief package during COVID-19 under PMGKY, consisting of free LPG cylinders for three months to the beneficiaries of PMUY (>80 million households). Households can claim three free refills of LPG cylinders (capacity 14.2 kg) for a period of three months (April-June 2020, extended till September) or can use the advance for refill up to 1 year (until March 2021). Those using economical cylinders (capacity 5 kg) are eligible to receive eight free refills in a period of 3 months (Ministry of Petroleum & Natural Gas- MoPNG, 2020).

The COVID-19 pandemic is still ongoing; reduced economic activities may continue to disrupt fuel supply, affordability, and usage of LPG. To overcome this economic impact, COVID-19 relief package PMGKY was announced and over 100 million free LPG cylinders were delivered to poor households to date. The implementation of such policies ensures sustained uptake and usage of clean cooking fuels during the pandemic. This not only helps the poor rural households with free, clean fuel but may have also enabled reduced pollution in indoor micro-environments.

5. Addressing new barriers: DPSIR approach

This paper also examines the interaction of the COVID-19 pandemic and India's clean fuel transition through the DPSIR approach (Driving Forces, Pressures, State, Impact, Responses) framework. The DPSIR framework describes the interdependence between human interaction and the environment. It has a wide-ranging scope (Zhou et al., 2015). The indicators of DPSIR are: D (driving forces) indicators, which reflect the anthropogenic activities that impact the environment such as energy consumption, economy, sustainability, etc; P (Pressures) indicators, show the barriers that impose stress on environment by these anthropogenic activities, such as violence, atmospheric emissions, use of resources etc; S (State) indicators which reflect changes in physical, chemical, and biological state, such as consumption of resources, financial, and social challenges; I (Impacts) refers to the effect on human health and the environment; and R (responses) refers to the reaction by society or policy makers to the undesired impact on environment, such as health, energy transition and other sector specific policies. In the current context, the framework focuses on the knowledge of new barriers during the COVID-19 outbreak and its impact on the scale-up of the clean fuels transition. Fig. 5 shows the model's five major elements, each of which has five sub-domains in the context of COVID-19 and clean energy. The findings highlight new barriers such as lockdown, transportation, weaker earnings, backsliding to traditional cookstoves, and violence as potential policy levers to encourage or discourage sustained use of clean cooking fuels.

The factors listed in the DPSIR model (Fig. 5) provide insights to inform better policy development decisions to tackle the transition to clean fuels in exigent situations such as COVID-19. Short-term, emergency-response plans on household energy can aid in addressing long-term challenges on HAP. Understanding socio-economic barriers impeding an energy transition, including the human value of time, economic viability, price, and household clean fuel uptake are required to promote a clean fuel transition. Relying on traditional biomass fuels increases drudgery, time consumption in drying and stacking of fuels, etc. Biomass fuels are, however, perceived as cheaper or free to households. There is a need to develop strategies to support policies focusing on transition and scaling up of household clean energy. These include working on price and access barriers, but also on socio-behavioral issues – such as the perception of cost, value of time, and issues related to taste – that may help drive clean fuel transitions. The policies implemented in

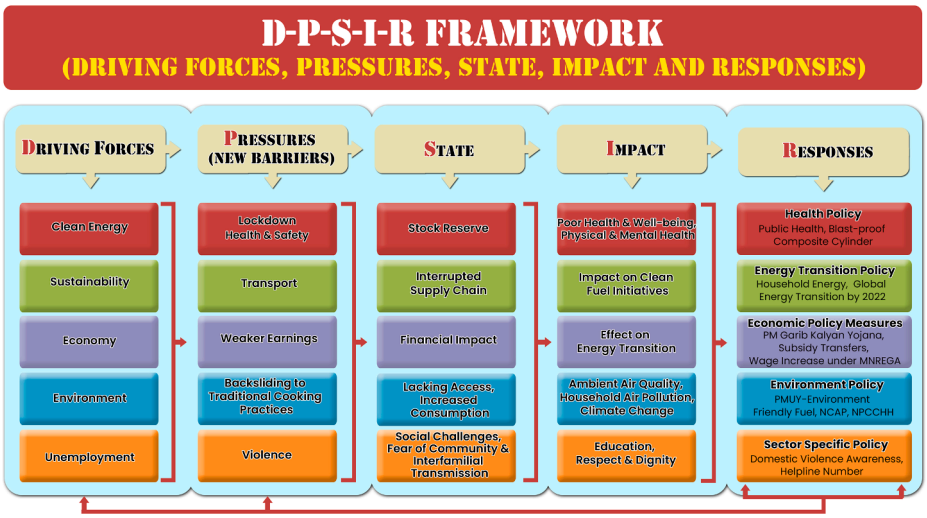

Fig. 5. DPSIR framework to address the new barriers and transition of clean fuel during the COVID-19 pandemic.

light of COVID begin to do this by providing free fuel and providing additional wages through MNREGA to eligible participants. A logical next step could be to link MNREGA messaging explicitly with clean fuel transitions: for example, if a household spends 10 h a week collecting and preparing biomass, that time could be spent earning wages through MNREGA, likely covering a portion of the cost of clean fuels and providing additional income to households.

Due to the fear of the spread of COVID-19 at the point of contact, transportation and supply of LPG has remained a substantial challenge. To ensure uninterrupted supply, LPG import and production has increased by major oil companies. Government of India has taken initiatives that focus on sustaining India's ongoing clean energy transition by announcing cash transfers and three LPG refills to PMUY beneficiaries under PMGKY to mitigate the economic impact of lockdown on poor and vulnerable sections of the society. Such coping strategies during the pandemic improve the affordability and may help sustain LPG penetration in rural areas, in turn helping to gain food and fuel security amongst the poor population.

From a supply standpoint, we have seen evidence of demand for second cylinders (double bottle connections) in rural areas. This matches behavior among middle and higher-income households in cities: they have two cylinders, ensuring a consistent fuel supply. If one runs out, they can put in a request for a refill and use the other until the refill comes. Such a system could resolve many issues in rural areas related to supply. For example, deliveries to rural habitations could be optimized so that multiple cylinders are dropped off at once by distributors (they know that all houses requesting cylinders have a 2nd cylinder they are using, and they know the approximate burn rate of cylinders per household). Such optimization exercises are well within the purview of Oil Marketing Companies, MoPNG, Niti Aayog, and both the state and central governments. Provision of reduced cost second cylinder connections could help alleviate supply-related concerns, and would additionally be useful during the COVID lockdown.

In India, the Panchayati Raj (three-tier rural governance) is the political system that results in local self-government of rural villages. Community leaders should address the unique nature of emergency situations at the local level – in their community – by piloting alternative distribution channels to improve the availability of clean fuels. This could take many forms, such as using Self-Help groups to arrange deliveries of cylinders or provide lending circles to help households afford clean fuels; additionally, marginalized members of the community (Lahiri-Dutt and Samanta, 2006; Patnaik et al., 2018) should be prioritized. Local governments could also provide some small social benefit schemes reserved for situations like COVID-19: unpredicted, unpredictable, and of unknown duration. Such a local safety net fits well into existing village life and does not necessarily impose structure from the central Government, which may invoke suspicion. Finally, the spread of information about schemes of all types is necessary: marginalized communities may not be aware of or utilizing new schemes like the COVID-related free fuel program or the updated MNREGA. This calls on development of support mechanisms to make households aware of these special schemes – and to encourage them to use them. The *Ujjwala Didi* program in Odisha is one such approach to ensure households take advantage of PMUY and related benefits. The perceived behavioral benefits of solid biomass fuel users should also be addressed using a persistent and comprehensive scientific approach. The exemplary dedication and management of community leaders to pave the way towards clean fuel transition will strengthen their leadership role and build their reputation in the community, in addition to providing other social benefits.

Strengthening rural entrepreneurs and self-help groups and enabling them to assist with a clean fuel transition may enhance the health and well-being of rural people. Thus, investing in clean fuel technologies could be considered an investment in health with substantial long-term benefits. WHO and the Global Burden of Disease identifies household air pollution as a leading risk factor for preventable illnesses and death (Brauer et al., 2016). Over 2.6 million deaths per year are attributable to exposure to HAP; the burden is linked to NCDs (Landrigan et al., 2017; Lim et al., 2012) pneumonia, low birthweight, and preterm birth, among other health endpoints.

In developing countries, the Government is the primary provider of health care services (WHO, 2006). Large scale outbreaks such as COVID-19 pose a substantial burden to the national economy (Mahato et al., 2020). The health burden from long-existing challenges such as household and ambient air pollution may be associated with increased COVID-19 morbidity and mortality due to air pollution exposure (Wu et al., 2020; Travaglio et al., 2020). Conticini et al. (2020) highlighted that the regions with high long-term exposure to air pollution witness elevated COVID-19 deaths. Wu et al. (2020) provided evidence that an increase of $PM_{2.5}$ concentration by 1 $\mu g/m^3$ is linked to about eight percent rise in the mortality rate of COVID-19. Chowdhury et al. (2019) and Sidhu et al. (2017) highlighted that permissible levels of air quality in India are achievable from household exposure reduction. Acting on HAP provides a large set of benefits outside of the pandemic, and, if the findings relating air pollution exposure to COVID severity and death are true, HAP exposure reductions could help slow the spread and intensity of the ongoing and future pandemics. COVID-19 is likely going to overburden the health systems as they stand; actions to reduce HAP may help

prevent future pandemics from having such an impact on already fragile healthcare infrastructure.

Several initiatives to reduce biomass fuel use have been imposed by the Government of India over the past four decades. Recently, during the economic slowdown in COVID-19, a relief package for free refilling of clean fuels was announced considering the low-marginal household financial instability to afford clean fuels and to reduce the burden associated with air pollution. However, solid biomass fuels could not be entirely replaced by clean cooking fuels by just providing aid for three months. Governments can embark upon this issue by making the provision of clean cooking fuels as part of their standing emergency response plans. The COVID-19 relief package offered by Ghana's Government, for example, subsidized the full clean fuel costs for the poorest consumers and provided a fifty percent discount to other consumers. Such initiatives address long-term challenges in the transition to clean fuels and prevent or reduce switching back to traditional biomass fuels. Therefore, we recommended the creation of additional, targeted subsidies for at least a year following COVID, as employment and the Indian economy recover.

6. Future directions and recommendations

The complete adoption of clean cookstoves is a complex process. We highlight various recommendations that can help India during the COVID-19 pandemic to ensure continued progress on an energy transition for better health, economy, and environment. These policy actions can be executed at different levels of Government. We suggest a number of future policy recommendations pertaining to the clean fuel transition to ensure resilient developing countries affected by the current and future pandemics of large-scale societal shocks:

- Focus and target policies to the poor and other marginalized populations to ensure sustained uptake and transition to clean fuels;
- Intensify efforts to involve direct engagement of private entrepreneurship for continued clean cooking fuel provision;
- Enhance the role of Information Communication and Technology (ICT) feedback systems for good governance and improving energy service quality;
- COVID-19-specific packages may be introduced for the severely affected communities to deal with the economic impact of the lockdown, beyond what has already been implemented;
- Development of reward mechanisms to ensure sustained use of LPG. For example, if the household commits to using only LPG, the cost of the second cylinder of fuel could be waived.

There is need to strengthen the efforts to create awareness about the health and environmental benefits of clean fuel use to promote changes in cooking behaviors.

7. Conclusion

We described the current impacts of COVID-19 on India's clean fuel transition, and actions taken by the Government to address potential decreases in clean fuel use. We also suggested numerous methods to improve sustained usage and applied the DPSIR framework to discuss the impacts of the COVID-19 pandemic. COVID-19 will not only affect the current clean fuel programmes that provide access to clean cooking, but it will also jeopardize the efforts of achieving energy transition as targeted in SDGs. There is an immediate need to frame policies that address the new barriers to prevent long-term changes, such as switching back to traditional cooking fuels in the current era of fuel transition. Long-term health and environmental benefits could be retained by initiating short term emergency response plans taken by the Government in other emergencies. The recommendations proposed in the present study could assist in developing approaches for dealing with current as well as future pandemics or other shocks to fuel supply, economic status, or mobility.

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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