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Abstract- COVID-19 poses an unforeseen challenge to the world. The virus is testing the capacity of public health systems globally and their ability to respond effectively. India is no exception. The country has already witnessed more than 35,000 confirmed positive cases by the end of April 2020, and the number is fast rising despite strict measures by the government. The virus has reached every state and union territory of the country. In the absence of a drug or a vaccine, the only measure available to fight this deadly novel pathogen is to adopt changes in behaviors and lifestyle – physical distancing, frequent hand washing, and proper respiratory etiquette. The government has imposed lockdown to maintain social distance since 24th March 2020, but it cannot continue for long due to the immense loss of economy and livelihood. The country needs to learn to co-exist with the virus and embrace the prescribed measure of physical distancing, and handwashing even after the government lifts the lockdown. The paper uses the data from the most recent Indian version of DHS, known as National Family Health Survey-4, to examine the feasibility of the adoption of these new norms and their impact on a densely populated country like India, where there are nearly half of the households (49%) with three or more people sleeping in a room, 35% going out to fetch water for daily usage, and 38% have no toilet facility within their household premises. The study uses multivariate analysis, Wagstaff's Concentration Index, and decomposition analysis to find out the extent of vulnerability across different socio-economic strata of the Indian population in adopting these safety measures to fend themselves from the corona infection.

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Socio-economic Vulnerabilities to COVID-19 in India: Swimming against the Tide

S. K. Singh [α], Aditi [σ] & Sudipta Mondal [ρ]

Abstract- COVID-19 poses an unforeseen challenge to the world. The virus is testing the capacity of public health systems globally and their ability to respond effectively. India is no exception. The country has already witnessed more than 35,000 confirmed positive cases by the end of April 2020, and the number is fast rising despite strict measures by the government. The virus has reached every state and union territory of the country. In the absence of a drug or a vaccine, the only measure available to fight this deadly novel pathogen is to adopt changes in behaviors and lifestyle – physical distancing, frequent hand washing, and proper respiratory etiquette. The government has imposed lockdown to maintain social distance since 24th March 2020, but it cannot continue for long due to the immense loss of economy and livelihood. The country needs to learn to co-exist with the virus and embrace the prescribed measure of physical distancing, and handwashing even after the government lifts the lockdown. The paper uses the data from the most recent Indian version of DHS, known as National Family Health Survey-4, to examine the feasibility of the adoption of these new norms and their impact on a densely populated country like India, where there are nearly half of the households (49%) with three or more people sleeping in a room, 35% going out to fetch water for daily usage, and 38% have no toilet facility within their household premises. The study uses multivariate analysis, Wagstaff's Concentration Index, and decomposition analysis to find out the extent of vulnerability across different socio-economic strata of the Indian population in adopting these safety measures to fend themselves from the corona infection. The paper acknowledges that widespread inequalities in protective behaviour from COVID -19 and the invisible virus will coexist till the development of a vaccine. The study, in its closing, recommends adopting focussed interventions with the most vulnerable groups, not only for changing their behavior but also improving their access to essential services on a war footing with a particular focus at people from low-income communities, who are socially deprived, and economically marginalized and living in resource-poor settings in 53 million-plus urban agglomerations of India.

I. Background and Rationale

The rapidly spreading severe acute respiratory syndrome coronavirus-2 (SARS-CoV-2), which originated from Wuhan city in China, was declared as a pandemic by the World Health Organisation (WHO) in early March 2020. Initially, not much could be said about the virus except for the fact that it was highly infectious. The disease spread fast and engulfed about 185 countries in a short period, with nations reporting human-to-human transmission (Cohen and Kupferschmidt, 2020). The entire human population generally lacks immunity to SARS-CoV-2 and hence is susceptible to the novel virus. Even after months, there has been no substantial containment in geographical spread, mortality, and economic losses caused due to the pandemic. Worldwide, it has engulfed 3,269,667 people, and there have been 233,704 reported deaths as on 30th April 2020 (JHU CCSE, 2020). China is the epicenter of the pandemic and witnessed the havoc first with a massive number of patients and deaths, later the disease spread to the entire world encasing almost all the major countries of the world including US, Italy, Spain, Iran, UK France, India and many more (Khan & Fahad, 2020). Currently, the case-fatality ratio of the current pandemic in the world is 7.1 percent. The United States has the maximum number of confirmed cases and deceased people due to the virus (JHU CCSE, 2020). The Indian sub-continent is not aloof to the disease. In India, as of 30th April 2020, a total of 35,043 confirmed cases and 1,154 deaths had taken place with the current case-fatality ratio of 3.3 percent (JHU CCSE, 2020). The reproduction number defines the transmissibility of a virus, and represents the average number of new patients rising due to an infectious person in a naïve population. SARS-CoV-2 is much more contagious than any known virus that affects human race. On an average one infected person passes the disease to 3.2 people (Liu et al., 2020; Ryu et al., 2020). The older adults with comorbidities and pregnant women are more prone to acquiring SARS-CoV-2 (Yi et al., 2020).

The COVID-19 is contagious during the latency period and is highly transmissible in humans, especially in the elderly and people with underlying diseases. People who have a weak immune system and who are exposed to the virus directly or indirectly are more likely to catch the infection. The symptoms of the disease are similar to that of pneumonia, common flu such as fever, malaise, and cough (Guo et al., 2020; Singhal, 2020; Yi et al., 2020). Yet, it is a more severe illness with a substantial risk of death, particularly among the elderly and especially among those with other chronic underlying conditions (Zhou et al., 2020). The disease has an incubation period of 1-14 days, and the advanced stage of the disease has people exhibiting symptoms like acute respiratory distress syndrome,

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respiratory failure, multiple organ failure, and eventually death (Guo et al., 2020). However, not all the affected people show symptoms of the disease. There are asymptotic carriers who do not have any visible signs, but they are the possible carriers of the infection (Ryu et al., 2020). For this one way out is testing, but again, there are constraints such as; only limited availability of testing kits and other health resources. The overall case-fatality rate of 2019-nCoV, as estimated by international experts, ranges from 3 percent to 14 percent (Ryu et al., 2020). The case-fatality ratio is less than that seen in two recent epidemics i.e., SARS-CoV-1 and Middle East Respiratory Syndrome (MERS)-CoV. Still, it is more concerning because the observed characteristics of this virus are excessive transmissibility and rapidity of the spread (Chowell, 2015). There are various predictions made for the COVID-19, including by a leading Harvard epidemiologist Marc Lipsitch who warned that the coronavirus would infect up to 70 percent of humanity within a year (HTHC, 2020).

The vaccine remains the only solution to end the COVID-19 pandemic. Yet, until now, no vaccine is in sight; clinical trials are going on to develop a vaccine against the novel coronavirus. However, as put forward by the WHO and other experts, developing and approving the use of a vaccine is a lengthy process, and it may take at least 18 months before such a vaccine is available. Hence, to limit the spread of the disease, it is need of the hour to not only treat the infected persons but also to take immediate steps to isolate them from the general population through social distancing and other behavioral measures. The novel coronavirus is known for its high infectivity, once its spread continues, it can lead to stage 3 or 'the community transmission' of the disease, which will make it impossible to track and contain the source of the infection (Singh & Adhikari, 2020). No approved treatments are available at present, various non-pharmaceutical interventions (NPIs) are the only options to halt the exponential rise of the disease. The measures include maintaining social distance, washing hands repeatedly, observing safe respiratory etiquette, avoiding contact with those infected with COVID-19, refraining from non-essential use of public transport, working from home and avoiding gatherings, socializing, and visiting other places where infections can spread rapidly. Hand hygiene and respiratory etiquettes are individual behavior. Hence, the health officials and governments have widely propagated these manners (Bhatia, 2020). It is well established that if we implement these measures promptly and effectively during a pandemic, it can reduce disease transmission. In the absence of a cure or an established theraputic strategy, curtailing transmission through preventive measures is the only means available to stem the growth of the pandemic (Cascella et al, 2020).

It is important to flatten the exponential growth curve of the COVID-19 cases because if the outbreak becomes severe in a country like India, then it can prove to be devastating as it will be overwhelming for the health system to handle. It will lead to a huge shortage of health workers and essential supplies like Personal Protective Equipment (PPE), masks, oxygen ventilators, testing kits, among others. Considering India's population size and existing health facilities, the problem will compound even further. As per the National Health Profile-2019, 713,986 beds are available in the government hospitals in India, which amount to 0.55 beds per 1000 population and around 915 government allopathic doctors per 10,00,000 population. With 1.38 billion population, and with much less number of hospital beds and health care physicians, not overwhelming the hospitals is the first and the foremost crucial step that the country can take and gradually prepare for the emerging cases of the disease (Bedford et al., 2020; Singh at al., 2020). These differentials will be even more glaring in rural areas compared to urban areas. Keeping the directives of the WHO and the healthcare professionals in view, the Indian government imposed a complete lockdown from 24th March 2020 till 17th May 2020 (IANS, 2020). The government has completely shut its borders, put in place restrictions on inbound travel, suspended all visas except diplomatic ones, and quarantined the travelers who came to the country (Bajpai, 2020). Additionally, it has been actively trying to make people understand the importance of social distancing and self-quarantining for preventing the spread of the virus and has been creating isolation wards, arranging testing kits, identifying as well as providing fast-track provision of medical facilities to those who have symptoms. The government suspended all public transports, including rail, inter-state bus services, and metro services. The masses have been encouraged to maintain personal hygiene, frequent handwashing with soap and water, or using alcohol-based hand sanitizer, mandatory use of facemask in case one has any of the symptoms, covering the face with a handkerchief while sneezing and, most importantly, to follow social distancing (Prem et al., 2020).

The importance of social distancing as a tool to limit disease transmission is well recognized, but there are several difficulties associated with this measure in a country like India. There are challenges in ensuring social distancing, especially in densely populated urban slums in Indian cities where people helplessly occupy and live together in small overcrowded and poorly ventilated homes (Bhatia, 2020). Accessibility to clean water for maintaining proper hygiene, as well as usage of soap as recommended, is also an issue. Given the Indian scenario, it would be worth delving deeper into the feasibility of using such measures successfully in the country.

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II. Research Questions and Objectives

The COVID-19, which is not randomly distributed in the population but transmits through human contacts, can be contained by ensuring social distancing and hand hygiene practices, which are the two significant behavioral interventions in addition to the above-discussed structural and ecological interventions promoted by the Governments and hordes of civil society organizations. The lockdown of a country or some selected states/districts in a country can be treated simply as a pause to shift the severity of the problem by breaking the chain of transmission, but. Still, it may not be the permanent solution to ensure preventive practices including social distancing. Keeping this in view, the key research question to be addressed in this study is the extent of vulnerability for a substantial proportion of Indians. The socially deprived, economically marginalized, those who were not a part of inclusive development, in adopting the protective measures against COVID-19. The specific objectives of this paper are to analyze the barriers in ensuring the protective measures i.e., social distancing and hand-hygiene practices, and examine the socio-economic inequalities in adopting preventive practices for COVID-19 in India.

III. Data and Methods

The study utilized data from the fourth round of the Indian DHS, popularly known as the National Family Health Survey (NFHS), which is a cross-sectional survey conducted during 2015-2016. NFHS is conducted under the stewardship of the Ministry of Health and Family Welfare (MoHFW), Government of India. The survey provides information on demographic and health indicators at the national, regional, state, and district levels from a nationally representative sample. NFHS-4 (2015-16) collected information from a total of 601,509 households and 699,686 women aged between 15-49 years (IIPS and ICF, 2017). Different rounds of NFHS have been a key source of information on household assets, WASH, household environment, and other socio-economic and developmental indicators. It is put to use for evidence-based decision making in the country. Other relevant information regarding the study design and response rates in the NFHS-4 are there on the Demographic and Health Surveys website (IIPS and ICF, 2017).

Among the various analytical approaches used in this paper, the first one is descriptive statistics to analyze the variation in household crowding as an indicator of vulnerability to maintain social distance and availability of soap or detergent at the place designated for hand washing in a household as an indicator of hand hygiene by some selected background characteristics. To analyze the adjusted effects of various predictors on the response variables, we applied a multivariate logistic regression technique. The study further calculated the Wagstaff's Concentration Index and decomposition to investigate the inequalities in the prevalence of preventive practices for COVID-19 measured in terms of household crowding, water source outside household premises, and not having a toilet within the household as the barrier to maintain social distancing. Socio-economic inequalities in barriers and preventive practices for COVID-19 were quantified with the concentration index and subsequently decomposed into associated factors using Decomposition Analysis. A concentration index (CI) provides a measure of socioeconomic inequality in the variables under study. It ranges from -1 to +1: a value close to zero indicates near equality, a value near -1 shows a greater concentration of the study variable among the poor (pro-poor) while a value increasing to +1 indicates greater concentration amongst the wealthier groups (pro-rich). The CI is twice the area between the concentration curve and the line of perfect equality, or as twice the weighted covariance between the outcome variables and the fractional rank in the wealth distribution divided by the mean of study variable. The study used the concentration index to assess the vulnerability to infection from COVID-19 owing to prevailing socio-economic inequality measured in terms of household crowding and presence of soap or detergent for handwashing at the place designated for handwashing in a household. The concentration index can be defined merely as twice the covariance between the study variables, (y: let household crowding) of individual i and the ranking of the socioeconomic status, r, divided by the mean of the study variable (μ):

$$CI = \frac{2}{\mu} \operatorname{cov}(y_i, r_i)$$

CI is a widely used measure since it ranks the individuals across SES, sensitive to changes in population distribution across SES and they can assess relative and absolute socioeconomic inequality (Kakwani et al., 1997; Wagstaff et al., 1991).

Even though concentration indices are relevant to show the extent of socioeconomic-related inequalities in variables under study, but it cannot explain the factors that contribute to observed disparities. Therefore, the study used the regression-based-decomposition methodology to decompose the concentration index to explain the socio-economic inequality as vulnerability to protection from COVID-19. Since the regressed variable of the study is continuous; therefore, the study used a linear probability model to decompose the concentration index. Thus, the expression of the model is- -

$$y_i = \alpha + \sum_j \beta_j x_{ji} + u_i$$

Here j is the probability of protection from COVID-19, associated with j determinants. The Cly decomposition happens as follow-

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$$CI_y = \sum_j (^{\beta_j \overline{x}_j}/_{\mu_y}) CI_{xj} + \frac{CI_u}{\mu_y}$$

where the term on the right-hand side represents income-related socio-economic inequality in the regressed variable that is not explained by systematic variation in x's by income. However, we are interested in the term on the right-hand side of the equation, which represents the contribution of each of the determinants to the Concentration Index CI(y).

IV. Results and Discussion

It is needless to mention that maintaining social distancing, constant use of masks at public places, and hand hygiene are some of the important means to curtail the spread of COVID-19 and protect the general population. However, the most recent demographic and health data of the country paints a complex and discouraging picture to ensure these behavioral changes. It is evident from Table 1 that nearly half of the households in the country (49%) suffer from the problem of overcrowding with three or more people sleeping in a room. Proportions of such households were significantly higher in rural areas (51%), and in the socially deprived and economically marginalized communities (53%-56% scheduled caste/ scheduled tribe households; 55% Muslim households, and 62% poorest households). The other two indicators adversely affecting social distancing in these communities are the location of the source of drinking water outside the household/dwelling/yard (35%) and no toilet facility within the household premises (38%). Despite all the structural interventions, people will move out for using these two facilities and hence, would be more vulnerable to adhering to the protocols of social distancing as the means of protection from the COVID-19. The pattern in this vulnerability to protection through social distancing is not uniform across different Indian states (Fig.1). The proportion of households with household crowding was the highest in Uttar Pradesh (61%) followed by Maharashtra (58%), Bihar and Gujarat (56% each), Telangana (55%), Madhya Pradesh (54%), Andhra Pradesh (53%), Mizoram (51%), Delhi (48%), Odisha (47%) and Chhattisgarh (45%). Similarly, the proportion of households with the source of water located outside household/yard/plot was the maximum in Odisha (68%) followed by Chhattisgarh (65%) Jharkhand (64%), Madhya Pradesh and West Bengal (55% each) and Telangana (45%). Most of these states have a significant proportion of the tribal population living in remote rural areas, who are socially deprived, economically marginalized, have poor or no access to healthcare, and hence, may require special focus, particularly in the latter stages of community transmission of COVID-19 in India.

The second important means of protection from COVID-19 is the hand hygiene with well-stated guidelines about frequency and modalities to wash hands with soap or detergent and sanitize with alcohol-based hand sanitizers. The NFHS-4 (2015-16) data, however, portrays that despite over 96 percent of households having a designated place for handwashing, almost one-in-seven households did not have water available and over one-in-three households did not have soap or detergent at the place designated for handwashing. The proportion of such households was significantly higher in rural areas (18% and 49%), scheduled tribe households (30% and 58%), and those coming from the poorer households (20% and 53%) and poorest households (32% and 73%) respectively. Regional disparity in the proportion of households lagging in the basic facilities to ensure hand hygiene by its members demonstrates comparatively larger concentration of such households in the eastern part of the country (23% and 57%), comprising of Bihar, Chhattisgarh, Jharkhand, Odisha, and West Bengal (See Table 1). Fig. 2 presents the percent of households whose members are highly vulnerable to ensuring hand hygiene as a means of protection from COVID-19 in different States/UTs. It portrays that people in Odisha (43%), Jharkhand (41%), Chhattisgarh (29%), Tripura (25%) and West Bengal (22%) were highly vulnerable to hand hygiene due to non-availability of water in their houses. Further, a substantial proportion of households in Odisha (65%), Jharkhand (64%), Tripura (51%), West Bengal (50%), Tamil Nadu (48%) and Madhya Pradesh (40%) did not have soap or detergent at the place designated for hand wash in their houses. Therefore, members of these households may be highly vulnerable in adopting hand hygiene practices to protect themselves from COVID-19 in the third stage of transmission at the community level. Thus, all the agencies engaged in curtailing the chain of transmission and protecting people from COVID-19, especially in the third stage of transmission, should adopt suitable strategies to address the vulnerability of socially deprived and economically marginalized communities in protecting themselves. The aforementioned is possible by motivating them to adopt micro-level social distancing even within their households to the extent possible and developing a support system and creating an enabling environment to practice hand hygiene.

More refined effects of these predictors on the response variable, which are related to various guidelines to follow for containing the spread of COVID-19, can be obtained only after computing the adjusted effects of these predictors on response variables. Table 2 portrays the Logistic regression odds ratios for the adjusted effects of some selected socio-economic characteristics on the vulnerability to infection from COVID-19, India. As far as social distancing is concerned, people from the richest wealth quintile (OR=0.14; 95% CI= [1.14-1.15]) were much less likely to live in a crowded home compared to people from poorest wealth quintile. Compared to the urban area,

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rural people (OR=0.67; 95%CI= [0.67-0.69]) were less likely to live in a crowded home. People from non-SC/ST and OBC caste category (OR=0.65; 95%CI= [0.64-0.67]) and the other backward castes (OR=0.86; 95%CI= [0.85-0.88]) were 35 percent and 14 percent, less likely to live in crowded setup respectively as compared to those from Scheduled Caste. In comparison to the Hindu family, the Muslim family (OR=1.63; 95%CI= [1.61-1.67]) were more likely to live in a crowded setting. Also, people from other religions (OR=1.09; 95%CI= [1.07-1.12]) were 9 percent more likely to live in crowded spaces. The people from northern region (OR=1.67; 95%CI= [1.64-1.70]) were 67 percent more likely to live in a crowded setting as compared to people from the eastern region and those from the western region (OR=2.00; 95%CI= [1.96-2.04]) were twice more likely to live in a crowded setting as compared to eastern region people. These findings are consistent with the reported number of positive coronavirus cases in India, in the absence of population-based testing, which is disproportionately higher in million-plus cities in the country with a larger concentration in Mumbai, Delhi, Ahmedabad, Indore, Bhopal, Jaipur, Agra, Lucknow among others. The situation is further threatening with a larger number of COVID-19 hotspots centered on slum pockets in these million-plus cities.

The availability of water at the place of hand wash is an important predictor of protecting from the vulnerability to infection. The richer people (OR=7.77; 95% CI= [7.52-8.03]) had more water available at the place of hand wash in comparison to the poorest. The rural people had 18 percent less likelihood of water available to them at the place of hand wash. The people from other castes (OR=1.15; 95%CI= [1.11-1.17]) were more likely to face the problem of water unavailability at the place of hand wash in comparison to people from a scheduled caste. In comparison to the Hindus, Muslims (OR=1.24; 95% CI= [1.21-1.28]) were 1.2 times more likely to have water available at the place of hand wash and the people from other religion (OR=1.34; 95% CI= [1.30-1.39]) were 1.3 times more likely to have water available at the place of hand wash. The central region people (OR=1.33; 95% CI= [1.30-1.37]) were more likely to have water available at their place of hand wash as compared to people from the eastern region. Similar was the case for people from southern region (OR=1.31; 95%CI= [1.30-1.37]). The people from the northeast region (OR=2.06; 95%CI= [1.99-2.13]), too, had water available to them more in comparison to people from the eastern region.

The availability of soap or detergent at the place of hand wash as an indicator of hand hygiene portrays that the richer people were more likely to maintain hand hygiene (OR=10.64; 95% CI= [10.41-10.88]), as compared to the poorest. The rural people (OR=0.71; 95% CI= [0.70-0.73]) were 29 percent less likely to maintain hand hygiene as compared to urban people. In comparison to people from scheduled caste, people from other castes (OR=1.22; 95%CI= [1.19-1.25]) were more likely to maintain proper hand hygiene. In comparison to Hindus, Muslims (OR=1.13; 95% CI= [1.11-1.16]) were more likely to maintain hand hygiene. The northern region people (OR= 2.24; 95% CI= [2.19-2.29]) were more likely to maintain hand hygiene as compared to the eastern region people. The people from the southern region (OR=0.90; 95%CI= [0.89-1.93]) were 10 percent less likely to maintain hand hygiene as compared to people from the eastern region. Those from the north-eastern region (OR=2.24; 95%CI= [2.19-2.29]) were more likely to maintain hand hygiene as compared to people from the eastern region.

Further, it is evident from Figure-3 that household crowding was concentrated mostly among poor households [Concentration Index: - 0.14], whereas, hand wash with the use of soap or detergent was prominent among rich households [Concentration Index: 0.23]. Therefore, it is essential to decompose the contribution of different predictors in the overall value of CIs. Table 3 provides the results of decomposition analysis for the estimated contribution of selected background characteristics in the economic inequalities of household crowding, as a proxy of vulnerability to social distancing and availability of soap or detergent for hand-washing as a proxy of maintaining hand hygiene. The value of absolute contribution indicates the extent of inequality contributed by the explanatory variable. A negative value of the concentration index indicates a larger concentration of variable understudy in poorer households. In the case of household crowding, it is evident that crowding is more concentrated amongst the poor than in rich households. Urban as the place of residence explains about 35 percent of the gap of economic inequality in terms of household crowding, whereas belonging to Scheduled Caste/Scheduled Tribe explains about 28 percent of the gap pertained by economic inequality between rich and poor. Additionally, possession of the Below Poverty Line (BPL) card explains about 28 percent of inequality. The location of water sources outside the house/plot/yard explains about 17 percent of the gap for economic inequality for household crowding. The western region of India narrowed down the gap between rich and poor.

On the other hand, the availability of soap or detergent for handwashing, which is an essential component of maintaining hand hygiene was much more concentrated in richer households than among poorer households. Around 47 percent of inequality was explained by urban place of residence, whereas the Scheduled caste/Scheduled tribe explained 11 percent of the gap. About 11 percent of the gap in economic inequality for the availability of soap or detergent for handwashing was explained by the location of the water source which was outside the house. About 12 percent

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and 9 percent of inequality were explained by the southern and western region of India to explain the gap between rich and poor in terms of use of soap and detergent for handwashing. These findings indicate that all the efforts to curtail the COVID-19 transmission chain may not be effective once the period of lockdown is over, which we cannot extend for an indefinite period. However, these structural barriers will restrain people in following the stringent measures of social distancing, which is mandatory in the absence of any vaccination or other forms of proper treatment.

V. Conclusions and Recommendations

Today the world is growing through an unprecedented crisis. Many countries were taken unaware and have failed terribly in containing the spread of the COVID-19. Initially, these countries did not recognize the gravity of the situation but, within a few weeks, realized the unimaginable economic and human costs of the COVID-19 pandemic. India is a vast and diverse country both demographically and geographically, and hence, handling such a crisis is a huge challenge in itself. This deadly virus has no boundaries, and it transmits from one human to another and often silently since the infected persons with no visible symptom also transmit the virus to others. Hence, India should educate and make the masses aware of the preventive measures and ensure that each one should religiously follow those before it goes completely out of hand. This pandemic has been an eye-opener and has taught us many a lesson. An important one being that we should learn to coexist with nature and not exploit it to the extent that we have to pay a huge price which may be no less than our existence. Despite all the efforts to curtail the chain of transmission of COVID-19, a large section of the population especially in resource poor settings in urban areas will find it difficult to adopt the prescribed preventive measures. India is home to 53 million-plus urban agglomerations where a substantial proportion of the population lives in slums under deplorable living conditions and often face various forms of social exclusions. The large urban agglomerations need to have a micro-plan for each slum under its jurisdiction and actively work for reducing their socio-economic vulnerability that impede them from maintaining the preventive measures.

The need of the hour is to adopt suitable strategies to address the vulnerability of socially deprived and economically marginalized communities to protect themselves by motivating them to adopt micro-level social distancing even within their households to the extent possible, developing a support system and creating enabling environment to practice hand hygiene. Another strategy to curtail the chain of transmission may be decongesting urban slums in all the 53 million-plus urban agglomerations by arranging temporary shelter homes outside cities and developing adequate quarantine facilities. Further, increasing the use of technology to track the mobile population suffering from COVID-19, putting them in quarantine, and strengthening testing facilities following a community based randomized sampling design are perhaps some of the key strategies to minimize the vulnerability of Indian population to COVID-19. Finally, India needs to address the vulnerability of its socially deprived and economically marginalized community in large cities to have a successful COVID-19 containment strategy.

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Table 1: Percent of households (HHs) whose members are highly vulnerable to ensure social distance and hand hygiene as the means of protection from COVID-19 in India, NFHS-4

Background Characteristics	Vulnerability to maintain Social Distance			Vulnerability to maintain Hand Hygiene		
	% of HHs with three or more members per room used for sleeping	% of HHs having water source located outside HH/ dwelling plot	% of HHs having no toilet facility within HH	% of HHs not having any designated place for hand wash	% of HHs with non-availability of water at the place of hand wash	% of HHs not having soap or detergent at the place of hand wash
Place of Residence						
Urban	43.5	20.4	10.5	2.4	6.3	17.5
Rural	51.3	42.9	54.1	3.7	18.0	47.8
Caste/Tribe						
SC	55.7	41.9	50.5	3.8	17.8	44.9
ST	53.4	59.9	65.6	4.6	29.7	58.2
OBC	49.3	33.1	40.4	2.9	12.2	37.0
Others	41.2	24.6	19.8	2.6	8.0	23.3
Religion						
Hindu	48.3	37.0	42.5	3.2	14.7	38.5
Muslim	55.2	25.7	24.1	3.8	9.9	32.5
Others	39.0	27.8	20.9	2.4	11.2	27.5
Wealth Quintile						
Poorest	62.2	56.9	88.1	5.8	32.1	72.5
Poorer	56.8	47.4	62.7	4.0	19.6	53.3
Middle	52.6	37.7	35.4	2.9	11.9	36.2
Richer	44.6	23.7	7.8	2.1	5.4	19.5
Richest	27.1	9.7	0.4	1.4	1.3	5.9
Region						
North	52.7	25.8	37.8	2.0	8.9	24.0
Central	51.7	39.3	57.6	2.6	21.2	44.4
East	48.1	43.8	51.5	5.1	23.4	57.3
North East	27.5	21.0	8.7	6.5	13.8	42.2
West	55.9	22.4	33.1	2.4	10.1	25.4
South	41.3	38.0	31.3	3.1	10.6	37.5
India	**48.6**	**35.1**	**38.9**	**3.2**	**13.9**	**37.1**

Table 2: Logistic regression odds ratios for the adjusted effects of some selected socio-economic characteristics on the vulnerability to infection from COVID-19, India

Covariates	Household crowding as a barrier in ensuring social distancing			Availability of water at the place of hand wash			Likelihood of hand hygiene		
	OR	CI with 95%		OR	CI with 95%		OR	CI with 95%	
Wealth Index									
Poorest®									
Poorer	0.71*	0.70	0.73	1.82*	1.79	1.86	2.36*	2.32	2.41
Middle	0.52*	0.51	0.53	3.39*	3.32	3.48	4.98*	4.89	5.08
Richer	0.34*	0.34	0.35	7.77*	7.52	8.03	10.64*	10.41	10.88
Richest	0.14*	0.14	0.15	33.75*	31.66	35.9	28.50*	27.63	29.40
Place Of residence									
Urban®									
Rural	0.67*	0.67	0.69	0.82*	0.86	0.90	0.71*	0.70	0.73
Caste									
SC®									
ST	0.76*	0.75	0.78	0.72*	0.70	0.74	0.93*	0.91	0.95
OBC	0.86*	0.85	0.88	1.22*	1.19	1.24	1.12*	1.11	1.15
Others	0.65*	0.64	0.67	1.15*	1.11	1.17	1.22*	1.19	1.25
Religion									
Hindu®									
Muslim	1.63*	1.61	1.67	1.24*	1.21	1.28	1.13*	1.11	1.16
Others	1.09*	1.07	1.12	1.34*	1.30	1.39	1.61*	1.57	1.65
Region									
East®									
West	2.00*	1.96	2.04	1.60*	1.56	1.65	2.02*	1.98	2.07
North	1.67*	1.64	1.70	2.01*	1.97	2.07	2.80*	2.75	2.86
South	1.22*	1.19	1.25	1.31*	1.28	1.36	0.90*	0.89	0.93
North East	0.58*	0.57	0.60	2.06*	1.99	2.13	2.24*	2.19	2.29
Central	1.39*	1.37	1.43	1.33*	1.30	1.37	1.71*	1.67	1.75
Constant	2.00	1.96	2.05	1.47	1.42	1.52	0.26	0.25	0.27

*Note: Log likely- Social Distancing -366965.64; Availability of water at the place of hand wash -202114.78; Hand Hygiene -297336.45; *P<0.01*

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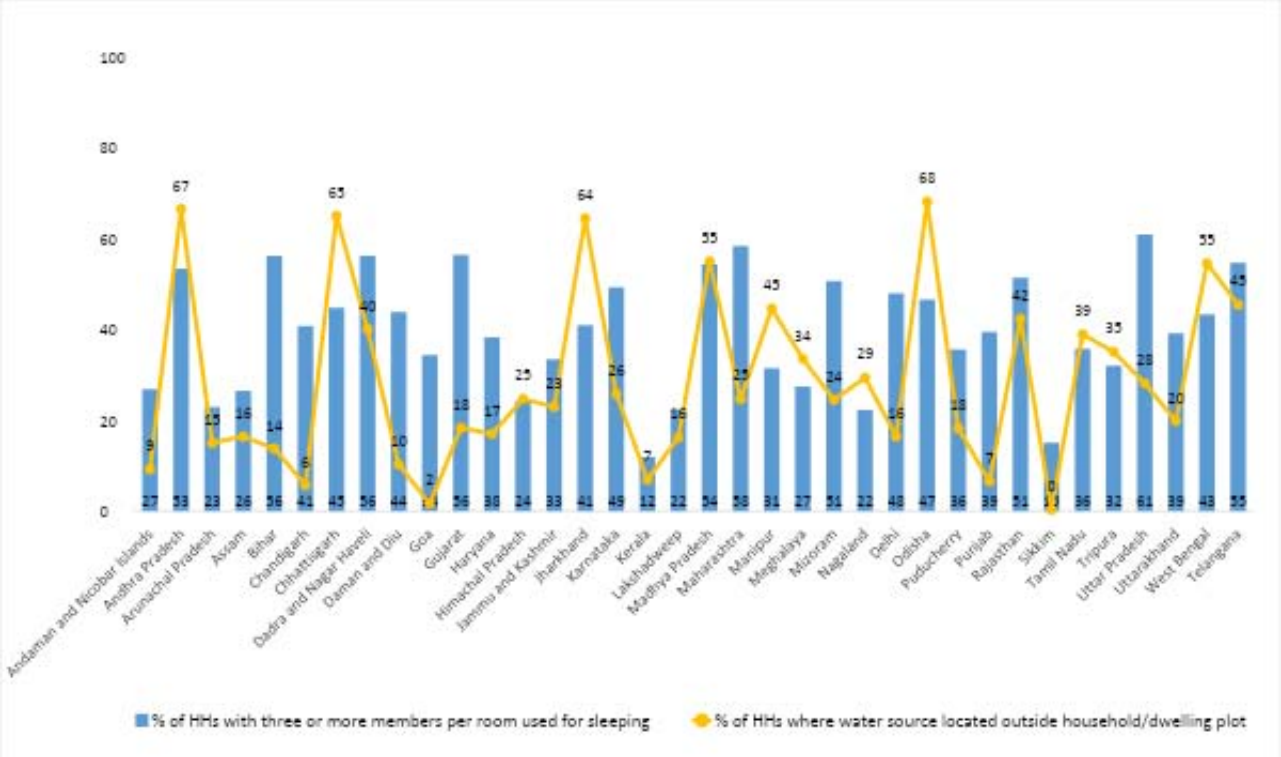


Figure 1: Percent of households whose members are highly vulnerable to ensure social distance as a means of protection from COVID-19 in different States/UTs of India, NFHS-4

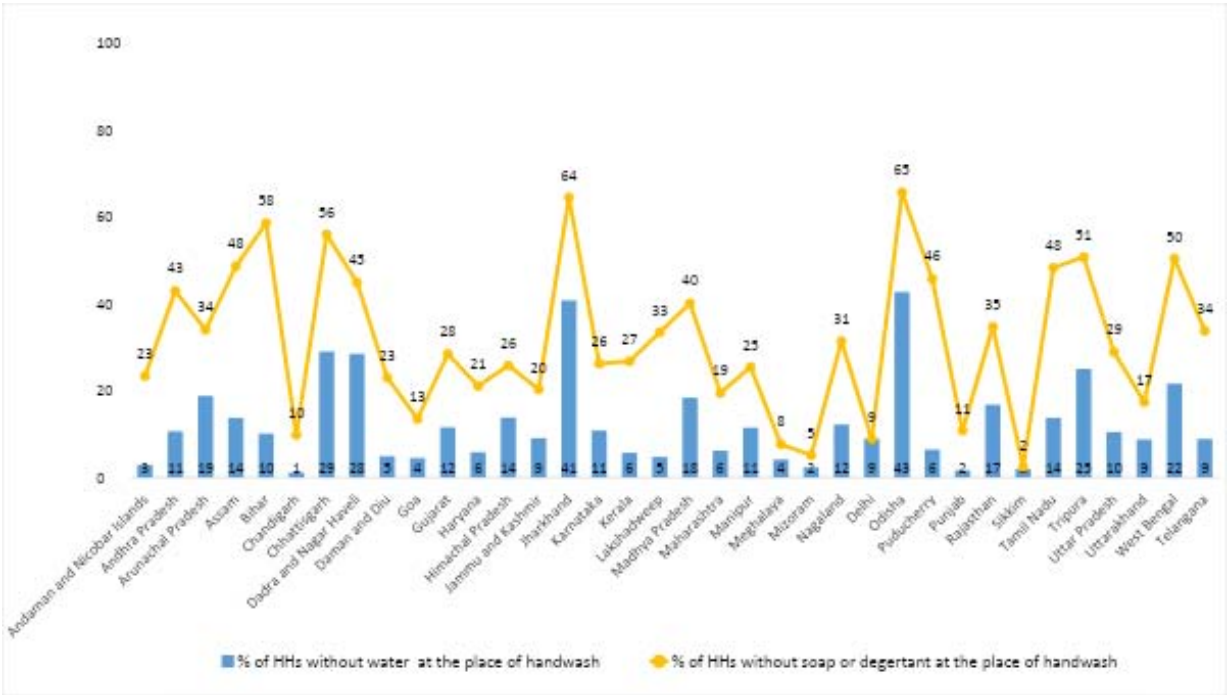


Figure 2: Percent of households whose members are highly vulnerable to ensure hand hygiene as a means of protection from COVID-19 in different States/UTs of India, NFHS-4

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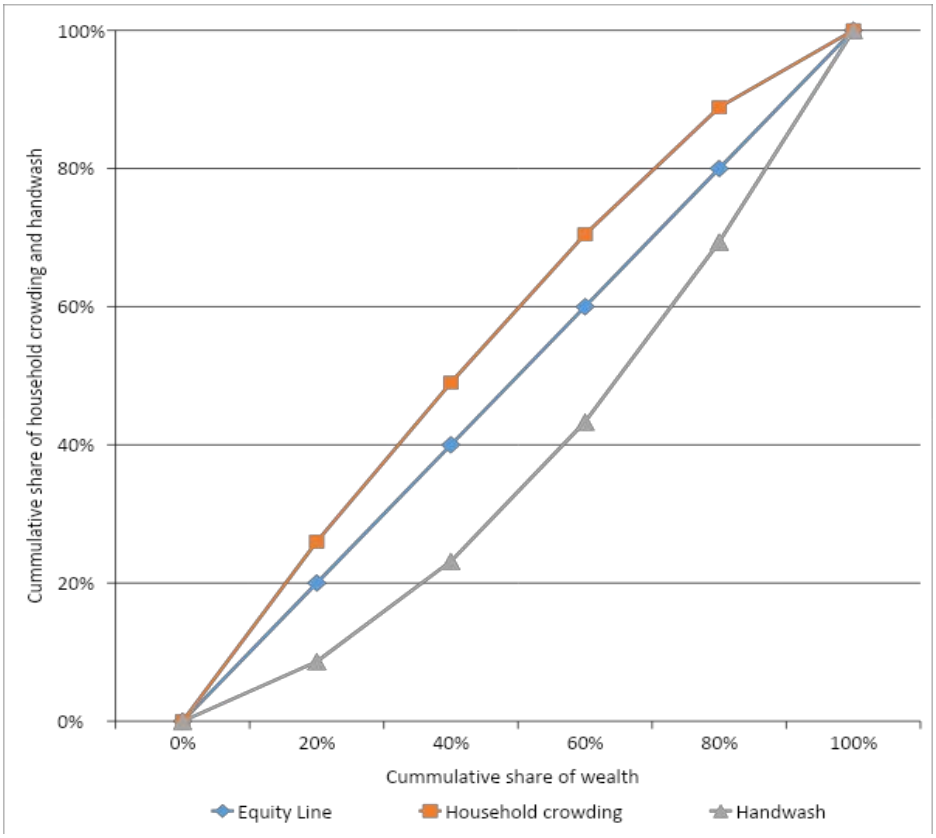


Figure 3: Concentration curve for household crowding and handwashing with soap or detergent among Households in India (NFHS-4)

Table 3: Decomposition analysis for the contribution of selected background characteristics in the economic inequality in household crowding and availability of soap and detergent for Handwashing (NFHS-4)

Variables	Household Crowding				Use of soap and detergent for Hand-wash			
	Elasticity	CI	Absolute contribution to CI	Percent contribution to CI	Elasticity	CI	Absolute contribution to CI	Percent contribution to CI
Urban place of residence	-0.032	0.427	-0.014	34.7	0.125	0.427	0.053	47.3
SC/ST caste group	0.047	-0.236	-0.011	27.6	-0.054	-0.236	0.013	11.4
Muslim religion	0.028	0.001	0.000	0.0	0.002	0.001	0.000	0.0
Non-Hindu/non-Muslim religion	-0.011	0.239	-0.003	6.8	0.008	0.239	0.002	1.7
Possession of BPL card	0.053	-0.213	-0.011	28.1	-0.034	-0.213	0.007	6.3
Water source outside house/plot	0.061	-0.114	-0.007	17.3	-0.108	-0.114	0.012	10.9
Western Region	0.044	0.132	0.006	-14.3	0.079	0.132	0.010	9.3
Northern Region	0.054	0.067	0.004	-9.0	0.095	0.067	0.006	5.6
Southern Region	-0.025	0.215	-0.006	13.8	0.060	0.215	0.013	11.6
North-eastern Region	-0.015	-0.192	0.003	-7.0	0.006	-0.192	-0.001	-1.1
Central Region	0.004	-0.185	-0.001	2.0	0.019	-0.185	-0.003	-3.0
Explained CI			-0.040	100			0.112	
Actual CI			-0.145				0.230	
Residual			-0.105				0.118	

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