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

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Letter to the Editor

Impact of nutritional status and anemia on COVID-19: Is it a public health concern? Evidence from National Family Health Survey-4 (2015–2016), India

The coronavirus disease 2019 (COVID-19) pandemic has now extended over the entire world, and has emerged as a prime public health threat. As of date 31st May, the total number of COVID-19 cases was approximately 6 million with about 0.36 million deaths over the world.[1] In India, the number of confirm cases are increasing day by day. As of date 31st May, the total number of confirmed COVID-19 cases in India was 190,535 with more than 5000 deaths.[2] The number of COVID-19 cases continues to rise, which requires an emergency public health response to combat the severity of the COVID-19 pandemic in India. The number of COVID-19 cases in India are not uniformly distributed, rather there are some hotspots where the maximum number of COVID-19 cases are recorded. A few major hotspot states were identified where the maximum number of COVID-19 cases were recorded to date. The major hotspot states were Maharashtra, Tamil Nadu, Delhi, Gujarat, and Rajasthan, respectively. More than 33% of the total COVID-19 cases were documented in Maharashtra, followed by 11% in Tamil Nadu, 9% in Delhi, 8% in Gujarat, and 4% in Rajasthan. More than 60% of the total COVID-19 cases were recorded from these five states in India. Now the basic question that arises in this context is why such high numbers of COVID-19 cases were recorded in these states. Recently, a number of research studies showed that COVID-19 is largely determined by a number of socio-environmental factors, such air temperature,[3–7] humidity,[8–10] environmental pollution[11] and smoking.[12] But to date, no study has assessed the impact of health status (e.g. nutritional status and anemia) on COVID-19. Considering this recent research gap, in this letter, we made an attempt to assess the impact of health status i.e. nutritional status and anemia on COVID-19 over the hotspot states in India. The data were collected from the National Family Health Survey- 4 (2015–2016). In many recent studies, health status of the people has an impact on COVID-19.[15–21] But the impact of nutritional status and anemia on COVID-19 remain unexplored.

The result of the study showed that the percentage of adults with below normal body mass index (BMI) (<18.5 kg/m^2) recorded higher in hotspot states as compared with others. For example, the average percentage of adults with BMI below normal was more than 20% in Maharashtra, Gujarat, and Tamil Nadu. BMI below normal indicates malnutrition and eating disorder condition. The result recorded that Gujarat had the highest percentage of women (27.2%) and men (24.7%) adults with below normal BMI (<18.5 kg/m^2) followed by Rajasthan (27% women and 22.7% men) and Maharashtra (23.5% women and 19.1% men). On the other hand, the highest percentage of adults (both male and female) with overweight or obesity was found in Tamil Nadu (29.55%) followed by Delhi (29.05%) and Maharashtra (23.6%). The percentage of adults with below normal BMI or obesity were very low where COVID-19 cases were low, such as in Arunachal Pradesh, Sikkim, and Mizoram. So, is there any relation between nutritional status and outbreak of COVID-19 cases? If the answer is 'YES', then it is really a big concern. The nutritional status of 'BIMARU' states (Bihar, Madhya Pradesh, Rajasthan, and Uttar Pradesh) and the States included in 'Empowered Action group' (such as Rajasthan, Bihar, Uttar Pradesh, Madhya Pradesh, Odisha, Chhattisgarh, Uttaranchal, and Jharkhand) are not satisfactory. Even public health facilities remained big issues in these states.[13,14] If there is any relation between nutritional status and COVID-19 outbreak then it not a good indicators in accordance with NFHS-4 (National Family Health Survey-4) data. In recent studies it was well recognized that there is an impact of nutrition on COVID-19.[15–19]

The percentage of anemia among adults was highest in Gujrat (38.3%) followed by Delhi (37.95%), Tamil Nadu (37.75%), Maharashtra (32.8%), and as compared with those states where COVID-19 cases are relatively low such as Sikkim, Arunachal Pradesh, and Mizoram. The highest percentage of men and women with anemia was found in Gujrat (21.7%) and Tamilnadu (55.3%) among hotspot states. It is also really a great public health concern because many studies recorded the relationship between anemia and respiratory disease[20,21] such as COVID-19. It is again a big public health concern because the states under the notion of 'BIMARU' and 'EAG' are the most vulnerable. The percentage of adults with anemia is high in these states such as Uttar Pradesh (38.05%), Bihar (46.3%), Jharkhand (47.55%), Odisha (39.84%), and Madhya Pradesh (39.5%), as compared with Goa (21.15%), Manipur (18.45%), Nagaland (19.9%), and Sikkim (25.3%) where COVID-19 cases are relatively low.

From the overall analysis, it was clear that nutritional status and anemia has an impact on COVID-19 cases over the hotspot states of India. The results of the study showed that adults with below normal BMI, overweight or obesity, and anemia are the most vulnerable to COVID-19. From the data collected from NFHS-4 (2015–2016) and previous literature, it was well recognized that nutritional status and anemia had an impact on respiratory diseases such as COVID-19. The study was performed over the (five) hotspot states of India from where more than 60% of COVID-19 cases were recorded. The outcome of the study is not only a big public health concern for the hotspot states, but also for those which are likely to be hotspots in upcoming days. The percentage of adults with below normal BMI, overweight or obesity, and

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anemia are also high in states such as Rajasthan, Bihar, Uttar Pradesh, Madhya Pradesh, Odisha, Chhattisgarh, Uttaranchal, and Jharkhand. Although a number of initiatives were adopted by the Government of India, including Indian Council of Medical Research at the national level and implemented several public health measures to combat the COVID-19 pandemic under the World Health Organization's guidelines, an effective emergency public health response is urgent to mitigate the severity of the disease for hotspot states, as well as those states that are likely to be hotspots in the upcoming days.

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