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Experience of Public Healthcare System in Recovery of Covid-19 Pandemic: District Level Evidences from Madhya Pradesh

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Abstract: This paper attempts to provide insights into the impact of COVID-19 on the public health care system (PHS), proactive measures taken for it, potential solutions, and focus areas for the coming days. Ever since the first case of COVID-19 was reported in India on January 30, 2020, and in Madhya Pradesh on March 20, 2020, attempts were made to operationalise several of these measures, but COVID-19 seems to have overtaken the functioning of health services. This paper analyses the qualitative and quantitative status of the public healthcare system in Madhya Pradesh, selecting five healthcare centres—SC, PHC, CHC, SDH, and DH. The Healthcare System Weightage Score (HSWS) is calculated to analyse the correlation between weightage score and recovery rate from COVID-19. Based on weightage scores ranging from 2.04 to 7.68, districts were categorised as high-6, moderate-20,low-20, and very low level-5 districtsin the level of the healthcare system (HS). It is suggested that the accessibility and availability of functional medicalfacilities affordable to every person must be insured, especially in the rural areas of the study region, to mitigate the pandemic.

Keywords: COVID-19, Healthcare System, Accessibility, Weightage Score, Recovery rate

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Introduction

The Novel Coronavirus (SARS-CoV-2) outbreak has significantly impacted daily life and healthcare systems worldwide, including in India (Iyengar et al.,2020). During the last two years, the focus has been moved from critical infrastructure protection to responding resiliently to the COVID-19 pandemic. This crisis creates a stressful situation in the Indian health system (Golechha,2021). India attempted to operationalise several of these measures, but COVID-19 seems to have overtaken the functioning of health facilities (Husain et al., 2020). Lockdown imposes a substantial economic and humanitarian burden on societies, particularly in developing countries, that persists even after the epidemic dies out. (Dixit et al., 2021). The first case of *COVID-19* in India was reported on January 30, 2020, and in Madhya Pradesh on March 20, 2020. Currently, 60 per cent of India's population lives in rural India. To provide healthcare facilities to the people living in rural India, the government has established 25743 Primary Health Centers, 158417 sub-centres, and 5624 Community Health Centers.

The magnitude of the coronavirus disease (COVID-19) outbreak is exponentially growing worldwide, inflicting significant mortality and morbidity. Like different global components, India is also suffering from the COVID-19 crisis. Mitigation Strategies via Way of Means India Government of India has been proactive in making plans and implementing guidelines to curtail the coronavirus disorder spread. The containment plan of the Ministry of Health and Family Welfare outlines the scenario-primarily based, totally strategic method to contain COVID-19 spread. It entails an advisory on social distancing measures, suspension of mass gatherings, social media for public awareness, cluster containment, COVID-19 trying out and treatment, vaccine trials and non-pharmacological

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interventions, remaining of faculty and colleges, suspension of public transport (trains/ buses) and COVID-19 instance handler's quarantine. Furthermore, India advocates worldwide collaboration to address the relentless virus spread.

A sound healthcare system delivers quality services to all people when needed, and it needs a well-trained workforce and well-maintained health facilities to deliver quality medicine and treatment (Anayah et al., 2021). Good health means higher labour productivity, increased well-being, and enhanced economic growth (Goel et al., 2020). Differences in health spending result in significant variations in health infrastructure in terms of hospitals, beds, ventilators, etc., across the states (Davalbhakta et al., 2020). At the same time, an ever-widening socio-economic gap between high and low-income households poses challenges to achieving the societal goal of equal health status and access to health care (Saikia, 2014).

The National Health Policy (NHP) 2017 advocates for exploring the role of Public-Private Partnership (PPP) in achieving Universal Health Coverage (Ghei et al., 2015). While about 70 per cent of India's population lives in rural areas, only 20 per cent of hospital beds are in rural areas (Taqi et al., 2017). Indeed, intra-urban disparities in health are not unique to India and have been shown to exist in other cities in developing as well as developed countries (Chatterjee &Laha, 2016). Also, healthcare infrastructure is an important indicator for analysing the country's healthcare policy and welfare mechanism.

Thus, the objective of providing good health to every Indian can only be viable through government as well as non-governmental initiatives where the government provides financial aid through various schemes and the non-governmental institution supplies medicine and medical equipment (Jana &Harata, 2016). The main reasons are the non-availability of health workers, inadequate infrastructure and facilities (Sarkar &Chouhan, 2021). Although it is impossible to transform primary health care in a day, week, or month, the proper steps in this direction will help in the future (Vij, 2019). Healthcare systems are services for diagnosing, treating, or caring for someone suffering from a physical or mental illness, injury, or disability. This includes procedures similar to any form of medical, dental, or surgical care but is not offered in connection with medical conditions and other government-notified services. A health system, also known as a healthcare system, is an organisation of people, institutions, and resources that provide health services to meet the health needs of target groups. Health facilities are hospitals, public health centres, and other public health facilities' providers on or near the site for healthcare provision.

The health infrastructure requires radical reform to deal with the challenge of developing the appropriate infrastructure in rural areas. The need is strengthening them and enabling them with an input mix of facilities, supplies, and human resources based on a real-time information system. The present study is an endeavour to analyse the public health care system in Madhya Pradesh.

The study area

Madhya Pradesh is situated in the central part of India between the latitude of 21.6°N to 26.30°N and longitude of 74°9'E to 82°48'E. According to the 2011 census, the state has a population of 72,597,565. Madhya Pradesh is divided into 51 districts for administrative purposes. These districts are arranged into ten divisions. The health system in Madhya Pradesh consists of a three-tier structure having primary, secondary, and tertiary healthcare (Chauhan et al., 2016).

According to Rural Health Statistics, at least 40 per cent population of Madhya Pradesh is entirely dependent on district hospitals for health services. Only eight districts have government facilities as per the required number of doctors. The number of sub-centres is 10226, Primary health centres are 1420, Community health centres are 324, Sub-divisional hospital is 72, District hospital is 51, and the number of beds available in public facilities is 38140 (Basak& Siddique, 2019). Access to sanitation conditions is relatively poor. However, various development schemes have been implemented to eradicate health issues in the region.

Objectives

In light of the preceding statements, the study's objective is to mark the ground reality about the availability of PHS during the pandemic in rural areas of the state and suggest an appropriate strategy for balanced health equality in the region. Therefore, the primary objectives of the study are to:

1. Find out the Healthcare System Weightage Score (HSWS) for each health system and determine the district-wise PHS.
2. To correlate the availability of PHS and the COVID-19 recovery rate.

Research questions

The study raises the following research questions for their answer with the help of data analysis.

1. What has been the public healthcare system's role in recovering from the COVID-19 pandemic?
2. Do major healthcare centres like Bhopal and Indore play an effective role in reducing the death rate?

Database and Methodology

The study has been conducted based on the secondary database collected from the Census of India, 2011 Rural Health Statistic of Madhya Pradesh 2019, National Health Profile 2020, National Family Health Survey 2019-21 (NFHS-5) and the official websites of different government departments of Madhya Pradesh state. As a result, all the hospitals, including sub-centre (SC), Primary Health Centre (PHC), Community Health Centre (CHC), Sub Divisional Hospitals (SDH) and District Hospitals (DH), have been considered part of the public health care system.

Case fatality rates (CFRs) and case recovery rates (CRRs) are frequently used to describe fitness outcomes associated with specific disease epidemics, such as the COVID-19 pandemic is the proportion of deaths due to a specified health condition compared to total infected cases. CRR is the proportion of recovered or discharged individuals with a specified health condition compared to total infected cases. (Khafaie, 2021). It is notated as:

$$Cj= X1/X*1 +X2/X*2 +X3/X*3+\ldots+Xi/X*i$$

$$= \sum^{n}_{i=1} Xi/X*i, \ldots \ldots \ldots (2)$$

Where Xi represents the i^{th} value of variable X and X*i is the mean of the same variable. According to Battegay et al., we used the proportion of total deaths and recovered cases of COVID-19 to total disease cases at global and national levels to estimate CFRs and CRRs, respectively.CFR= (Total deaths attributed to COVID-19/ Total cases of COVID-19) * 100

CRR= (Total recovered individuals attributed to COVID-19/Total cases of COVID-19) * 100

The analysis carried out in the present paper is both quantitative and descriptive. The availability of healthcare infrastructure is one of the most important components of the study. The methodological steps followed in the present study are:

1. Identification of the status of the public health care system through the weightage score method.
2. Karl Pearson's equation has been applied to establish the correlation between the district score and the COVID-19 recovery rate.
3. All the districts have been categorised into the four levels of PHS according to their PHS score.

Result and Discussion

This paper examines the district-wise status of a public health care system in Madhya Pradesh. The weightage of the healthcare system is calculated for all five types of PHS available in the state.

Table 1: Public healthcare system weightage score of Madhya Pradesh (HSWS)

Health Care System	Weightage Score
Sub Centre (SC)	200.5
Primary Health Centre (PHC)	28.9
Community Health Centre (CHC)	6.47
Sub Divisional Hospital (SDH)	1.64
District Hospital (DH)	1.000

Source: Computed by authors

The Sub Centre scored the highest score with 200.5, whereas the District Hospital has the lowest weightage score with a value of 1.000. HSWS calculates the district-wise healthcare index to compare the mortality and recovery rate from COVID-19. For instance, in the Agar Malwa district, its subcentre value is 77, divided by the mean sub centres value of 200.5 to get a value of 0.38 (Table 2).

The total HS score is found by adding the values of all the indicators corresponding to one district. For instance, the total HS Score for Agarmalwa stands at 2.04, the sum of corresponding individual weightage scores of 0.38,0.20,0.46,0, and 1 (Table 2). Accordingly, among the 51 districts of Madhya Pradesh, Chhindwada district records the highest position in respect of total HS score with a composite score of 8.96, followed by Dhar with 8.01 and the lowest in Agar Malwa with 2.04 (Table 2).

Table 2: District-wise public healthcare system score of Madhya Pradesh

District	SC	PHC	CHC	SDH	DH	Total score	Death rate	Recovery rate
Agar Malwa	0.38	0.20	0.46	0	1	2.04	2.05	97.94
Alirajpur	0.90	0.54	0.92	0	1	3.37	1.3	96.6
Anuppur	0.82	0.61	1.23	0	1	3.67	0.9	99.06
Ashok Nagar	0.64	0.37	0.30	1.21	1	3.54	1.5	98.4
Balaghat	1.43	1.29	1.07	1.82	1	6.62	0.7	99.1
Barwani	1.61	1.02	1.23	1.21	1	6.08	1.07	98.8
Betul	1.58	1.22	1.38	0.60	1	5.79	2.1	97.6
Bhind	1.02	0.95	1.07	0.60	1	4.66	1.06	98.8

Bhopal	0.32	1.76	0.30	1.82	1	5.22	0.7	99.0
Burhanpur	0.48	0.51	0.61	0	1	2.60	1.5	98.4
Chhatarpur	1.15	1.36	1.54	0	1	5.05	1.1	98.6
Chhindwada	1.49	2.34	1.69	2.42	1	8.96	1.7	96.0
Damoh	0.86	0.61	0.92	0.60	1	4.00	2.2	96.5
Datia	0.53	0.44	0.61	1.21	1	3.81	1.1	98.7
Dewas	1.02	0.85	1.07	1.21	1	5.16	0.6	99.3
Dhar	2.32	1.76	2.31	0.60	1	8.01	1.03	98.8
Dindori	0.93	0.74	1.07	0	1	3.76	0.6	99.2
Guna	0.78	0.64	0.77	0.60	1	3.80	0.8	99.0
Gwalior	0.58	1.87	0.46	2.42	1	6.34	1.1	98.7
Harda	0.38	0.23	0.61	0	1	2.24	1.8	98.0
Hoshangabad	0.76	0.57	0.92	1.21	1	4.48	0.9	98.9
Indore	0.56	1.97	0.92	1.82	1	6.28	0.9	98.9
Jabalpur	0.87	1.73	0.92	1.82	1	6.35	1.3	98.5
Jhabua	1.43	0.71	0.77	1.21	1	5.12	0.8	99.1
Katni	0.79	0.68	0.92	0.60	1	4.00	1.2	98.6
Khandwa	0.88	1.05	1.07	0.60	1	4.62	2.3	97.6
Khargone	1.55	2.14	1.54	1.21	1	7.44	1.7	98.0
Mandla	1.34	1.15	1.23	0.60	1	5.33	0.4	99.4
Mandsaur	0.88	1.36	1.07	1.21	1	5.53	0.9	99.0
Morena	1.16	0.91	1.07	1.82	1	5.97	1.1	96.7
Narsinghpur	0.66	0.78	1.07	0.60	1	4.13	0.7	99.2
Neemuch	0.50	0.61	0.46	1.21	1	3.79	1.06	98.7
Panna	0.75	0.57	0.92	0	1	3.26	0.8	99.0
Raisen	0.91	0.71	1.07	1.82	1	5.52	2.1	97.8
Rajgarh	1.05	1.02	0.77	2.42	1	6.27	1.9	97.6
Ratlam	0.96	1.02	0.92	1.21	1	5.12	2.1	97.6
Rewa	1.54	1.36	1.38	1.82	1	7.11	0.9	99.0
Sagar	1.30	1.39	1.69	1.82	1	7.21	2.3	97.3

Satna	1.51	1.7	1.38	1.21	1	6.81	1.1	96.8
Sehore	0.79	0.81	1.23	1.21	1	5.06	0.7	99.2
Seoni	1.38	1.08	0.77	1.82	1	6.06	0.4	99.4
Shahdol	1.14	1.02	1.07	0.60	1	4.84	1.1	98.7
Shajapur	0.57	0.57	0.61	1.82	1	4.58	1.1	98.8
Sheopur	0.52	0.40	0.462	0	1	2.39	1.9	98.0
Shivpuri	1.28	0.51	1.38	0	1	4.18	1	98.9
Sidhi	0.96	0.95	0.92	0	1	3.83	0.9	96.0
Singroli	1.00	0.51	1.07	0	1	3.59	0.9	99.0
Tikamgarh	1.01	0.81	1.07	0	1	3.90	1.6	98.0
Ujjain	1.01	1.25	0.77	3.64	1	7.68	0.9	99.0
Umaria	0.60	0.44	0.46	0	1	2.51	1	96.9
Vidisha	0.98	0.91	1.07	1.21	1	5.19	1.9	97.9

Source:1. Rural Health Statistic of Madhya Pradesh 2019-20 (number of healthcare systems)

2. Department of Public Relations, Madhya Pradesh (COVID-19 cases)

3. Computed by the author (weightage score, death rate and recovery rate)

Note: Individual weightage score = Individual attribute value/ Mean attribute value

Total Healthcare system Score = Summation of individual quotient values (the higher the score, the higher the level of the healthcare system)

Table 2 reveals that on the one hand, Seoni, Mandla, Dindori, and Guna have been recorded as the lowest number of death, and on the other hand, Indore, Bhopal, Jabalpur, and Gwalior have recorded the highest number of deaths for the reason of no proper testing, tracing and a more significant number of sugars-blood pressure patient. The total number of deaths varies from district to district, but the recovery rates have almost the same trends among the districts. According to the Karl Pearson correlation coefficient method, the intensity of the linear relationship between healthcare system scores and recovery rate is 0.05, which indicates a lower degree of correlation between them due to high vaccination coverage in the minimum time frame.

The sum of the weightage scores of sub-centres, Primary Health Centres, Community Health Centres, Sub Divisional Hospitals and District Hospitals is recognised as the total score of the particular district. The HS score value varies from 2.04 to 8.96.

Based on the healthcare system score (HSS) values, the districts have been grouped into four categories high, moderate, low and very low (Table 2), reflecting the relative levels of healthcare infrastructure. The high-level HS category includes districts that have scored more than 7.00 and include six districts, namely Chhindwara, Dhar, Ujjain, Rewa, Sagar, and Khargone. The moderate level category includes 20 districts, with scores ranging between 5.00 and 7.00. The majority of District 20 is marked under the low-level category, which has a score ranging between 3.00 to 5.00.

Finally, the very low category districts scored less than 3.00 score which includes five districts, namely Umaria, Sheopur, Harda, Burhanpur and Agarmalwa.

Table 3: Level of healthcare system of Madhya Pradesh

Healthcare system score	Level of the healthcare system	Number of districts	Name of District
Above 7.00	High	6	Chhindwara, Dhar, Ujjain, Rewa, Sagar, Khargone
5.00-7.00	Moderate	20	Vidisha, Satna, Sehore, Seoni, Ratlam, Mandla, Mandsaur, Morena, Indore, Jabalpur, Jhabua, Gwalior, Dewas, Betul, Barwani, Balaghat, Bhopal, Chattarpur, Raisen, Rajgarh.
3.00-5.00	Low	20	Tikamgarh, Singrauli, Sidhi, Shivpuri, Sajapur, Shahdol, Panna, Neemuch, Narsighpurkatni, khandwa, Hosagabad, Dindori, Guna, Damoh, Datia, Bhind, Ashoknagar, Anuppur, Alirajpur
Below 3.00	Very low	5	Umaria, Sheopur, Harda, Burhanpur, Agarmalwa

Source: Computed by author

Based on this categorisation, a map has been produced to show different levels of the HS and COVID-19 recovery rates as shown in the map. The recovery rate ranged from a high of 99.4 per cent for Mandla and Seoni to a low of 96 per cent for Chhindwara and Sidhi districts, giving a range difference of 3.4. The districts have been grouped into four categories high(above 99 per cent), moderate (98-99 per cent), low (97-98 per cent)and very low(below 97 per cent) recovery rate in the COVID-19 pandemic.

High level

Only six districts out of fifty-one with a score index value of >7.00 fall into this category (table.3). The index value ranged from a high of 8.96 for Chhindwara to a low of 7.11 for Rewa district, giving a range difference of 1.85 between the two. It indicates that employees of health centres had been actively participating in vaccination supply to the population of that area—efficiency and accessibility of healthcare infrastructure in terms of population coverage. There is better connectivity in the healthcare centres at different levels. Although PHS is available and affordable to almost all population segments.

Moderate level

Twenty of the fifty-one districts with a score index of 5.00-7.00 fall in this category. The index value ranged from a high of 6.81 for Satna to a low of only 5.05 for Chhatarpur district, giving a range difference of 1.76. Thus, it shows that a healthcare system aims to provide healthcare facilities to the people, thereby improving their health status. This is possible due to awareness campaigns by the government, door-to-door vaccination, school and drive-in vaccination, and the appointment of nodal officers to maintain rules and regulations of COVID guidelines.

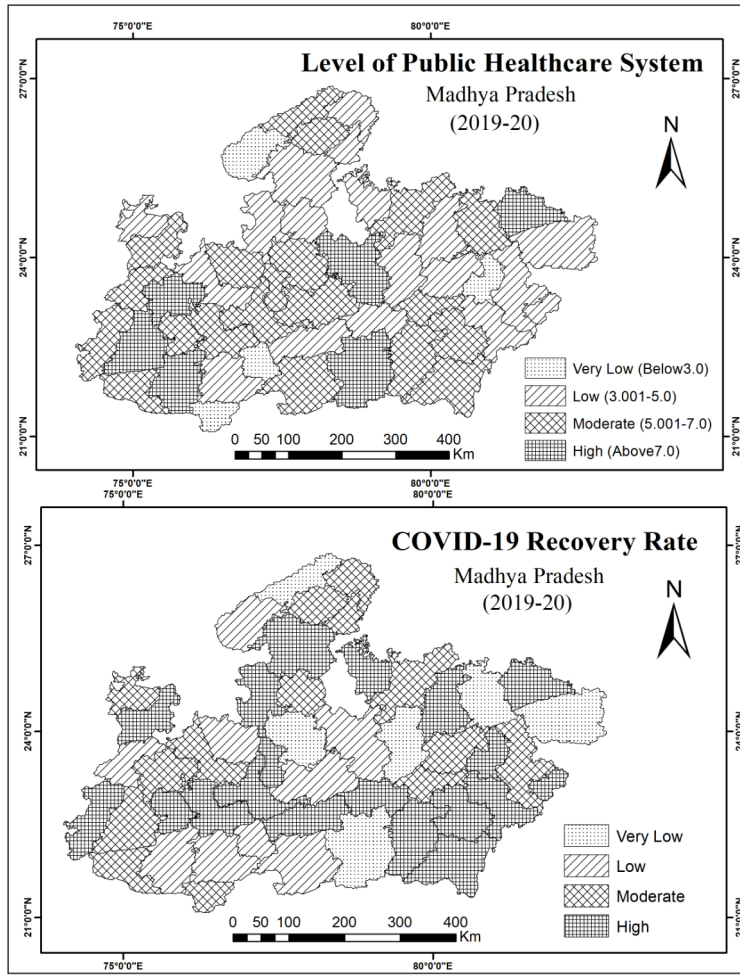

Fig.1

Low level

Twenty of the fifty-one districts with a score index of 3.00 to 5.00 fall in this category. The index value ranged from a high of 4.84 for Shahdol to a low of only 3.26 for the Panna district, giving a range difference of 1.58 between the two. In these districts, proper government guidelines were not followed. It indicates that health infrastructure is an important indicator for understanding a region's healthcare delivery provisions and welfare mechanisms in low-level districts. Infrastructure has been described as the basic support for delivering public health activities. In this sense, their role should facilitate community participation and involve them in the necessary actions to address the social and cultural barriers that lead to poor health.

Very low level

Five of the fifty-one districts with a score index of < 3.00 fall into this category. The index value ranged from a high of 2.60 for Burhanpur to a low of only 2.04 for Agarmalwa district, giving a range difference of 0.56. It has a hybrid healthcare system, including public and private healthcare providers. However, most private healthcare providers are concentrated in urban areas, providing secondary and tertiary healthcare systems. The major issues in rural healthcare are inadequate health

infrastructure, lack of proper healthcare facilities and skilled human resources in the existing health centres.

Vaccination

Before the availability of vaccines, nations, in large part, trusted mobility and tried to mitigate the COVID-19 pandemic. The first protection and efficacy outcomes for vaccines in opposition to SARS-CoV-2 have been posted between the end of 2020 and the start of 2021. The outcomes show that vaccination saved 30 thousand people. In summary, the outcomes endorse that each vaccination rule has been important in decreasing both the spread and the number of deaths. Vaccination decreased the general death rate to 4.6 per cent from 9.0 per cent in Bhopal, Indore, and other major districts.

Vaccination significantly reduced unfavourable outcomes, with non-ICU hospitalisations, ICU hospitalisations, and deaths decreasing from 63.5 to 66.7 per cent, 65 to 68.6 per cent, and 69.3 to 73.1 per cent, respectively, over the same period.

In Madhya Pradesh, residents have the right to enter the COVID-19 vaccine. Covishield (Oxford-AstraZeneca) is the primary vaccine administered. This vaccine is given in doses 12 to 16 weeks apart. As of May 16, 2021, Madhya Pradesh has reached and succeeded in its aim of 179,000 human beings vaccinated to 182,378 human beings vaccinated. As of August 13, 2021, COVID-19 vaccines had been administered to 36,739,380 people in Madhya Pradesh. As of August 14, 2021, Madhya Pradesh has shown a total of 791,998 cases and has recorded 10,514 deaths. Some findings suggest that there has been significant improvement in the rural healthcare infrastructure, especially in the case of health centres in the region, after the implementation of NRHM in 2005.

NRHM mission was completed via key countrywide programs, namely, the National Disease Control Programs (NDCP) and the Integrated Disease Surveillance Project (IDSP). NRHM additionally enabled mainstreaming AYUSH, i.e., Ayurvedic, Yoga, Unani, Siddha and Homeopathy health structures. As a result, the public health expenditure in India declined from 1.3 per cent of GDP in 1990 to 0.9 per cent in 1999. In 2009-10, the country's general public expenditure on health as a percentage of GDP was around 1.1 per cent, up from 0.96 per cent in 2005-06. There was a 30 to 40% increase in institutional transportation during the early post-NRHM period of 2007-08 (383%) and late post-NRHM period of 2011-12 (65.5%), respectively, from the pre-NRHM Period of 2000-04 (24.8%), as opposed to a seven-percentage point increase in the pre-NRHM Period from pre-NRHM Period 1 of 1995-99 (18.5%).

Public health infrastructure has the nerve centre of the public health care system'. The recent pandemic of COVID-19 has been a wake-up call not only for the public health realm but also for working towards strategies for mitigating pandemics, which is now a top global public health priority. Healthcare infrastructure is also importantfor understanding any health system's provisioning and working. According to the national health profile, the state government has set itself a target of administering both doses of the COVID-19 vaccine to the entire eligible population. The four components of surge capacity are staff, supplies, space and structure. The private health sector is small, concentrated in urban areas and unaffordable for most (Chokshi et al., 2016).

Conclusion

Addressing a newly emerged pandemic is a challenging task. To explore the status of healthcare facilities to mitigate the impact of COVID-19, accessibility and availability of medical facilities are much required in pandemic situations. It should be ensured that every village must have at least one medical centre with proper functional facilities. Overall analysis shows that socio-economic factors are an indivisible part of addressing the COVID-19 pandemic. Vulnerability assessment using an HS index can provide an understanding of real-world situations. The low HS score districts should be prioritised based on their unprivileged health infrastructure. Finally, more research is needed for a more inclusive outcome.

The states and national stakeholders must rethink the rural public health infrastructure development and create health advisory bodies to review the post-acute sector's response, identify

opportunities to improve performance going forward and develop a pandemic response plan for post-acute care providers. (Hebbar et al., 2020). This article attempts to provide insights into how COVID-19 has impacted the public health care system, what measures have been taken proactively and what could be potential solutions and focus areas for the coming days.

The evaluation shows that authorities' spending is crucial to enhancing the healing rate. There may be numerous doable causes for this. A growth in health spending factors in the direction of a more evolved financial system, and it can additionally be instrumental in supplying higher checking out and screening facilities. Large-scale testing could help determine cases and, as a result, in treatment and healing.

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