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Non-Communicable Diseases and Covid-19 Pandemic: A Spatial Analysis of Multiple Healthcare Burden in India

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Abstract

Background: The entire world experiences triple as well as multiple burdens of diseases with the co-existence of prevailing burden of communicable diseases and evolving heavy burden of non-communicable diseases (NCDs) along with the outburst of COVID-19 crisis. **Materials and Methods:** The study has been extracted from the Global Burden of Disease Study 2019. Publicly available data related to COVID-19 and NCD burden from the Ministry of Health and Family Welfare, Government of India, COVID-19 Tracker, and Kerala Government's Directorate of Health Services. **Results:** The burden of COVID-19 is larger in states with a higher prevalence of non-communicable diseases and in states that are further along in the epidemiological transition. Around 95 percent of the deceased had one or more comorbidities, and the majority of them had several comorbidities. NCDs such as Hypertension and diabetes, as well as coronary artery disease, chronic kidney disease, and cancer, are appeared as a common predictor of COVID-19 mortality. **Conclusion:** The COVID-19 action, as well as a sustained and enhanced emphasis on NCD diagnosis, intervention, and interrelated facets of healthcare system, are essential. Future policy interventions should be focus on whole sectors such as health, education, employment, poverty, and local governance to address the underlying social, economic, and environmental grounds of ill health including pandemic to mitigate the repercussions and to achieve the sustainable development goals.

Keywords: Comorbidity, COVID-19, Healthcare burden, Non-communicable diseases

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Introduction

Health is the most significant dimension of human well-being. Good health accumulates the process of human capital. It is a sign of development. During the process of development, due to unsustainable pattern of activities plethora of diseases will be emerged as a challenge to the economy. The outbreak of the COVID-19 pandemic has served as a stark reminder that our economies and the whole entity are inextricably linked to our health. At this juncture, entire world experiences triple burden of diseases with the co-existence of the prevailing burden of communicable diseases and evolving heavy burden of non-communicable diseases (NCDs) along with the outburst of the COVID-19 crisis. Noncommunicable diseases are one of the foremost challenges confronted by all the countries, especially among developing countries in this 21st century. The economic and social consequences of chronic diseases are felt by all countries, particularly vulnerable sections of the society. The interaction of coronavirus disease and non-communicable diseases could raise the global disease burden. The substantial burden of NCDs along with the COVID-19 crisis has made the situation more vulnerable.

The COVID-19 pandemic has devastated the entire globe, resulting in thousands of deaths per day. In comparison to Western countries, many LMICs are facing converging episodes of chronic infectious and NCD diseases, resulting in an increase in the prevalence of multi-morbidity, the co-occurrence of two or even more long-term illnesses.[1] During this pandemic, people living with NCDs with allied comorbidities and higher levels of social and economic distress are less likely to seek medical care. As a result, health outcomes deteriorate, together with poor quality of life, increased hospitalization, and death. NCDs have indeed been identified as a significant health risk in COVID-19 patients. Furthermore, people who are living in nations with significant social and economic disparities are more likely to have concomitant NCDs, making it more vulnerable to COVID-19's effects.[2] People with NCDs are more likely to become seriously ill or die as a result of COVID-19 since the outbreak. COVID-19 and NCDs have a symbiotic effect on other, NCDs make people more vulnerable to COVID-19, while COVID-19 makes people more vulnerable to NCD-related risk factors.[2] As per World Health Statistics 2020, between the ages of 30 and 70, the annual decrease in the likelihood of dying from a serious NCD is slowing. Indeed, NCDs are the major cause of death in the 30–70 age category in Southeast Asia. In most countries, health systems were unable to effectively respond to the healthcare needs of persons afflicted by NCDs. Consequently, the burden of COVID-19-related mortality and morbidity, as well as NCD-linked comorbidities is mounting, that poses a bigger challenge to present healthcare systems, particularly in low- and middle-income countries. The strong linkage between COVID-19 and noncommunicable diseases is a challenge for achieving the sustainable development goals (SDGs), particularly those related to NCDs.[3,4] This is likely to adversely affect the SDG agenda

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globally in varying degrees, particularly the agenda on health and wellbeing especially in a developing country like India.

COVID-19 has unequivocally established the nexus between communicable and non-communicable diseases.[5] COVID-19 has an impact on the global health system, both directly as a communicable disease and indirectly more severe through its impact on NCDs. A devastating association between both communicable disease and NCDs has never been observed earlier.[6,7] Gaur *et al*. demonstrated that COVID-19 disease burden and death rates significantly linked to higher state-level burden of NCDs and risk factors in India.[8] Hypertension, diabetes, and chronic respiratory conditions were the most common comorbidities seen in COVID19 patients admitted to intensive care units across most nations.[9] Evidences has identified that there is a correlation between baseline noncommunicable illnesses and COVID-19 cases.[10] Evidence indicates that certain chronic conditions, such as diabetes and hypertension, have been found to be more prevalent amongst COVID-19 patients. Since the COVID-19 pandemic, people who require treatment for chronic ailments such as cardiovascular disease, cancer, and diabetes have been unable to access the proper health care and medications. In comparison to individuals without chronic conditions, studies show that COVID-19 patients had a higher risk of poor clinical outcomes, such as mortality.

The south Indian state of Kerala has experienced a good human and social development trajectory, however, high prevalence of morbidity is a serious matter of concern. The increasing rate of morbidity especially chronic NCDs can have a severe economic impact on the society. A large percentage of individuals in Kerala suffer from chronic diseases, particularly hypertension, diabetes, and atherosclerosis, which are known to lead to chronic difficulties such as heart failure and kidney disease.[11] Kerala has the highest prevalence of cancer, which in itself is higher than the national average. The growing NCD burden with multimorbidity is yet another problem persists in the state. Due to the pandemic, conditions like anxiety, psychosomatic, and mental problems have also been emerged as significant health concern. As per Kerala Death Audit Report 2021, almost every single one of the deceased had a comorbidity, and the majority of them had several comorbidities.[12] In this backdrop, the current study aims to assess the association between the COVID-19 pandemic with the burden of NCDs in the Indian state of Kerala.

Materials and Methods

The study has been employed publicly available data related to COVID-19 and NCD burden. The data regarding NCDs, deaths, disability-adjusted life years (DALYs) has been extracted from the global burden of disease study (GBD) 2019.[13] The burden of NCDs at the state level, as well as their risk factors and epidemiological transition index, have been evaluated. The study has used data of confirmed COVID-19 cases, deaths, and case fatality ratio from the Ministry of Health and Family Welfare, Government of India, and also from COVID-19 Tracker (https://www.covid19india.org/).[14,15] Data on daily confirmed new coronavirus cases and deaths for the state of Kerala has been gathered from the Kerala Government's Directorate of Health Services.[16]

Results

In India, the number of Coronavirus disease cases and deaths has exploded, causing havoc on the country's health-care system. The country has experienced the alarming increase in March 2021 and was much more severe than those that recorded in 2020. With more than 31.5 million cases and 424,351 deaths documented by July 2021, India has one of the greatest absolute burdens of COVID-19 infection. The burden of COVID-19 is dramatically higher in much more advanced and urbanized parts of the country, where NCD risk factors are more prevalent.[8] India is rated second in the world in terms of daily new cases and fifth in terms of daily new deaths.[15] In India, the top three states with the newest cases are Kerala, Maharashtra, and Andhra Pradesh. Eighty-two percent of new cases are reported in Kerala, Maharashtra, Andhra Pradesh, Tamil Nadu, and Karnataka. Maharashtra, Kerala, Odisha, and Tamil Nadu account for 76% of all new fatalities reported. Although Maharashtra has reached a plateau of 8000 new cases per day, Kerala's condition has become a source of concern, with the state reporting over 20,000 cases during the last week of July. Kerala stands for 40% of active cases in the country, with Maharashtra responsible for the remaining 20%. Together, the two states account for more than 60% of active cases.[17]

The rates of COVID-19 cases and deaths vary widely among Indian states [Table 1]. The states with the highest number of confirmed cases include Maharashtra, Kerala, Karnataka, and

Table 1: COVID-19 cases, deaths and rates in various states in India (as on 31st July 2021)

States and UTs	*Cases*	*Deaths*	*Case Fatality Ratio*
Andaman and Nicobar Islands	7539	129	1.7
Andhra Pradesh	1,968,462	13,395	0.7
Arunachal Pradesh	48,122	231	0.5
Assam	566,982	5275	0.9
Bihar	724,880	9644	1.3
Chandigarh	61,954	811	1.3
Chhattisgarh	1,002,008	13,525	1.3
Dadra & Nagar Haveli, Daman and Diu	10,653	4	0
Delhi	1,436,350	25,054	1.7
Goa	171,205	3148	1.8
Gujarat	824,900	10,076	1.2
Haryana	769,942	9638	1.3
Himachal Pradesh	206,161	3505	1.7
Jammu and Kashmir	321,607	4379	1.4
Jharkhand	347,173	5129	1.5
Karnataka	2,906,999	36,587	1.3
Kerala	3,411,489	16,838	0.5
Ladakh	20,338	207	1
Lakshadweep	10,195	50	0.5
Madhya Pradesh	791,828	10,513	1.3
Maharashtra	6,310,194	132,948	2
Manipur	99,331	1566	1.6
Meghalaya	65,589	1096	1.7
Mizoram	38,925	150	0.4
Nagaland	27,945	570	2
Odisha	978,705	6019	0.6
Puducherry	121,005	1795	1.5
Punjab	599,130	16,294	2.7
Rajasthan	953,677	8954	0.9
Sikkim	26,754	345	1.3
Tamil Nadu	2,561,587	34,102	1.3
Telangana	645,406	3805	0.6
Tripura	78,580	752	1
Uttar Pradesh	1,708,441	22,763	1.3
Uttarakhand	342,161	7362	2.2
West Bengal	1,528,720	18,149	1.2
India	31,695,186	424,808	1.3

Source: MoHFW, GOI

Tamil Nadu [Figure 1]. The total cases of death are also high in these states. However, in the instance of Kerala, the case fatality ratio is different. The states such as Mizoram, Arunachal Pradesh, Kerala, and Lakshadweep have case fatality rates, approximately 0.5 percent, whereas Punjab, Uttarakhand, Maharashtra, have rates of much more than 2 percent.

The existing literature and evidence strongly display the linkage between novel coronavirus diseases and NCD-related comorbidities. The present COVID-19 pandemic demonstrates how the prevalence of NCDs can raise the chances of death from a communicable disease. Hypertension, diabetes, COPD, cardiovascular illness, and cerebrovascular disease were identified as major risk factors for COVID-19 patients.[18] The 86 percent of COVID-19 patients had coexisting diseases such as diabetes, chronic kidney disease, hypertension, or heart disease, signaling that an existing condition makes a person more vulnerable to coronavirus infection in India. The percentages of mortality recorded in COVID-19 patients with NCD conditions such as cardiovascular disease (13.2%), diabetes (9.2%), chronic respiratory disease (8%), hypertension (8.4%), and cancer (7.6%) significantly greater than in patients without coexisting disorders, as per available data (0.9%).[9,19]

As per a recent WHO study, 22% of the world's population has a chronic disease that raises the chance of COVID19 fatalities, and the majority of these illnesses are NCDs. According to GBD study, 71 percent of all deaths in 2016 were due to NCDs in the world.[20] Every year, almost 15 million people aged 30 to 69 die from a noncommunicable disease, and 85 percent of these fatalities falling in low- and middle-income countries.[21] Subsequently, NCDs represent a huge and growing segment of the disease burden, and consequently cause for anxiety, in nations around the world. Heart disease, diabetes, cancer, and chronic respiratory illness are the major NCDs. The epidemiological load of chronic illnesses and their risk factors is growing worldwide. Apart from the COVID crisis, NCDs and their risk factors are the world's largest cause of death. Tobacco and alcohol use, poor diets, physical inactivity, hypertension, obesity, and environmental factors are all common risk factors for NCDs. It is projected that addressing these primary risk factors might eliminate at least 80% of all heart disease, stroke, and diabetes, as well as 40% of cancer.[22]

It has been widely documented that NCD risk factors, as well as chronic conditions, enhance the likelihood of extreme outcomes in COVID-19.[8] In India, NCDs are projected to account for 63 percent of deaths. CVDs, cancer, diabetes, and chronic respiratory illnesses are the nation's top causes of death. The state-wise data on NCDs-related DALY and epidemiological index are shown in Table 2. COVID-19 burden is higher in states with a higher incidence of NCD and in advanced stages of epidemiological transition. The burden of COVID-19 is much higher in more developed and urbanized states of the country, where NCD risk factors are more prevalent. States with significant NCD burdens and advanced stages of epidemiological transition, such as Kerala, Tamil Nadu, Maharashtra, West Bengal, Karnataka, and Delhi, have seen a high burden of COVID-19 diseases.

Kerala is apparently experiencing a significantly higher level of epidemiological change when compared to other Indian states. Disease prevalence has been growing over the years for NCDs in the state. Yet, fast urbanization, migration, age pattern, inadequate nutrition and changing lifestyle have to be found Kerala in a condition where facing a continually increasing burden of NCDs. NCDs are responsible for approximately 90% of premature death in Kerala, particularly among those aged 15–69. Ischemic heart disease, cancer, stroke, chronic obstructive pulmonary disease, diabetes, and chronic kidney disease account for nearly half of the total illness load in terms of DALYs and death in Kerala [Table 3]. Kerala's rising elderly population and sedentary lifestyles might well have contributed to the rise in NCDs.

Around 95% of the deceased had one or more comorbidities, and the majority of them had several comorbidities. NCDs like

Table 2: State wise burden of non-communicable disease, healthcare indices and COVID-19 cases

States	*Epidemiological transition index*	*Non-communicable diseases (Percentage of total DALYs)*	*Confirmed COVID-19 cases*
Andhra Pradesh	2.7	63.3	1,968,462
Arunachal Pradesh	1.82	58.6	48,122
Assam	1.61	56.0	566,982
Bihar	1.35	50.3	724,880
Chhattisgarh	1.67	53.8	1,002,008
Delhi	2.63	66.3	1,436,350
Goa	4.76	74.7	171,205
Gujarat	2.17	59.8	824,900
Haryana	2.5	61.0	769,942
Himachal Pradesh	3.33	67.8	206,161
Jammu & Kashmir and Ladakh	2.94	63.8	321,607
Jharkhand	1.45	53.5	347,173
Karnataka	2.94	65.4	2,906,999
Kerala	6.25	76.9	3,411,489
Madhya Pradesh	1.67	51.7	791,828
Maharashtra	3.03	66.0	6,310,194
Manipur	2.38	61.6	99,331
Meghalaya	1.56	56.4	65,589
Mizoram	1.89	57.4	38,925
Nagaland	2.13	56.6	27,945
Odisha	1.72	54.3	978,705
Punjab	3.45	68.9	599,130
Rajasthan	1.52	51.3	953,677
Sikkim	2.22	68.2	26,754
Tamil Nadu	3.85	68.0	2,561,587
Telangana	2.63	62.7	645,406
Tripura	2.22	65.3	78,580
Uttar Pradesh	1.47	49.2	1,708,441
Uttarakhand	2.17	61.7	342,161
West Bengal	3.03	66.0	1,528,720

Source: GBD India Compare, https://vizhub.healthdata.org/gbd-compare/india
India covid-19 tracker, https://www.covid19india.org/(2021)

Table 3: Burden of major NCDs in India-DALY and Death in India and Kerala, 2019

Type of disease	*Kerala*		*India*	
	DALYs	*Death*	*DALYs*	*Death*
Ischemic Heart Disease	12.72	25.37	7.97	16.17
Cancer	9.18	13.09	5.75	9.95
Stroke	5.41	10.8	3.71	7.44
COPD	4.71	7.7	4.55	9.57
Diabetes	4.3	3.95	2.73	2.91
Chronic Kidney Diseases	3.32	4.89	1.61	2.37

Source: GBD India Compare, https://vizhub.healthdata.org/gbd-compare/india

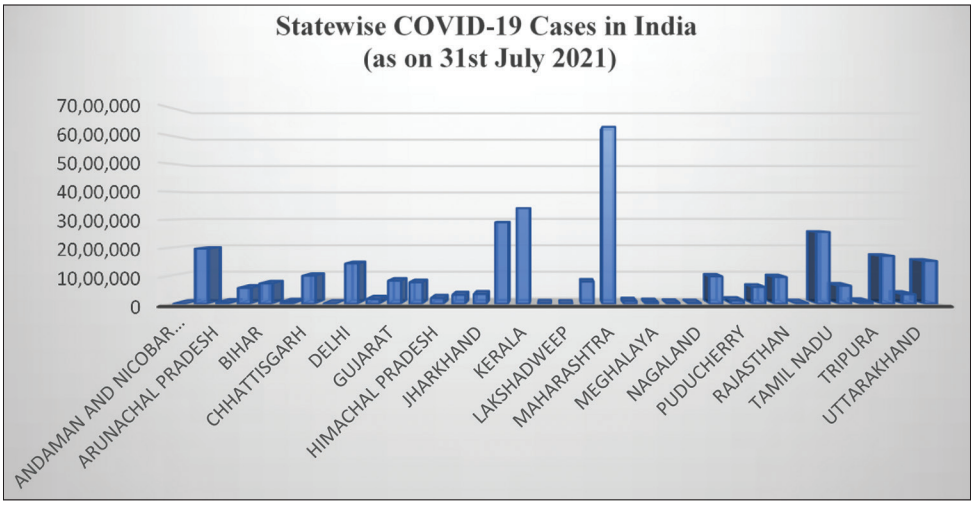

Figure 1: State wise Covid-19 cases in India
Source: https://www.covid19india.org

Hypertension and diabetes, as well as coronary artery disease, chronic kidney disease, and cancer, are appeared as a common predictor of COVID-19 mortality. In Kerala, among the deceased, diabetes mellitus was the most common comorbidity found (57%) followed by hypertension (54%) and majority of them had multiple comorbidities [Figure 2].

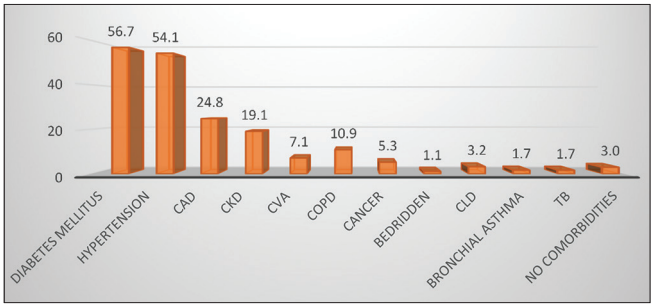

Figure 2: Presence of comorbidities among the COVID-19 deaths in Kerala
Source: Author's calculation from various Death Audit Reports 2020–2021, Department of Health and Family Welfare, Government of Kerala

Discussion

The global world experiencing a double crisis of health and economic jeopardy during the pandemic of novel coronavirus diseases. The entire world economy is wedged with the pandemic, and such economic failures have a deleterious impact not only on health system, but also on a diverse system of activities. As a result, when it comes to COVID-19, health systems in countries, which are often under-resourced and overburdened, are prone to incur high healthcare costs and accompanying economic troubles. The COVID-19 might impede access to and quality of key health interventions to NCDs, that are already among the world's top causes of morbidity and mortality. NCD-affected people are suffering from more severe conditions of COVID-19 and also have worse outcomes. Diabetes mellitus, hypertension, cerebrovascular disease, coronary artery disease, and COPD are among the most widely mentioned noncommunicable illnesses that have already been shown to reflect high mortality rate in COVID-19 patients. Evidence shows that after the pandemic, people with and without NCDs had changed their lifestyles, with less physical activity and more sedentary behavior, fewer vegetable intake, and more ultra-processed products including frozen snacks and meals.[23] People with NCDs were found to be less active, eat fewer vegetables, and spend more time sedentary, such as watching television during the outbreak of coronavirus disease.

In India, 86 percent of COVID-19 patients had comorbid diseases such diabetes, chronic renal disease, hypertension, or heart problems, indicating that an existing condition makes people highly exposed to coronavirus infection.[9] A further key economic concern during COVID-19 would be increasing out-of-pocket expenditure in the country due to the large NCD load and low public investment in the health care. The prolonged epidemic has aggravated chronic ailment burden by substantially disrupting health care systems' ability to provide routine screening, assessment, treatment, and preventive measures. Evidence indicates that certain chronic conditions, such as diabetes and hypertension, have been found to be more prevalent amongst COVID-19 patients. Since the COVID-19 pandemic, people who require treatment for chronic ailments such as cardiovascular disease, cancer, and diabetes have been unable to access the proper health care and medications. In comparison to individuals without chronic conditions, studies show that COVID-19 patients had a higher risk of poor clinical outcomes, such as mortality.

COVID-19, which is normally a modest condition, is of serious concern for persons with NCDs as well as co-morbidities due to the extreme probability of severe disease and death particularly in a developing country like India. In terms of daily new cases, India is ranked second in the globe and fifth in terms of new deaths. The COVID-19 cases and mortality differ significantly between Indian states. Kerala, Maharashtra, and Andhra Pradesh are the top three states in India with the most recent instances. Despite the fact that Maharashtra's prevalence rates have stabilized around 8000 per day, Kerala's situation has been a subject of concern, with the state reporting over 20,000 cases over the last several days. The burden of COVID-19 is larger in states with a higher prevalence of non-communicable diseases and in states that are further along

in the epidemiological transition. Kerala, Tamil Nadu, Maharashtra, West Bengal, Karnataka, and Delhi have witnessed a high burden of COVID-19 diseases due to high NCD loads and advanced stages of epidemiological change.

Kerala, the southern state with high human and social development with low level of economic advancement than some other states in India, has been facing a health crisis due to the demographic and epidemiological transition and resulting triple burden of communicable, NCDs and COVID-19 pandemic. NCDs grew six-fold in the recent decade, from 2004 to 2014, among different kinds of illnesses.[24] It is evident that NCDs are much more prevalent in Kerala. The state is facing highest prevalence of noncommunicable diseases including cardiac disease, diabetes, cancer, chronic pulmonary disorders, and their risk factors.[25] Another issue in the state is the growing NCD burden, which is accompanied by multimorbidity. In this situation, Kerala is more susceptible to COVID-19 than in any other Indian state due to its high geriatric population and high prevalence of NCDs and even its risk factors. The primary concern nowadays is really to prevent the spread of the COVID-19 virus in the country, and also to protect the most vulnerable members of society, such as the elderly as well as those with underlying conditions of chronic illnesses, such as cardiovascular disease, hypertension, diabetes, cancer, and other respiratory conditions, and also obesity.[6] Evidences display that nearly 95% of the deceased had one or more comorbidities, with the majority having several comorbidities. In this pandemic period, diabetes was the most common comorbidity among the deceased in Kerala, followed by hypertension, and the majority of them had many comorbidities. Apart from this, COVID-19 has also been linked to a variety of mental health and psychological issues.[26] Health anxiety, psychosomatic or mental disorders, and medically unexplainable symptoms may become a major global health issue in the future.

At this critical stage of the COVID-19 pandemic, the convergence of COVID-19 with noncommunicable diseases, particularly among the elderly, is additional critical concern in the state. The elderly make up more than 70 percent of total of the COVID-19 people that has deceased. Furthermore, the state faces the highest levels of out-of-pocket health expenditure burden in India. Meanwhile, the increased prevalence of chronic diseases resulting in a higher financial burden in the state further Jeopardise during the epidemic. High out-of-pocket health spending in the state as a result of the triple burden of infectious, chronic non-communicable, and coronavirus diseases, combined with the state's lockdown, has resulted in an economic and health crisis, with impoverishment trapping people in a vicious cycle of poverty. With the outbreak of the pandemic in the state, large category of people who are occupied in the informal sector of the economy loss their job and loss of regular income which adversely affects the consumption, saving and healthy behavior makes the situation more vulnerable even in the long run.

The lack of systematic cause-specific morbidity, comorbidity, and mortality data, as well as socio-economic and demographic-based databases of COVID-19 cases and deaths, are one of the major limitations of the study. Considering the paucity of current evidence, there is a need to study the association and impact of chronic multiple NCD conditions with coronavirus diseases at household level. Moreover, future area of the study is to explore the impact of COVID-19 on NCD patients in the unorganized sector and particularly across the vulnerable and marginalized sections of the society.

Conclusion

COVID-19 and NCDs both have a detrimental influence on global and national output, productivity and household outlay, resulting in a negative impact on a country's total economic growth. At this juncture, the COVID-19 action, as well as a sustained and enhanced emphasis on NCD diagnosis, intervention, and interrelated facets of healthcare system is essential. In this scenario, it is necessary to enact public policies that encourage health-promoting behaviors, along with regulatory measures for the protection and prevention of NCDs, as well as the expansion of primary health care, especially for NCD care. Since the persisting COVID-19 risks across individuals living with NCDs, targeting them for vaccination should be a primary agenda of health system. In particular, consideration should be given to the elderly, adolescents, and other disadvantaged populations, in order to meet their unique health requirements. Enhancing grass-root level local planning might benefit populations to access equitable, reasonable, high-quality, and effective care in a timely manner and ensure optimal allocation of resources to vulnerable population. Future policy interventions should be focus on whole sectors such as health, education, employment, poverty, and local governance to address the underlying social, economic, and environmental grounds of ill health including pandemic to mitigate the repercussions and to achieve the SDGs.

Ethical Issues

Nil.

Ethical Approval Statement

This study used secondary data for analysis. Thus, ethical approval was not required.

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References

1. Pati S, Mahapatra P, Kanungo S, Uddin A, Sahoo KC. Managing multimorbidity (multiple chronic diseases) amid COVID-19 pandemic: A community-based study from Odisha, India. Front Public Health 2021;8:584408.
2. Yadav UN, Rayamajhee B, Mistry SK, Parsekar SS, Mishra SK. A syndemic perspective on the management of non-communicable diseases amid the COVID-19 pandemic in low-and middle-income countries. Front Public Health 2020;8:508.
3. Thakur JS, Nangia R, Singh S. Progress and challenges in achieving noncommunicable diseases targets for the sustainable development goals. FASEB Bioadv 2021;3:563-8.
4. Thankappan K. Coronavirus disease 2019 and noncommunicable diseases: Lessons learned so far and implications for the future. Int J Non-Commun Dis 2020;5:155.
5. Doraiswamy S, Cheema S, Mamtani R. The COVID-19 and lifestyle nexus: Settling the debate. Glob Health Promot 2021;1-5:17579759211018417.
6. Dawa N, Thankappan KR, Narain JP. Evolving COVID-19 pandemic in

India: Why addressing chronic diseases today is even more critical. Epidemiol Int 2021;6:1-3.
7. Narain J. COVID-19 and chronic noncommunicable diseases: Profiling a deadly relationship. Int J Non-Commun Dis 2020;5:25.
8. Gaur K, Khedar RS, Mangal K, Sharma AK, Dhamija RK, Gupta R. Macrolevel association of COVID-19 with non-communicable disease risk factors in India. Diabetes Metab Syndr 2021;15:343-50.
9. Thakur J, Paika R, Singh S, Narain J. COVID-19 and noncommunicable diseases: Impact and the strategic approaches. Int J Non-Commun Dis 2020;5:29.
10. Azarpazhooh MR, Morovatdar N, Avan A, Phan TG, Divani AA, Yassi N, *et al*. COVID-19 pandemic and burden of non-communicable diseases: An ecological study on data of 185 countries. J Stroke Cerebrovasc Dis 2020;29:105089.
11. Muraleedharan M, Chandak AO. Emerging challenges in the health systems of Kerala, India: Qualitative analysis of literature reviews. JHR 2021.
12. Death Audit Reports. Department of Health and Family Welfare, Government of Kerala; 2021. Available from: https://www.kerala.gov.in/health-family-welfare-department. [Last accessed on 2021 Jul 29].
13. GBD India Compare; 2019. Available from: https://www.vizhub.healthdata.org/gbd-compare/india [Last accessed on 2021 Jul 29].
14. Ministry of Health and Family Welfare, Government of India; 2021. Available from: https://www.mohfw.gov.in [Last accessed on 2021 Jul 31].
15. India COVID-19 Tracker; 2021. Available from: https://www.covid19india.org [Last accessed on 2021 Jul 31].
16. Directorate of Health Services, Government of Kerala; 2021. Available from: https://www.dhs.kerala.gov.in. [Last accessed on 2021 Jul 29].
17. Monthly Economic Review. Economic Division Department of Economic Affairs, Government of India; 2021. Available from: https://dea.gov.in. [Last accessed on 2021 Aug 10].
18. Wang B, Li R, Lu Z, Huang Y. Does comorbidity increase the risk of patients with COVID-19: Evidence from meta-analysis. Aging 2020;12:6049-57.
19. Guan W, Liang W, Zhao Y, Liang H, Chen Z, Li Y, *et al*. Comorbidity and its impact on 1590 patients with COVID-19 in China: A nationwide analysis. Eur Respir J 2020;55:2000547.
20. GBD 2016 Disease and Injury Incidence and Prevalence Collaborators. Global, regional, and national incidence, prevalence, and years lived with disability for 328 diseases and injuries for 195 countries, 1990-2016: A systematic analysis for the global burden of disease study 2016. Lancet 2017;390:1211-59.
21. World Health Organization. Non-Communicable Diseases Fact Sheet. Geneva: World Health Organization; 2021. Available from: https://www.who.int/news-room/fact-sheets/detail/noncommunicable-diseases. [Last accessed on 2021 Jul 28].
22. Institute for Health Metrics and Evaluation. Findings from the Global Burden of Disease Study 2017. Seattle, Washington: Institute for Health Metrics and Evaluation; 2018.
23. Malta DC, Gomes CS, Barros MB, Lima MG, Almeida WS, Sá AC, *et al*. Noncommunicable diseases and changes in lifestyles during the COVID-19 pandemic in Brazil. Rev Bras Epidemiol 2021;24:e210009.
24. Paul K, Chaudhary M, Chowdhary R, Sengupta R. Changes in levels of morbidity and hospitalisation in Kerala: A district level analysis (1995-2014). Clin Epidemiol Glob Health 2020;8:21-8.
25. Thankappan KR, Shah B, Mathur P, Sarma PS, Srinivas G, Mini GK, *et al*. Risk factor profile for chronic non-communicable diseases: Results of a community-based study in Kerala, India. Indian J Med Res 2010;131:53.
26. Nayar N, Joseph SJ, Bhandari SS, Dutta S, Shoib S. Gearing up to tackle mental health issues in the post-COVID-19 world. Open J Psychiatry Allied Sci 2021;12:65.