

REVIEW SUMMARY

Social vulnerability indicators in pandemics focusing on COVID-19: A systematic literature review

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Abstract

Introduction: Social factors can affect the vulnerability of disaster-prone communities. This review aimed to identify and categorize social vulnerability indicators in the COVID-19 pandemic.

Methods: This systematic review was conducted in February 2021. Bibliographies, citation databases, and other available records were investigated based on the aim of the study. The Joanna Briggs Institute (JBI) critical appraisal tools were applied for assessing the included articles retrieved through the comprehensive and systematic literature search. Descriptive and thematic analyses were done to extract the indicators affecting social vulnerability in the COVID-19 pandemic.

Results: Thirty-one eligible articles were included and 85 indicators of social vulnerability were extracted. The indicators were categorized in seven main categories, including; Household, community composition; Race, minority status and language; Socio-economic status; Community health status; Public health infra-structures; Education; Information, technology and communication.

Conclusion: Regions with higher social vulnerability experienced greater mortality rates during the COVID-19 pandemic. Additional research is needed to measure the social vulnerability index in pandemics to prioritize distribution of scarce resources and ensure effectiveness and equity for all regions of countries.

KEYWORDS

COVID-19, indicators, pandemic, social vulnerability

1 | INTRODUCTION

Natural and man-made disasters have always affected humans with their negative and harmful effects (Fatemi et al., 2017; Flanagan et al., 2011). Known measures taken to reduce vulnerability against disasters, can be categorized into physical, human, financial, social, political, and environmental dimensions (Aliabadi et al., 2015; Armas & Gavris, 2013; Cutter & Finch, 2008). Vulnerability is a key concept for understanding risk and the consequences associated with a risk. In initial

studies, the vulnerability of a system refers to those conditions of a system that existed before the occurrence of the hazard, and considers the indicators to be effective in exacerbating the effects of that hazard (Ackerman, 2006; Guillard-Gonçalves et al., 2014). Gradually, this definition was completed by the United Nations Office for Disaster Risk Reduction (UNISDR) to include the conditions determined by physical, social, economic, and environmental factors or processes, which increase the susceptibility of an individual, a community, assets or systems to the effects of hazards. Social vulnerability is the characteristics

of an individual or group and their situation that affect their capacity to prevent, respond, sustain and recover from the effects of hazards (Cutter et al., 2003; Zebardast, 2013). Other researchers consider social vulnerability to be the result of social inequalities and regard factors, such as urbanization level, educational status, and income level to be effective for exacerbating social vulnerability (Fekete, 2009; Holand & Lujala, 2013; Lawal & Arokoyu, 2015; Thomas et al., 2020).

The COVID-19 epidemic as a biological disaster has already affected all communities around the world and has created a public health emergency (Fatemi & Moslehi, 2021). According to the World Health Organization (WHO), from the beginning of the pandemic to January 21, 2022, there have been almost 340,543,962 confirmed cases and 5,570,163 deaths reported throughout the world. All countries particularly those with higher social vulnerability index are concerned about the high influence of the pandemic on their socially and economically vulnerable people (Bodrud-Doza et al., 2020; OE, OA, Parajuli, Hingle, & Robinson, 2020; Pessoa et al., 2020). These groups have more difficulty accessing health care facilities as well as implementing preventive measures, such as lock-down regulations-problems that have led to an increase in vulnerability, a greater risk of infection and higher possibility of community disease transmission (Kavan, 2021; Kithia et al., 2020; Pomazanov et al., 2021). For example, many African-American people live in crowded and environmentally polluted environment are much more vulnerable to diseases such as asthma, as well as COVID-19, when compared to whites (Boserup et al., 2020; Credit, 2020). Working in indoor industrial locations where physical presence is necessary and social distancing is difficult for adherence and increases the risk of getting infected with COVID-19 (Lins-Filho et al., 2020; Snyder & Parks, 2020). Some cultural and economic characteristics of societies, including age, income, employment, and insurance status can result in people not using health facilities in a timely manner, increasing predictable mortality from COVID-19 (De Oliveira et al., 2020; I. Karaye & Horney, 2020).

The relationship between social vulnerability and COVID-19 has emerged as a complex and somewhat unknown challenge for health policy makers and evaluators. Paying attention to the indicators affecting the social vulnerability of communities against COVID-19 can help authorities to better control and manage COVID-19 in vulnerable communities (I. M. Karaye & Horney, 2020; Khazanchi et al., 2020; Neelon et al., 2020). Therefore, this review aimed to identify and categorize social vulnerability indicators related to the COVID-19 pandemic.

2 | METHOD

The following steps were conducted to prepare the manuscript which was then evaluated with a PRISMA checklist.

2.1 | Inclusion and exclusion criteria

The included documents were peer reviewed articles and reports that focused on social vulnerability indicators during pandemics through

out the world, and were in the scope of research question of this study. No publication date was imposed. Articles that were not related to the indicators of social vulnerability against COVID-19 or other occurred pandemics were excluded. Documents with no full texts availability or in other languages except English were also excluded.

2.2 | Databases and search strategy

This systematic review covered the electronic governmental, non-governmental, and academic resources, such as articles, books, guidelines, and reports. International electronic databases, including PubMed, Web of Science, Scopus, and ProQuest were investigated. Google Scholar was also searched by hand-searching. All the search terms related to "social vulnerability" were found by the PubMed Mesh system, and expert opinion about synonyms of terms in combination with "COVID-19" and "indicators." The search syntax was written using keywords and synonyms which were searched in title, abstract, or keyword fields in databases. The selected key words were the same during searching in websites and databases. The summarized form of search strategy was ("social vulnerability") AND (indicators OR components) AND (COVID-19 OR pandem*).

2.3 | Study selection

Researcher (SF) performed the screening of the titles and abstracts to choose the relevant articles. Then, two independent researchers (SF and MRKHA) investigated the full-text of the selected studies according to the inclusion and exclusion criteria. In the case of disagreements between two researchers in each stage, the judgment was assigned to a third researcher (FF). The process for selecting and reviewing the articles are shown in Figure 1.

2.4 | Quality appraisal

The selected articles were evaluated using the Joanna Briggs Institute (JBI) critical appraisal tools. All the evaluated articles were categorized in three groups, including low, moderate, and high after quality appraisal. The documents evaluated low were excluded and the articles categorized in moderate and high groups were included in the study. JBI critical appraisal tools are reliable tools to investigate different studies, including RCT, systematic review, observational (cross-sectional, case report, and etc.), qualitative, and other scientific studies.

2.5 | Data extraction and analysis

Regarding data extraction, two forms were developed. One of the developed forms included descriptive information, including the author's name, country where the study was conducted, publication date, and methodology. Another form contained the extracted domains

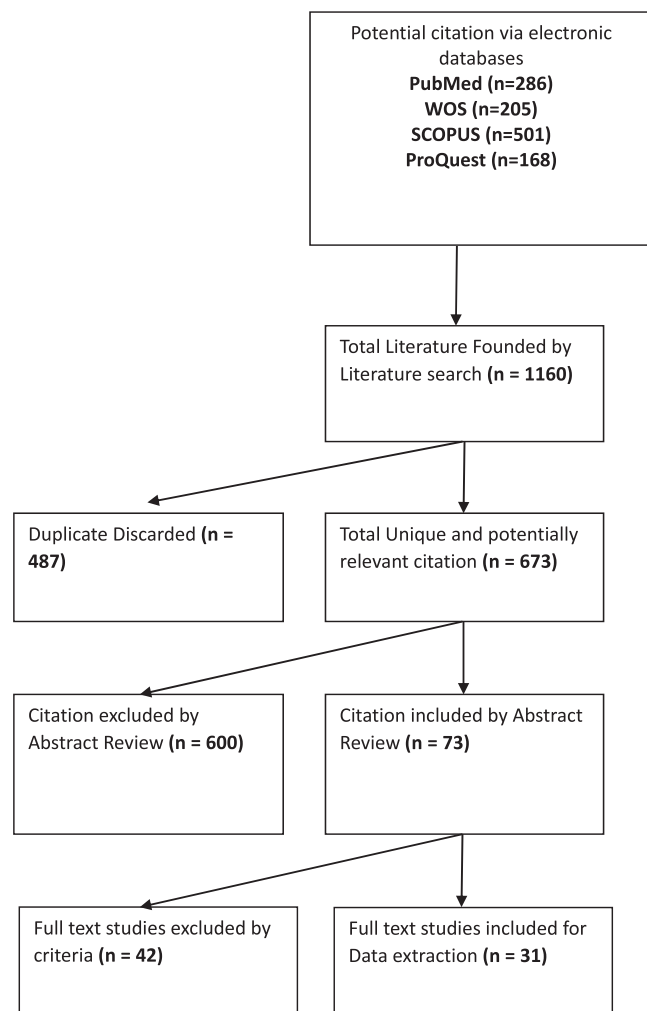


FIGURE 1 PRISMA diagram of systematic article selection

and indicators of social vulnerability in pandemics focusing on COVID-19. Thematic synthesis approach was applied to gather information, and inductive analysis was performed (Boyatzis, 1998). The authors extracted the mentioned descriptive information and coded the social vulnerability domains and indicators of each study, then grouped the similar codes, and finally analyzed the grouped findings to categorize the effective domains and indicators of social vulnerability related to COVID-19. The accuracy and completeness of the extracted data were checked by authors in a discussion group.

3 | RESULTS

A total of 1160 potentially relevant studies were identified through searching process. After excluding, 487 duplicate titles, 673 remaining articles were screened; of these, 600 were excluded based on their similarity in titles and abstracts. Finally, the content of the 73 articles were reviewed and 42 articles were included based on inclusion criteria for full text review; 31 were included for data extraction. The included articles were evaluated using the JBI critical appraisal tools and

categorized to low, moderate, and high methodological quality. Thirty two percent of studies were determined as high quality, 36% were moderate quality, and 32% were recognized as low quality (Table 1). Figure 1 shows the process of assembling the data used in the analysis.

3.1 | Descriptive analysis

Most of the included studies were conducted in the United States ($n = 22$, 70.9%) followed by Brazil ($n = 4$; 12.9%) and Indonesia ($n = 2$; 6.5%). Other studies were from India ($n = 2$; 6.5%) and Sweden ($n = 1$; 3.2%). The descriptive analyses of the relevant articles are presented in Table 1. The most commonly used method for analyzing social vulnerability in COVID-19 was mapping the social vulnerability layer in a specific region and demonstrating COVID-19 cases on the layer using geographic information system (GIS) (Armas & Gavris, 2013; Flanagan et al., 2018; Garcia et al., 2020; Guillard-Gonçalves et al., 2014; LeRose et al., 2021; Zebardast, 2013; Zhang et al., 2015). All the included studies tried to identify and visualize the most effective social vulnerability indicators on COVID-19 epidemic in the specific areas. The included articles and their characteristics are shown in Table 1.

3.2 | Thematic analysis

Eight domains and 95 relevant indicators affecting social vulnerability in the COVID-19 pandemic were excluded from the 31 reviewed papers. Most of the studies had the same indicators and variables for determining the effect of social vulnerability on COVID-19, with more than one variable was used to tap the same underlying indicator. For instance, the household and community composition or socioeconomic status were found as the most recurring domains of social vulnerability measured, respectively, by 15 and 55 individual indicators in the reviewed studies. Due to further investigation and elimination of the same concepts, the two mentioned domains were measured by 11 and 28 indicators, respectively (Table 2).

The most cited domains and variables of social vulnerability affecting COVID-19 in relevant studies were household and community composition (*population aged 65 years or older, population aged 17 years or younger*), minority (*American Indian, immigrant population*), socioeconomic status (*unemployment rate, population living below poverty line*), and public health infrastructures (*population access to health insurance, hospital beds, No. per 10000 population or primary care physicians, No. per 10000 population*). Housing type; transportation and food, community health status, education and information; technology and communication were the domains of social vulnerability to COVID-19 used in less than 40% of the reviewed studies.

4 | DISCUSSION

Compared to the previous epidemics, such as SRARS, MERS, and influenza H1N1, the concept of social vulnerability in COVID-19 has

TABLE 1 Descriptive analysis of included papers for the systematic review of literature

No.	Title	1 st Author	Country	Year	Type of study	Appraised Quality	Study objective
1	Impact of social vulnerability on COVID-19 incidence and outcomes in the U.S. (Nayak et al., 2020)	Aditi N.	USA	2020	Ecological study	Moderate	To examine the association of Social Vulnerability Index (SVI) with the case fatality rate and incidence of COVID-19
2	Neighborhood inequity: Exploring the factors underlying racial and ethnic disparities in COVID-19 testing and infection rates... (Credit, 2020)	Credit K.	USA	2020	Cross-sectional	High	To explore the effects of factors underlying racial and ethnic disparities in COVID-19 testing and infection
3	Proposing Additional Indicators Related to COVID-19 to the Children's Social Vulnerability Index in Indonesia (Adwiluvito & Rakhmawan, 2020)	Adwiluvito H.	Indonesia	2020	Cross-sectional	High	To provide an overview of the social vulnerability by proposing some COVID-19 related indicators to the SVI of children to the district level
4	Social vulnerability and equity: The disproportionate impact of COVID-19 (Gaynor & Wilson, 2020)	Gaynor T.S.	USA	2020	Cross-sectional	Moderate	To explore the effects of racism to lead disproportionate infection and death rates in the U.S.
5	Assessing the spread of COVID-19 in Brazil: Mobility, morbidity and social vulnerability (Coelho et al., 2020)	Coelho F.C.	Brazil	2020	Cross sectional	High	To identify regions with high geographical and social vulnerability against COVID-19
6	Social vulnerability in the pandemic period: correlation between social determinants of health and COVID-19 incidence in Brazilian regions (De Gois et al., 2020)	Moura J.N.	Brazil	2020	Qualitative study	Moderate	To find the correlation the social vulnerability in Brazilian regions with the number of COVID-19 confirmed cases
7	Spatial variation in socio-ecological vulnerability to Covid-19 in the contiguous United States (Snyder & Parks, 2020)	Snyder B.F.	USA	2020	Ecological study	Moderate	To develop a hierarchical socio-ecological vulnerability index that might contribute to community vulnerability to COVID-19
8	Structural Inequalities Established the Architecture for COVID-19 Pandemic Among Native Americans... (Aggie J. Yellow Horse, Yang, & Huyser, 2021)	Yellow Horse A.G.	USA	2020	Cross-sectional	High	To explore whether areas with high percentages of Native American residents are experiencing the equal risks of contracting COVID-19
9	Bridging the gap between social and health vulnerability in rural India: A case of COVID-19 (Surendra, 2020)	Surendra S.	India	2020	Commentary	Moderate	To bridge the gap between health and social vulnerability of five village during COVID-19 pandemic

(Continues)

TABLE 1 (Continued)

No.	Title	1 st Author	Country	Year	Type of study	Appraised Quality	Study objective
10	The impact of social vulnerability on COVID-19 in the U.S.: An analysis of spatially varying relationships (I. M. Karaye & J. A. Horney, 2020)	Karaye I.M.	USA	2020	Cross sectional	High	To estimate the association between case counts of COVID-19 infection and social vulnerability in the U.S
11	The CHASMS conceptual model of cascading disasters and social vulnerability: The COVID-19 case example (Thomas et al., 2020)	Thomas D.	USA	2020	Qualitative study	Moderate	To apply the conceptual model to COVID-19 as an illustration of how underlying inequities give rise to foreseeable inequitable outcomes
12	The impact of socioeconomic vulnerability on COVID-19 outcomes and social distancing in Brazil (Lins-Filho et al., 2020)	Lins-Filho P.C.	Brazil	2020	Cross sectional	Moderate	To assess the impact and correlation of socioeconomic vulnerability on COVID-19 outcomes and social distancing in Brazil
13	Social Vulnerability and Racial Inequality in COVID-19 Deaths in 508 Chicago (Kim & Bostwick, 2020)	Kim S.J.	USA	2020	Cross sectional	High	To understand the emerging pattern of racial inequality in the effects of COVID-19
14	The Relationship Between Social Vulnerability and COVID-19 Incidence Among Louisiana Census Tracts (Biggs et al., 2020)	Biggs E.N.	USA	2020	Ecological study	Moderate	To examine the association between the CDC's SVI and COVID-19 incidence among Louisiana census tracts.
15	The spatial association of social vulnerability with COVID-19 prevalence in the contiguous United States (Wang et al., 2020)	Wang C.	USA	2020	Cross sectional	Moderate	To examine the spatially varying relationships between social vulnerability factors and COVID-19 cases and deaths in the contiguous U.S.
16	Transition from Social Vulnerability to Resiliency vis-à-vis COVID-19 (Pyne et al., 2020)	Pyne S.	USA	2020	Qualitative study	Moderate	To examine the possible association of social vulnerabilities in U.S. cities with COVID-19 case fatality ratios
17	An empirical analysis of association between socioeconomic factors and communities' exposure... (Ilbeigi & Jagupilla, 2020)	Ilbeigi M.	USA	2020	Cross sectional	High	To do the groundwork for hazard preparedness programs considering social and economic inequalities
18	Association Between Social Vulnerability and a County's Risk for Becoming a COVID-19... (Dasgupta et al., 2020)	Dasgupta S.H.	USA	2020	Cross sectional	High	To analysis the relationship between social vulnerability and areas with rapid incidence of COVID-19

(Continues)

TABLE 1 (Continued)

No.	Title	1 st Author	Country	Year	Type of study	Appraised Quality	Study objective
19	Association of Social and Demographic Factors With COVID-19 Incidence and Death Rates in the US (Karmakar et al., 2021)	Karmakar M.	USA	2020	Cross sectional	Moderate	To investigate the relationship between county-level socio-demographic risk factors and the incidence of COVID-19
20	Characterizing the spread of COVID-19 from human mobility patterns and Socio Demographic indicators (Roy & Kar, 2020)	Roy A.	USA	2020	Cross sectional	High	To investigate the complex relationship between human mobility patterns and socio-demographic characteristics during the epidemic to assess the overall prevalence of COVID-19
21	COVID-19 and Brazilian Indigenous Populations (Cupertino et al., 2020)	Graziela A.C.	Brazil	2020	Review	Moderate	To investigate the Challenges of Caring for Indigenous Peoples in Brazil in the COVID-19 Outbreak
22	County-Level Association of Social Vulnerability with COVID-19 Cases and Deaths in the U.S. (Khazanchi et al., 2020)	Khazanchi R.	USA	2020	Cross sectional	Moderate	To investigate the relationship between social vulnerability and COVID-19 in rural and urban communities
23	COVID-19: Immediate predictors of individual resilience (Ferreira et al., 2020)	Ferreira R. J.	USA	2020	Cross sectional	Moderate	To determine the important measures and strategies to promote community resilience against COVID 19
24	COVID-19 in New Mexico Tribal Lands: Understanding the Role of Social Vulnerabilities and Historical Racisms (Yellow Horse et al., 2020)	Yellow Horse A. J.	USA	2020	Cross sectional	High	To investigate the effects of COVID-19 on New Mexico indigenous peoples to address structural vulnerabilities
25	COVID-19: risk accumulation among biologically and socially vulnerable older populations (Calderón-Larrañaga et al., 2020)	Calderón L.A.	Sweden	2020	Review	Moderate	To propose a conceptual framework to explain the various biological and social vulnerability factors that may lead to COVID-19 among the elderly
26	Disproportionate Impact of COVID-19 Pandemic on Racial and Ethnic Minorities (Boserup et al., 2020)	Boserup B.	USA	2020	Cross sectional	High	To investigate the impact of the COVID-19 epidemic on racial/ ethnic groups in the U.S.
27	Food Insecurity, Social Vulnerability, and the Impact of COVID-19 on Population Dependent on Public Assistance/SNAP... (Esobi et al., 2021)	Esobi I.C.	USA	2020	Cross sectional	High	To investigate the effect of demographic and socioeconomic variables on COVID-19 cases in all 46 counties of South Carolina

(Continues)

TABLE 1 (Continued)

No.	Title	1 st Author	Country	Year	Type of study	Appraised Quality	Study objective
28	Human development, social vulnerability and COVID-19 in Brazil: a study of the social determinants of health (De Souza et al., 2020)	De Souza, C.D.	Brazil	2020	Cross-sectional	High	To determine the social factors associated with the incidence, and mortality rate of COVID-19 in Brazil
29	American Indian and Alaska Native People: Social Vulnerability and COVID-19 (Hathaway, 2020)	Hathaway E.D.	USA	2020	Commentary	Moderate	To determine social vulnerability of American Indian and Alaska native people by geographic area
30	Bridging a false dichotomy in the COVID-19 response: a public health approach to the 'lockdown' debate (Prasad et al., 2020)	Vandana P.	India	2020	Commentary	Moderate	To provide a framework based on principles that can be used to define the scope and scale of an epidemic
31	COVID-19 as a global disaster: Challenges to risk governance and social vulnerability in Brazil (De Freitas et al., 2020)	De Freitas C.M.	Brazil	2020	Commentary	Moderate	To overview of challenges related to risk management and coping and reducing vulnerabilities to COVID-19

attracted greater attention (Pyne et al., 2020). Epidemics exacerbate social vulnerability especially in case of race, shelter or housing, as well as transportation status, economics, and environmental aspects of communities. Justice and education create conditions that make it difficult to maintain health in COVID-19 pandemic (I. Karaye & Horney, 2020; Thomas et al., 2020). In other words, greater social vulnerability is associated with increased risk of COVID-19 detection and mortality (Khazanchi et al., 2020).

In this review, different indicators affecting social vulnerability in the COVID-19 pandemic were found from literature review. Some articles estimated the social vulnerability by calculating (Garcia et al., 2020; LeRose et al., 2021). The manuscripts usually applied the 16 similar indicators for measuring SVI in the area understudy and a few of articles had partial differences in the number and type of using indicators. The complementary action after measuring the SVI is mapping the social vulnerability for the requested area. The social vulnerability mapping is beneficiary for identifying most of the vulnerable places and prioritizing the distribution of scarce resources in the COVID-19 pandemic to ensure equity for residents (Neelon et al., 2020; Snyder & Parks, 2020; Wang et al., 2020). Some of the outcomes in this study, provided the social vulnerability mapping and some others extracted the required social vulnerability indicators via literature review, survey or interview with experts. One of the reasons for not providing social vulnerability mapping was related to lack of data about COVID-19 infected people and the required information for social vulnerability indicators. In case of existing data related to social vulnerability indicators and COVID-19 patients, mapping social vulnerability in the

COVID-19 pandemic could be extracted using remote sensing methods and GIS.

In this review, the social vulnerability indicators were categorized in domains, indices, and variables in some of the manuscripts. Calculating SVI requires quantitative data in four domains, including socioeconomic status, household and community composition, racial and ethnic minority groups, and housing type and transportation. Additionally, further indicators, such as public infrastructure, population health status or education were introduced for measuring the social vulnerability in the COVID-19 pandemic in some of the articles. Due to variety of relevant social vulnerability indicators in the COVID-19 pandemic and to make them easier to use, we have proposed a comprehensive categorization of them in this study (Table 2). Studying these indices in different contexts and estimating the social vulnerability of subpopulations may help the authorities and policy makers to optimize resources in disaster management of the COVID-19 pandemic that is the most important global health, social, and economic challenge at this time (Coelho et al., 2020; De Souza et al., 2020; Pessoa et al., 2020).

All countries specifically developing countries could profit from using the following categories of social vulnerability indicators in the COVID-19 pandemic:

Household and community composition: Age is one influential indicator on social vulnerability in the COVID-19 pandemic. Children and the elderly are more vulnerable to receive various medical, financial, and emotional needs. Due to high vulnerability to disease, vulnerable groups, people under the age of 17 and over 65 need to be supported by family members and community healthcare teams in the COVID-19

TABLE 2 Reviewed domains and indicators of social vulnerability in COVID-19

Domain	Indicator	Reference
Household, community composition	<i>Population aged 65 years or older</i>	(Biggs et al., 2020; Boserup et al., 2020; Credit, 2020; Esobi et al., 2021; Gaynor & Wilson, 2020; Hathaway, 2020; I. Karaye & Horney, 2020; Karmakar et al., 2021; Khazanchi et al., 2020; Nayak et al., 2020; Roy & Kar, 2020; Wang et al., 2020; Yellow Horse et al., 2020; Yellow Horse et al., 2021)
	<i>Population aged 18 years or younger</i>	(Biggs et al., 2020; Gaynor & Wilson, 2020; Hathaway, 2020; I. M. Karaye & Horney, 2020; Khazanchi et al., 2020; Nayak et al., 2020; Roy & Kar, 2020; Wang et al., 2020; Yellow Horse et al., 2020)
	<i>% people with a disability</i>	(Biggs et al., 2020; Dasgupta et al., 2020; Esobi et al., 2021; Hathaway, 2020; I. M. Karaye & Horney, 2020; Karmakar et al., 2021; Khazanchi et al., 2020; Nayak et al., 2020; Prasad et al., 2020; Roy & Kar, 2020; Yellow Horse et al., 2020)
	<i>% Households which heads aged 60+ years old</i>	(Adwiluvito & Rakhmawan, 2020; Khazanchi et al., 2020)
	<i>Single parent household</i>	(Biggs et al., 2020; Dasgupta et al., 2020; Gaynor & Wilson, 2020; Hathaway, 2020; I. M. Karaye & Horney, 2020; Khazanchi et al., 2020; Roy & Kar, 2020; Surendra, 2020; Yellow Horse et al., 2020)
	<i>% Female-headed households with children</i>	(Adwiluvito & Rakhmawan, 2020; Kim & Bostwick, 2020; Yellow Horse et al., 2021)
	<i>% of women aged 10 to 17 who had children</i>	(De Souza et al., 2020)
	<i>% Households with children aging Under 18 years old</i>	(Adwiluvito & Rakhmawan, 2020; Gaynor & Wilson, 2020)
	<i>% of people aged 6 to 14 who do not attend school</i>	(De Souza et al., 2020)
	<i>Family size (number of people live in a family)</i>	(Adwiluvito & Rakhmawan, 2020)
	<i>life expectancy</i>	(Coelho et al., 2020; De Souza et al., 2020; Karmakar et al., 2021)
Race, minority status & language	<i>Speak English "less than well"</i>	(Biggs et al., 2020; Boserup et al., 2020; Dasgupta et al., 2020; Karaye & Horney, 2020; Karmakar et al., 2021; Khazanchi et al., 2020; Nayak et al., 2020; Roy & Kar, 2020; Yellow Horse et al., 2020; Horse et al., 2021)
	<i>Hispanic</i>	(Biggs et al., 2020; Boserup et al., 2020; Credit, 2020; Dasgupta et al., 2020; Snyder & Parks, 2020)
	<i>American Indian</i>	(Boserup et al., 2020; Cupertino et al., 2020; Hathaway, 2020; Karmakar et al., 2021; Yellow Horse et al., 2020; Yellow Horse et al., 2021)
	<i>African Americans</i>	(Boserup et al., 2020; Credit, 2020; Karmakar et al., 2021; Kim & Bostwick, 2020; Snyder & Parks, 2020)
	<i>% of whites</i>	(Biggs et al., 2020; Boserup et al., 2020; Credit, 2020; Dasgupta et al., 2020; Gaynor & Wilson, 2020; Kim & Bostwick, 2020)
	<i>Alaska native population</i>	(Boserup et al., 2020; Hathaway, 2020; Karmakar et al., 2021; Yellow Horse et al., 2020; Yellow Horse et al., 2021)
	<i>Refugees or immigrant population</i>	(Calderón-Larrañaga et al., 2020; I. M. Karaye & Horney, 2020; Lawal & Arokoyu, 2015; Prasad et al., 2020; Thomas et al., 2020)
Socioeconomic status	<i>% Living below poverty line</i>	(Biggs et al., 2020; Boserup et al., 2020; Coelho et al., 2020; De Souza et al., 2020; Esobi et al., 2021; Gaynor & Wilson, 2020; Hathaway, 2020; Ilbeigi & Jagupilla, 2020; I. M. Karaye & Horney, 2020; Khazanchi et al., 2020; Kim & Bostwick, 2020; Nayak et al., 2020; Prasad et al., 2020; Roy & Kar, 2020; Snyder & Parks, 2020; Surendra, 2020; Wang et al., 2020; Yellow Horse et al., 2020; Yellow Horse et al., 2021)
	<i>Gini income inequality index</i>	(Coelho et al., 2020; De Souza et al., 2020; Karmakar et al., 2021; Lins-Filho et al., 2020; Snyder & Parks, 2020; Yellow Horse et al., 2021)
	<i>Unemployment rate</i>	(Biggs et al., 2020; Boserup et al., 2020; De Gois et al., 2020; Esobi et al., 2021; Hathaway, 2020; Ilbeigi & Jagupilla, 2020; Khazanchi et al., 2020; Kim & Bostwick, 2020; Nayak et al., 2020; Prasad et al., 2020; Roy & Kar, 2020; Surendra, 2020; Wang et al., 2020; Yellow Horse et al., 2020; Yellow Horse et al., 2021)

(Continues)

TABLE 2 (Continued)

Domain	Indicator	Reference
	<i>Per capita income</i>	(Biggs et al., 2020; De Souza et al., 2020; Hathaway, 2020; Ilbeigi & Jagupilla, 2020; I. M. Karaye & Horney, 2020; Kim & Bostwick, 2020; Roy & Kar, 2020; Yellow Horse et al., 2020)
	<i>Proportion in at risk industries</i>	(Snyder & Parks, 2020)
	<i>Proportion in at risk occupations</i>	(Snyder & Parks, 2020)
	<i>Activity rate of persons aged 10 to 14 years of age</i>	(De Souza et al., 2020)
	<i>% of urban population</i>	(Coelho et al., 2020)
	<i>% households which heads worked in informal sector</i>	(Adwiluvito & Rakhmawan, 2020)
	<i>% family receiving public assistance</i>	(Esobi et al., 2021; Surendra, 2020; Yellow Horse et al., 2021)
	<i>% Children under poverty</i>	(Adwiluvito & Rakhmawan, 2020)
	<i>% Children with no access to the internet</i>	(Adwiluvito & Rakhmawan, 2020)
	<i>Food security</i>	(Cutter et al., 2003; Esobi et al., 2021; Ferreira et al., 2020; Karmakar et al., 2021; Prasad et al., 2020; Surendra, 2020)
	<i>Average number of people in a single household</i>	(Boserup et al., 2020; Prasad et al., 2020; Yellow Horse et al., 2021)
	<i>Number of homeless persons</i>	(De Freitas et al., 2020; Kim & Bostwick, 2020; Prasad et al., 2020; Surendra, 2020)
	<i>Multi-unit structures, % housing in structures with 10 or more units</i>	(Biggs et al., 2020; Credit, 2020; Dasgupta et al., 2020; Gaynor & Wilson, 2020; Hathaway, 2020; I. M. Karaye & Horney, 2020; Khazanchi et al., 2020; Nayak et al., 2020; Roy & Kar, 2020; Yellow Horse et al., 2021)
	<i>Space of apartment buildings</i>	(Yellow Horse et al., 2020)
	<i>% Mobile homes</i>	(Biggs et al., 2020; Dasgupta et al., 2020; Hathaway, 2020; I. M. Karaye & Horney, 2020; Nayak et al., 2020; Roy & Kar, 2020; Yellow Horse et al., 2020)
	<i>% Persons in institutionalized group quarters such as prisons, nursing homes (already described), dormitories or schools</i>	(Biggs et al., 2020; Dasgupta et al., 2020; Hathaway, 2020; I. M. Karaye & Horney, 2020; Nayak et al., 2020; Prasad et al., 2020; Surendra, 2020; Wang et al., 2020; Yellow Horse et al., 2020)
	<i>Population density or crowding</i>	(Biggs et al., 2020; Calderón-Larrañaga et al., 2020; Credit, 2020; Dasgupta et al., 2020; De Freitas et al., 2020; Hathaway, 2020; Ilbeigi & Jagupilla, 2020; I. M. Karaye & Horney, 2020; Khazanchi et al., 2020; Prasad et al., 2020; Roy & Kar, 2020; Yellow Horse et al., 2020)
	<i>Jobs requiring physical contact with other people</i>	(Calderón-Larrañaga et al., 2020)
	<i>Population do not have safe homes to shelter in-place</i>	(I. M. Karaye & Horney, 2020; Thomas et al., 2020)
	<i>% Households with no vehicle available</i>	(Biggs et al., 2020; Boserup et al., 2020; Dasgupta et al., 2020; De Freitas et al., 2020; Gaynor & Wilson, 2020; Hathaway, 2020; I. M. Karaye & Horney, 2020; Khazanchi et al., 2020; Nayak et al., 2020; Roy & Kar, 2020; Yellow Horse et al., 2020)
	<i>% Households using public transport</i>	(Biggs et al., 2020; Boserup et al., 2020; Dasgupta et al., 2020; De Freitas et al., 2020; Gaynor & Wilson, 2020; Hathaway, 2020; I. Karaye & Horney, 2020; Khazanchi et al., 2020; Nayak et al., 2020; Roy & Kar, 2020; Yellow Horse et al., 2020)
	<i>% Working population spend more than 60 min on commute</i>	(Yellow Horse et al., 2021)
	<i>% Working population access to public transportation</i>	(Karmakar et al., 2021; Yellow Horse et al., 2021)
	<i>Means of essential transport during a crisis</i>	(Pyne et al., 2020)
	<i>% People lacking access to adequate food</i>	(Esobi et al., 2021; Prasad et al., 2020)

(Continues)

TABLE 2 (Continued)

Domain	Indicator	Reference
Community health status	Health risk score	(Kim & Bostwick, 2020)
	% Obesity	(Cupertino et al., 2020; Karmakar et al., 2021; Snyder & Parks, 2020)
	% Smoking	(Snyder & Parks, 2020)
	% Hypertension	(Boserup et al., 2020; Cupertino et al., 2020; Snyder & Parks, 2020; Surendra, 2020)
	% Diabetes	(Boserup et al., 2020; Calderón-Larrañaga et al., 2020; Cupertino et al., 2020; Snyder & Parks, 2020)
	CHF	(Boserup et al., 2020)
	COPD	(Boserup et al., 2020)
	Nutrition status	(Calderón-Larrañaga et al., 2020)
	social distancing scores	(Boserup et al., 2020)
	Lack of exercise	(Calderón-Larrañaga et al., 2020)
Public health infra-structures	access to healthcare, especially high complexity care	(Calderón-Larrañaga et al., 2020; Credit, 2020; Cupertino et al., 2020)
	Number of physicians per 10000 population	(Prasad et al., 2020)
	Primary care clinicians other than physicians, No. per 10000 population	(Credit, 2020)
	Hospital beds, No. per 10000 population	(Adwiluvito & Rakhmawan, 2020; Snyder & Parks, 2020)
	Intensive care unit beds, No. per 10000 population	(Calderón-Larrañaga et al., 2020)
	Testing rate	(Calderón-Larrañaga et al., 2020; Credit, 2020)
	Reserved medical stocks	(Pyne et al., 2020)
	regional level secure essential supply chains	(Pyne et al., 2020)
	% Population access to health insurance	(Esobi et al., 2021; Snyder & Parks, 2020; Yellow Horse et al., 2021)
	% Population access to life insurance	(Esobi et al., 2021)
	persons younger than 65 years without health insurance	(Karmakar et al., 2021; Yellow Horse et al., 2020)
	% Children with no access to the health insurance	(Adwiluvito & Rakhmawan, 2020)
	Number of healthcare facilities or hospitals in the area understudy	(Adwiluvito & Rakhmawan, 2020; Credit, 2020)
	% households with electricity, piped water, sufficient water supply and sewage disposal	(Biggs et al., 2020; Coelho et al., 2020; Cutter et al., 2003; De Freitas et al., 2020; De Gois et al., 2020; De Souza et al., 2020; Prasad et al., 2020; Yellow Horse et al., 2020)
	urban households with garbage collection service	(De Souza et al., 2020)
	Hygiene conditions, and access to soap and alcohol gel;	(Cupertino et al., 2020; De Freitas et al., 2020; Prasad et al., 2020; Surendra, 2020)
	Absence of state and municipal policies	(De Freitas et al., 2020)
Communication participation	(De Freitas et al., 2020)	
Education	Illiteracy rate	(De Souza et al., 2020)
	Percentage of children living in families where none of the residents have completed primary school	(De Souza et al., 2020)
	No high school diploma	(Biggs et al., 2020; Esobi et al., 2021; Hathaway, 2020; I. M. Karaye & Horney, 2020; Kim & Bostwick, 2020; Nayak et al., 2020; Roy & Kar, 2020; Wang et al., 2020; Yellow Horse et al., 2020; Yellow Horse et al., 2021)

(Continues)

TABLE 2 (Continued)

Domain	Indicator	Reference
	% People aged 25 or over who completed high school	(De Souza et al., 2020)
	University education	(Snyder & Parks, 2020)
	% Households with averagely low education level	(Adwiluvito & Rakhmawan, 2020; Coelho et al., 2020)
Information; technology & communication	Shortage and lack of adapted information	(Calderón-Larrañaga et al., 2020)
	% Population having cell phone or telephone	(Yellow Horse et al., 2020)
	% Population access to internet	(Pyne et al., 2020; Yellow Horse et al., 2020)

pandemic and previous epidemics. A second important social vulnerability indicator is gender in this categorization (Ferreira et al., 2020). In some countries, especially those in the low to middle income category, women's inequalities and community constraints make them more vulnerable to poverty and mortality in disasters and emergencies. The literature reviewed in this study indicated that females had less access to facilities and information compared to males in the COVID-19 pandemic in many parts of the world. Further studies as well as corrective measures and education to improve the quality of life in females during disasters and emergencies are needed. Households with young children under the age of 5 years also need more support from community and health system. Due to the health needs of children, such as vaccination and healthcare services, it is recommended to have necessary educational courses for parents in order to prevent childhood diseases at healthcare centers. Parental awareness can better protect children during epidemics and pandemics. Additionally, people with disabilities need support from rehabilitation centers and relevant service organizations to receive healthcare, both routine and related to COVID-19 infection.

Race, minority status and language. Race, ethnic minority, and language are the other important categorization in the social vulnerability against COVID-19 pandemic (Gaynor & Wilson, 2020). Refugees or immigrant populations are vulnerable since they are in the process of integrating into a society and have only recently become familiar with their new communities (Falkenhain et al., 2020). Minority groups have access to fewer resources, such as testing sites, medicine or vaccine to ensure effectiveness and equity for all residents in a region. This discrimination in access to resources may lead to higher prevalence of COVID-19 and the continuity of transmission chain of the pandemic at the community level. The findings of several studies have shown that Black people were one of the groups most affected by COVID-19 morbidity and mortality in the United States and Brazil (De Oliveira et al., 2020). Additionally, it is important to recognize that age-related and place-based factors interact synergistically to increased risk of COVID-19. For instance, one study showed that older Black people are at higher risk of COVID-19 infection and related mortality (Chatters et al., 2020).

Socio-economic status: This social vulnerability domain can be measured by many indicators. Poverty is one of the most important indicators result in poor availability and accessibility of nutrition, san-

itation, and health care system (Freitas & Cidade, 2020). Percentage of unemployment is the main variable for measuring poverty in the community. The scientific evidence shows that the countries with low income and more poverty have been more affected by pandemic disease (De Souza et al., 2020; Ilbeigi & Jagupilla, 2020). Living in suburban areas or working at high-risk occupations in industrial parks cause the spread of COVID-19 due to crowded areas and high physical contacts with other people (Freitas & Cidade, 2020). Lack of food security and inadequate food has negative effects on population and people prone to COVID-19 infection. Additionally, the distribution of medicine and health items with equality would decrease the vulnerability of population to COVID-19 in the community.

Housing & transportation: The type of residence can be related to the number of people living together in the same place. Individual houses, hotels, nursing centers, prisons, dormitories, mobile homes are different types of residence have unavoidable role in the prevalence of COVID-19. Environmental health and suitable ventilation are two important factors in order to control the transmission of coronavirus in all the mentioned places. The findings of the study in Brazil indicated that the degree of suffering generated by the pandemic depends on the area where individuals live and the social conditions to which they are subjected (De Souza et al., 2020). Also, population density should be considered in the living places for the implementation of social distancing in the COVID-19 pandemic (Dasgupta et al., 2020). Public transportation, such as buses, subway, trains, and planes, is an effective factor to maintain the COVID-19 active transmission chain. Considering the number of people using the public transportation and the possibility of presence of a person with COVID-19 as a passenger, as well as time of transportation would be the main factors in the transmission of coronavirus.

Health status: Previous health status as an important domain of social vulnerability to coronavirus. Obesity, smoking, high blood pressure, diabetes, and poor nutritional conditions can contribute to the severe incidence of COVID-19 and death (Islam et al., 2021). One study in India found low public health levels in the rural areas made residents more vulnerable to COVID-19 (Surendra, 2020).

Public health infra-structures: Existence of public health infra-structure in the community determines the increase or decrease in the prevalence mortality and morbidity of COVID-19. The number of healthcare facilities, physicians per 10,000 populations, and hospital

beds per 10,000 populations affect the population access to efficient healthcare services. Predicting surge capacity in hospitals and healthcare centers to limit avoidable losses of life and livelihood, percentage of population access to health insurance as well as access to safe water and food that can be effective in COVID-19 prevention and reducing the difficulties of patients. One study in Brazil found that the great heterogeneity in hospital capacity across the country posed an important challenge for resource allocation to patients during the pandemic (Coelho et al., 2020). Moreover, health insurance coverage might also inform the likelihood of individuals to seek treatment after infection and may be a reasonable source for estimating the burden of illness in the community (Snyder & Parks, 2020).

Education: Individual education level is a social vulnerability domain in the COVID-19 pandemic. Promoting public awareness of coronavirus behavior and highlighting its prevention strategies, such as knowledge of hand hygiene, wearing masks, social distancing, and promoting the culture of self-quarantine, play a key leadership role in COVID-19 management in rural and urban areas (Singh, 2020).

Information, technology & communication: Access to updated information, technology and communication can decrease the social vulnerability of people to COVID-19. Applying devices, such as cell phones, computers and unlimited access to internet is beneficiary for learning and receiving the newest information, virtual consultation with doctors about COVID-19 symptoms, and timely access to medications during the COVID-19 pandemic. Learning and adaptation represent measures which can be undertaken to strengthen the community to understand and adapt to the government strategies, health system, and policy makers to control and manage the pandemic (Caraka & Lee, 2020).

5 | LIMITATIONS

The full text of a few research studies could not be found despite contacting their corresponding author, so they were excluded. Furthermore, a limited number of included studies focused on SARS-CoV and MERS-CoV. Moreover, given that only two years have passed since the onset of COVID-19 disease, there are no in-depth studies and definitive results about COVID-19. Therefore, there are many unknown factors about COVID-19, so the present study was also affected by these limitations.

6 | IMPLICATIONS

The identifying and categorizing the indicators of social vulnerability resistant to COVID-19 in this study helps to establish the appropriate prevention and mitigation programs. Providing the mapping of regions according to identified social vulnerability indicators is beneficiary to recognize the more vulnerable areas that have the potential to convert hot zone of pandemic. Therefore, the policy makers and health officials have to allocate more sources such as vaccines, medical personnel and medications to these vulnerable regions in the related planning and making decisions about COVID-19.

7 | CONCLUSION

A systematic review was undertaken to identify the indicators of the social vulnerability against COVID-19 for establishing the appropriate programs and studies to decrease the harmful consequences of the pandemic. The measures of effective hazard mitigation and emergency response must begin with an understanding of determined social vulnerability in hot spots of the COVID-19 pandemic to prevent spreading of the disease to other areas and places.

To the best of the authors' knowledge, there are limited indicators making people and places vulnerable to pandemics. Additional comparative studies are required to develop an appropriate set of indicators of social vulnerability in pandemics, such as COVID-19, for an all-hazards approach to emergency management. Indicators of social vulnerability in pandemics may be useful for studying relevant risks, although studies still need to be done to compare the generalizability and validity of these indicators.

COMPETING INTERESTS

The authors have no conflicts of interest to declare.

DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available from the corresponding author upon reasonable request.

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