

Main Factors Affecting the Readiness and Responsiveness of Healthcare Systems during Epidemic Crises: A Scoping Review on Cases of SARS, MERS, and COVID-19

Mohammadtaghi Mohammadpour¹, MSc; Effat Zarifinezhad², MSc; Arash Ghanbarzadegan³, DDS; Khodadad Naderimanesh⁴, MSc; Nasrin Shaarbafchizadeh⁵, PhD; Peivand Bastani⁶, PhD

¹Department of Health Care Management and Health Economics, School of Management and Medical Informatics, Shiraz University of Medical Sciences, Shiraz, Iran;

²Department of Medical Surgical Nursing, School of Nursing and Midwifery, Shiraz University of Medical Sciences, Shiraz, Iran;

³Australian Research Centre for Population Oral Health, Adelaide Dental School, University of Adelaide, Adelaide, South Australia, Australia;

⁴Social Determinant of Health Research Centre, Yasuj University of Medical Sciences, Yasuj, Iran;

⁵Health Management and Economics Research Centre, Isfahan University of Medical Sciences, Isfahan, Iran;

⁶Health Human Resources Research Centre, School of Health Management and Medical Informatics, Shiraz University of Medical Sciences, Shiraz, Iran

Correspondence:

Peivand Bastani, PhD;
School of Health Management and Medical Informatics, Diamond Building, 29th Alley, Ghasrodassht St., Postal code: 71336-54361, Shiraz, Iran
Tel: +98 71 32340774-8
Fax: +98 71 32340039
Email: bastanip@sums.ac.ir
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What's Known

- COVID-19 is the third coronavirus, after severe acute respiratory syndrome and Middle East respiratory syndrome, with highly pathogenic impacts to cause an outbreak.
- Only if healthcare systems are thoroughly prepared and responsive can they be relied upon to overcome such outbreaks.

What's New

- Managerial interventions are the main priority during the COVID-19 outbreak, and health centers' readiness is directly affected by plans proposed by health policymakers and managers.
- Macro external dimensions such as socioeconomic and environmental factors can also affect a healthcare system's readiness against COVID-19.

Abstract

Background: Given the significance of the preparedness and responsiveness of healthcare systems in relation to epidemics, this study aimed to determine their influencing factors during epidemic crises with a view to utilizing the findings in the battle against the coronavirus disease 2019 (COVID-19) outbreak.

Methods: This scoping study was conducted in 2020 via the Arksey and O'Malley approach. A systematic search was conducted on five online databases from January 2000 to June 15, 2020. Initially, 1926 English articles were retrieved based on their abstracts. After the screening process, 60 articles were considered for the final analysis. Data were charted by applying Microsoft Office Excel 2013 and were synthesized via thematic analysis.

Results: Five main factors have affected the responsiveness and preparedness of countries during the epidemics of severe acute respiratory syndrome (SARS), Middle East respiratory syndrome (MERS), and COVID-19: community-related interventions, managerial interventions, socioeconomic factors, the readiness of hospitals and health centers, and environmental factors. These themes are associated with 38 related sub-themes. The thematic framework shows that interactions between these five determinants can affect the preparedness and responsiveness of healthcare systems during pandemics/epidemics.

Conclusion: According to the results, healthcare systems need to pay attention to their internal capacities, managerial interventions, and health centers to overcome the current pandemic. They should also consider such external factors as socioeconomic and environmental determinants that can affect their potential preparedness against pandemic/epidemic crises. Community-related interventions such as improvement of the community health literacy, teamwork, and social responsibility can enhance the readiness of healthcare systems against the COVID-19 outbreak.

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Introduction

On December 31, 2020, the World Health Organization (WHO) received reports on patients with pneumonia in Wuhan, China. After about a week, the Chinese government confirmed a new

coronavirus termed “the coronavirus disease 2019 (COVID-19)”. Faced with the broad prevalence of the virus the world over, on March 11, 2020, the WHO declared severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) to be a pandemic based on previous knowledge.¹ Because of the unknown nature of the disease, however, the identification of SARS-CoV-2 still depends on previous information regarding the severe acute respiratory syndrome (SARS) epidemic in 2003.² SARS-CoV-2 is considered the third coronavirus, after SARS and Middle East respiratory syndrome (MERS), with highly pathogenic impacts to have emerged during the past two decades.³

Previous evidence from the epidemics of SARS and MERS has shown that only on the condition of readiness and responsiveness on a vast and sustainable level can governments and healthcare systems overcome outbreaks.⁴ For instance, evidence on the epidemic of SARS indicated that certain factors were culpable for inappropriate control and high mortality among patients and healthcare providers; these factors included insufficient interorganizational coordination, a lack of hierarchical command, inadequate allocation of resources to the healthcare systems involved in crises, weakness in risk management, and disorders in information flow.^{5, 6} Research has also laid emphasis upon actual and potential challenges that may occur at the time of such outbreaks. By way of example, Draper and colleagues concluded that potential health risks for healthcare staff working during a pandemic were greater than those in normal circumstances.⁷ All these pieces of evidence greatly stress the value of preparedness and the power of disaster management in healthcare systems. This indication can assume greater significance, when the degree of the extensiveness and engagement of healthcare systems is compared between the recent outbreaks. Records show that although COVID-19 has thus far had lower mortality than SARS and MERS (2.3% vs. 9.5% and 34.4%, respectively),⁸ healthcare systems at large have been more impacted by COVID-19. The picture seems even graver, when considering that despite the introduction of some medicines as candidates for COVID-19 therapy, highly effective medicines or vaccines have yet to be confirmed.⁹ There is also evidence that in stark contrast to the previous epidemics, so rapid is the rise of the incidence of SARS-CoV-2 infections and related deaths, that a global panic is inevitable.¹⁰

Effective prevention-based plans and policies and moving toward fair universal health

coverage can lessen the social and economic burden of diseases. Also of vital importance is the complete protection and safety of healthcare workers during epidemics.¹¹ Invariably, epidemic crises complicate the process of control, which explains why improving the community engagement and investing in initial warning systems may lead to the betterment of the control and reduction of political, social, and economic impacts.^{12, 13}

Tackling a pandemic viral outbreak needs a comprehensive collaboration between public and private sectors, and an extensive concentrated approach adopted by various organizations involved. Ministries of health may be considered the steward of community health, but surely they cannot manage pandemic circumstances alone.^{14, 15} It is, therefore, critical to forge an integrated powerful leadership among all the involved organizations and establish a central committee to direct and supervise activities.¹⁶ Hawryluck and colleagues proposed an “infectious disease outbreak disaster plan” encompassing such necessary elements as education, manpower, data collection, research, surveillance, teamwork, communication, lobbying, and systems thinking.¹⁷

Given the different experiences of various countries in encountering the epidemics/pandemics of SARS, MERS, and COVID-19, especially those regarded as underdeveloped or developing with low incomes and concomitant challenges in terms of financial procurement, resource allocation, and faulty managerial structures, it is advisable to draw upon such collective know-how with a view to identifying what influences the preparedness and alertness of healthcare systems.

Accordingly, we sought to determine the factors affecting the readiness and responsiveness of healthcare systems during epidemic crises with the aim of utilizing the findings in the current battle against the COVID-19 outbreak.

Materials and Methods

This study was conducted as a scoping review based on the framework of Joanna Briggs.¹⁸ In keeping with the Arksey and O'Malley approach, this scoping review extracted diverse articles on the basis of their designs, methodology, and study populations.¹⁹

Scoping reviews can potentially recognize the main components and related aspects of a certain concept, and thus, help to depict a comprehensive and thematic map from the gathered evidence and strongly identify the

gaps of knowledge in the scope.²⁰ Accordingly, we moved through the following five steps:

Identification of the Research Question

The research question was “What are the main factors affecting the readiness and preparedness of countries during an epidemic crisis?”

The PPC (population, content, and context) for the scoping review was defined in the first step. The population was considered to include all countries involved in an epidemic crisis or somehow affected by the epidemic impacts; the content was considered to encompass all the strategies, factors, and elements that affect the readiness and responsiveness of healthcare systems; and the context was considered to consist of all the environmental, social, managerial, and political characteristics that influence healthcare systems during an epidemic crisis.

The main emphasis of this scoping review was placed on the epidemic outbreaks of SARS, MERS, and COVID-19.

Searching and Retrieving Relevant Studies

Relevant studies were found through a systematic search on three online databases: ISI Web of Science, Scopus, and ProQuest. PubMed search engine was also used to search two databases of PubMed Central and MEDLINE. All the stated databases were searched from January 1, 2000, to June 15, 2020. The search strategy is depicted in table 1, according to which all the keywords were applied according to MeSH terms in two categories. The logical operator “OR” was used between all the synonym keywords. Then, the keywords in the first category were merged with those in the second by applying the logical operator “AND”. EndNote X7.1 (Thomson Reuters, USA) was employed to manage references. The inclusion criteria were all English full texts with quantitative, qualitative, or mixed-method designs and all papers in any kind of review. Proceedings, policy papers, guidelines, and instructions were

excluded. Additionally, a hand-search was done in Google Scholar because it lacks the capacity of searching according to keywords or abstracts. Most of the results of this hand-search were not relevant and were, therefore, excluded (figure 1).

Inclusion of Relevant Studies

In this step, 1926 articles were retrieved based on the Preferred Reporting Items for Systematic Reviews and Meta-analysis (PRISMA) flowchart (figure 1). From this total, 469 articles were duplicated and 1234 items were excluded based on title review. A total of 136 abstracts were relevant, and 48 full texts from among them were subjected to the final analysis. Abstracts, whose full texts were not in English, were excluded. All these processes were done by two of the researchers separately. Critical Appraisal Skills Program (CASP) was used as a valid tool for criticizing the quality of the included articles.²¹

Data Extraction and Charting and Final Collation

A data extraction form was applied for data charting. All the included papers were extracted via Microsoft Office Excel 2013 by two of the researchers. These papers were selected according to the study aim or their outcome. Otherwise stated, articles on the experiences of countries and healthcare systems as regards readiness and responsiveness during one of the SARS, MERS, or COVID-19 epidemics/pandemics were included in data extraction and charting. Data were continuously extracted, and the data charting was updated. The thematic analysis approach was applied to analyze the charted data.²²

Summarizing and Reporting the Results

The data extracted and charted from the previous step were analyzed using a qualitative thematic analysis.²³ First, the authors familiarized themselves with the data by reading all the included papers and the extractions, and then tried to identify the initial codes to each meaningful extraction. Thereafter, all the initial

Table 1: The search strategy of the scoping review
<i>Search Engines and Databases:</i> PubMed (PubMed Central and MEDLINE), ISI Web of Science, Scopus, ProQuest, and Google Scholar
<i>Limits:</i> Language (only resources with at least an abstract in English)
<i>Date:</i> up to June 15, 2020
<i>Strategy:</i> #1 AND #2
#1 coronavirus[Title/Abstract] OR 2019-ncov[Title/Abstract] OR “novel coronavirus”[Title/Abstract] OR “respiratory syndrome coronavirus”[Title/Abstract] OR MERS[Title/Abstract] OR “Middle East respiratory coronavirus”[Title/Abstract] OR MERS-COV[Title/Abstract] OR SARS[Title/Abstract] OR sars-cov-2[Title/Abstract]
#2 preparedness[Title/Abstract] OR readiness[Title/Abstract] OR “Emergency Preparedness”[Title/Abstract] OR “Civil Defenses”[Title/Abstract] OR “response plan”[Title/Abstract] OR “RESPONSE STRATEGY”[Title/Abstract] OR “country readiness”[Title/Abstract]

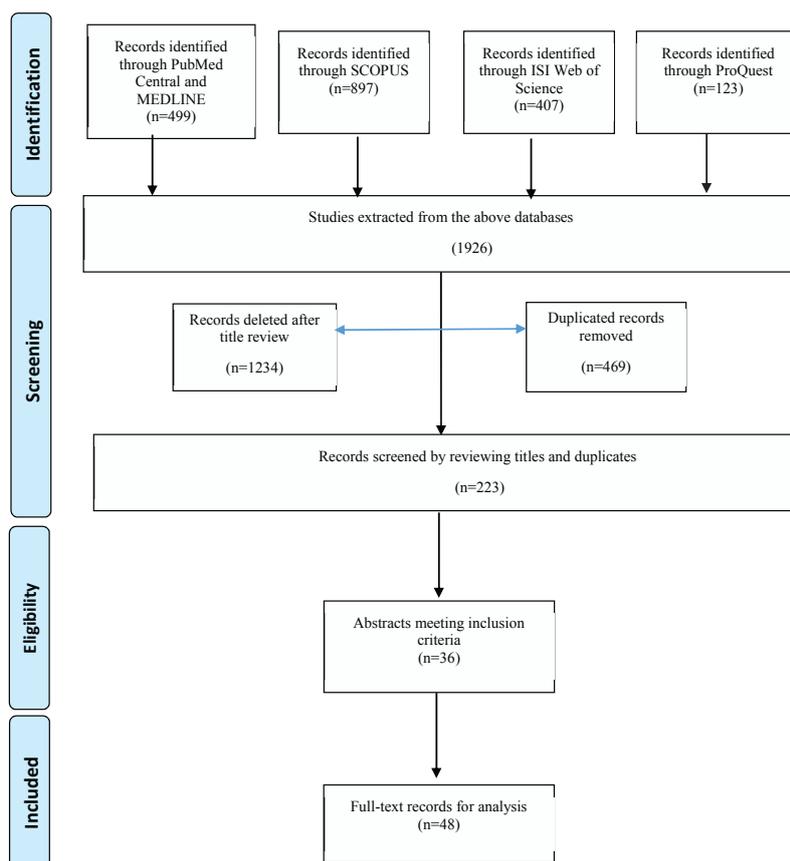


Figure 1: The PRISMA flowchart of the scoping review shows the process of searching, retrieving, and screening evidence via selected databases.

codes were revised and finalized before they were categorized as sub-themes and related main themes. Finally, the sub-themes and themes were labeled and tabulated. To better understand the concept and achieve the aim of the scoping review, we illustrated a map of the relationships between the sub-themes and the main themes.

Ethics Approval and Consent to Participate

This study was approved by the Ethics Committee of Shiraz University of Medical Sciences (No. IR.SUMS.REC.1399.396).

Results

The findings of the present study are presented in table 2. From a total of 48 studies ultimately extracted for analysis, five main themes and 38 sub-themes were identified. The main topics were community-related interventions, socioeconomic factors, environmental factors, the readiness of hospitals and health centers, and managerial interventions, each of which is described in detail below:

Community-Related Interventions

One of the strategies emphasized in

the included studies is community-related interventions. Four (13.16%) studies regarded these interventions as important strategies in dealing with epidemic/pandemic conditions.^{24, 27-29} Improving community behavior and engagement is effective in eradicating epidemic-related threats and effects.²⁸ For instance, personal and environmental health is considered one of the most basic community-related behaviors with a high impact on controlling epidemic/pandemic crises.²⁴

Socioeconomic Factors

Socioeconomic determinants can affect community health and sociocultural issues. Furthermore, a lack of stable organizational leadership and financial resources leads to the failure of healthcare systems, an example of which is countries' fears of reporting epidemics due to economic consequences.⁴⁶ Social health determinants should also be considered by health policymakers during epidemic/pandemic crises. Public distrust and social stress have been commonplace in countries such as South Korea, where policymakers need to redouble their efforts to build trust. Addressing social inequalities and health communication strategies has also been a weighty issue in South Korea's experience.²⁹

Table 2: The main factors affecting the readiness and responsiveness of countries during SARS, MERS, and COVID-19 epidemic/pandemic crises

Main Factors	Sub-Factors
Community-related interventions	Personal and environmental hygiene ²³
	Improving community behavioral communication ²⁴
	Community engagement ²⁴⁻²⁶
	Public's preventive and avoidance measures ^{23, 27, 28}
	Social distancing ^{24, 29}
	Reducing citizens' anxiety ^{23, 24}
Socioeconomic factors	Telecommunication and media ³⁰⁻³²
	Political and institutional ^{28, 31}
	Social determinants of health ^{23, 27, 28, 33, 34}
	Universal access to healthcare during an outbreak ³⁵
Environmental factors	Developing communication strategies ³⁶
	Legislation ^{37, 38}
	Urbanization and globalization ¹¹
	Increasing human-animal interactions ³⁹
Readiness of hospitals and health centers	Homeless service providers ^{15, 34}
	Increasing the capacity of intensive care units ⁴⁰
	Enhancing surveillance ³¹
	Negative emotional work ³³
	Utilizing the private sector ³
	Training and simulation ³
	Laboratory preparedness ³⁸
	Applying specified protocols ⁴¹
	Communicable disease control medical networks ⁴²
	Surge capacity ^{38, 41, 30, 43}
	Appropriate use of personal protective equipment ^{36, 44, 45}
	Expanding telehealth ³⁰
	Screening implementation ^{30, 43}
Managerial interventions	Financial resources ^{23, 27, 46, 31, 47}
	Human resource and workforce management ^{23, 27, 46, 30, 47-49}
	Information, education, and training ^{23, 27, 46, 31, 26, 45, 50, 51}
	Physical resources ⁴⁴
	Leadership and intergovernmental relationships ³⁶
	Collaboration between health and non-health sectors ^{3, 52}
	Supplies and staffing ^{44, 38}
	Disaster response plans ^{3, 44, 53}
Crisis practice guidelines ^{31, 36, 37}	

SARS: Severe acute respiratory syndrome, MERS: Middle East respiratory syndrome, COVID-19: Coronavirus disease 2019

Another factor, which is identified in the current study, is sociocultural behavior. Related experience in South Korea concerning MERS indicates that many healthcare workers cited the issue of stigma and avoidance, along with anger and rage, on the part of the general population as some of the emotional challenges in dealing with the disease.³⁵ Another experience gained from the SARS outbreak is the significance of public access to health services to prevent the outbreak.³⁷

Environmental Factors

Environmental factors, as another theme, can show the multidisciplinary relationships between health and external factors at the macro level. Countries have been advised to build capacity in public health laws for better prevention and control policies in epidemic/pandemic crises.³⁹

Environment factors can spread in a vast related domain. According to our results, a known environmental factor is the extension of urbanization, leading to the proximity of more people and the greater possibility of the transmission of contagious diseases. On the other hand, a lack of housing gives rise to the spread of slums and inadequate access to sanitary drinking water and food.¹³ Another environmental factor influencing the occurrence and spread of epidemics is the increase in human-animal interactions.³⁴ Moreover, experiences garnered from previous epidemic/pandemic crises point to the formidable challenges of homelessness and the provision of health services to the homeless. Indeed, poor health among this population doubles the need to take appropriate notice of this sector of society.⁵⁴

Readiness of Hospitals and Health Centers

The readiness of hospitals and health centers forms the cornerstone of the preparedness and responsiveness of healthcare systems. Increasing the capacity of intensive care units (ICUs) by exploiting other hospital wards and using the personnel of other wards under the supervision and training of ICU staff is one of the strategies of hospital readiness in case of epidemic/pandemic crises.^{55, 56}

With respect to the high admission rates in the public health sector during the current epidemic, past experience has shown that coordination between private and public sectors and the use of private sector capacity in this area are helpful.¹⁵ A key component in sustaining public health capacity is running simulations to assess a healthcare system's preparedness in the face of a crisis and epidemic with the aim of identifying weaknesses.⁴ Laboratory preparedness is also a factor with the ability to play a meaningful role in the spread of contagious diseases.⁴¹

Observing personal protection protocols and emphasizing patient and staff safety can significantly diminish the incidence of disease in epidemics according to Saudi Arabia's experience in the MERS outbreak.⁴² The experience of some countries in epidemic crises has shown the success and effectiveness of establishing centers and networks related to the diseases. A case in point is the successful experience of Taiwan.⁴⁴

Managerial Interventions

Financial, physical, and human resources affect the management and control of epidemics. Financial resources can be in the form of specific budgets for crises provided by the government or society.³⁸ Collaboration between the health sector and other organizations such as agriculture industries, tourism agencies, border guards, and animal health authorities is very important and effective during epidemics.⁴

Experiences from other epidemics show that the shortage of human resources, especially nurses, requires planning for recruitment and training. It is also necessary to pay sufficient heed to medical equipment and supplies as their scarcity in epidemic crises is a common experience.³⁶ It is also crucial to constantly revise and update guidelines on personnel health and safety on account of the fact that more often than not, there is a dearth of knowledge about viruses in the event of a viral epidemic.²⁵

Finally, figure 2 illustrates the probable relationships between the main factors that can affect the readiness and responsiveness of healthcare systems. Health centers

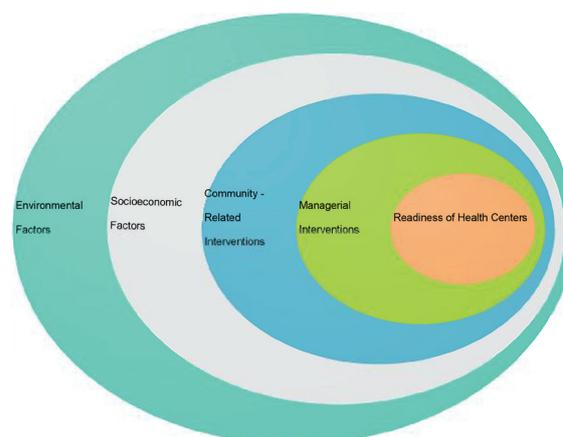


Figure 2: The circle of the preparedness and responsiveness of healthcare systems during outbreaks shows that readiness can be influenced not only by managerial and community-related interventions, as internal and micro factors, but also by socioeconomic and environmental factors, as external and macro factors.

are deemed the keystone of a healthcare system in the struggle against outbreaks such as COVID-19. Managerial interventions can directly affect the potentiality of the preparedness and responsiveness of health centers. Nonetheless, even more effective than managerial interventions are community-related interventions insofar as they have the potentiality to influence the management of healthcare systems. At the same time, the socioeconomic determinant of the community, followed by environmental and global factors, is a factor that can exert more pronounced negative or positive effects on the circle on a national or international level (figure 2).

Discussion

The results of the current study show that five main factors have affected the preparedness and responsiveness of healthcare systems against the epidemics/pandemics of SARS, MERS, and COVID-19: community-related interventions, socioeconomic factors, environmental factors, the readiness of hospitals and health centers, and managerial interventions, each of which is discussed in depth below.

Such interventions can significantly augment the potentiality to confront epidemic/pandemic crises. Apropos this finding, results from a scoping review showed that the two categories of “collaboration, coordination, and partnerships” and “communication” could influence the degree of the resilience of healthcare systems during outbreaks and natural disasters.⁵⁷

Among community-related interventions, three important sub-factors should be taken into account: personal and environmental

hygiene, community behavior improvement, and community engagement. Previous investigations have underscored the significance of risk communication protocols and robust engagement with patients during epidemics/pandemics.^{58, 59} It appears that attention to personal and environmental health by strengthening public health information and encouraging the community to obey public protocols can boost the readiness and responsiveness of healthcare systems during epidemic/pandemic crises such as the COVID-19 outbreak.

Another important sub-factor in this area is social distancing. On this topic, Wilder-Smith and Freedman pointed to the role of public health measures such as social distancing in controlling the SARS epidemic in 2003 and enumerated the use of public health techniques of social distancing, isolation of sick people, and individual and community-wide quarantine as probable effective techniques to control the 2019 novel coronavirus (2019-nCoV).⁶⁰

The last sub-factor achieved from the present results in this area is the reduction of citizens' anxiety. It is safe to assume that anxiety has the potential to be endemic during viral pandemics. On this point, Jalloh and colleagues claimed that symptoms of anxiety, depression, and post-traumatic stress disorder were common after one year of Ebola response.⁶¹ Concurrently, Wong and colleagues estimated that during the SARS epidemic, the anxiety level was high among medical students, and those who were in infected regions.⁶² It is in this context that mental interventions in the form of virtual or individual consults and programs and messages disseminated via media can be helpful in promoting community mental health.

The sub-factors of political and institutional factors, social determinants, sociocultural factors, economic factors, universal access, and the development of communication strategies can influence the preparedness and responsiveness of healthcare systems. In the same line, Mamelund and colleagues concluded that a low socioeconomic status should be considered a priority in administering vaccines against the pandemic of influenza.⁶³ Moreover, Zyaambo and colleagues concluded that the socioeconomic position of patients could determine differences in healthcare needs, in tandem with health-seeking behavior.⁶⁴

Considering political and institutional factors, Liverani and colleagues highlighted the notion that these factors might have an indirect effect on the preparedness of healthcare systems inasmuch as health evidence could be drawn upon in the decision-making process.⁶⁵ This

influence may be intensified during pandemic/epidemic crises.

Environmental factors constitute the third category affecting the preparedness and responsiveness of healthcare systems vis-à-vis pandemic/epidemic crises. These factors incorporate a vast array of elements, from legislation, urbanization/ globalization, and climate change to increased human-animal interactions, and thus, need categorization for specialized attention. Jerrett and colleagues underscored the significance of environmental effects on healthcare expenditure in that they could, directly and indirectly, influence the capability of healthcare systems in combating pandemic/epidemic crises.⁶⁶

In our scoping study, we found legislation to play a meaningful role in the readiness and responsiveness of healthcare systems against pandemics. In agreement with this result, Buliva and colleagues cited the lack of integrated approaches, weak surveillance systems, and the absence of comprehensive response plans among the weighty concerns in this respect.³⁴

The readiness of hospitals and health centers is among the factors, which can impact the preparedness of healthcare systems during pandemic/epidemic crises. Different sub-factors are at play in this context, including ICU capacity, surveillance, negative emotional work, training and simulation, laboratory preparedness, communicable disease control medical networks, and surge capacity.

On this matter, Samina and colleagues called for the preparedness of hospitals in dealing with pandemics by following national and international guidelines.⁶⁷ Along the same lines, Henry maintained that the collaboration among public health laboratories on the provincial level was necessary to access up-to-date and accurate data and specimens for the management of the influenza pandemic.⁶⁸

With regard to surge capacity, Singh and colleagues warned that lack of a universal definition and collective decision-making concerning surge threats could render procedures duplicative. They also highlighted the importance of vector outbreak prevention and urged that differences be taken into consideration between the endemic outbreak of malaria and the pandemic of H1N1.³⁶ Surge capacity should be reinforced particularly for healthcare systems with restricted facilities. Phua and colleagues also gave prominence to the need for the development of the capacity of ICUs during the COVID-19 pandemic through collaboration between hospital practitioners and administrators, on the one hand, and

policymakers, on the other.³³

Finally, with respect to training and simulation, Shearer and colleagues utilized decision analysis and simulation for infectious pandemic planning and concluded that a decision model for controlling epidemic/pandemic crises required attention to the integration of related evidence.⁶⁹

Managerial interventions constituted the last theme extracted in this study. Such interventions encompass a vast category of sub-factors such as financial, physical, and human resources; information, education, and training; leadership; intergovernmental relationships; interoperability between health and non-health sectors; supplies; staffing; disaster response plans; crisis management and guidelines; and the rapid development of practice guidelines. Managerial interventions can cover manifold functions, from planning, resource allocating, staffing, and budgeting to monitoring, leadership, teamwork, and communication. On this subject, Oppenheim and colleagues proposed a framework for epidemic preparedness containing five indices of public health infrastructure, physical infrastructure, institutional capacity, economic resources, and public health communication,⁷⁰ all of which are eminently applicable and significant in epidemic/pandemic crises such as the COVID-19 outbreak. According to the results, it appears that managerial interventions can play an effective and prominent role during the current pandemic. Hence, there is a need for macro-managerial interventions in all the aspects of prevention, from the spread of the disease, the control of the pandemic, surveillance, and preparedness to the preservation and enhancement of the capacity of the whole healthcare system. On this detail, considering the role of primary healthcare systems in facing the new pandemic situation or probable future changes in the present pandemic is recommended.

The salient strength of the present study is our comprehensive analysis of the related evidence on the three coronavirus-related epidemic/pandemic crises. Furthermore, our presenting a map to depict the significant dimensions of the readiness and responsiveness of healthcare systems during the crises of SARS, MERS, and COVID-19 can be deemed another strong point of the current investigation. Nevertheless, first and foremost among the limitations of the current investigation is our inclusion of records only in the English language. Future scoping studies on this domain should triangulate the results from the viewpoints of policymakers, health managers, and healthcare providers *in situ*.

Conclusion

The results of the present scoping study show that notwithstanding their dissimilarities, healthcare systems around the globe should pay heed to the common determinants of preparedness and responsiveness against epidemics/pandemics such as MERS, SARS, and COVID-19. These determinants, however, have different attributes. Alternatively stated, health centers, as the first determinant, have an internal nature at the core of the preparedness and responsiveness of healthcare systems during outbreaks. Managerial interventions, as the second internal factor, should be able to meet and manage the needs of health centers. Socioeconomic and environmental factors are two external factors that can affect the preparedness and responsiveness of healthcare systems. These two can be discussed on a national or international level. Finally, community-related interventions may have a dual nature and need a strong relationship between healthcare systems and other public and private systems as well as the whole community. It seems that these five determinants together can upgrade the readiness and responsiveness of healthcare systems during pandemic crises such as the COVID-19 outbreak.

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References

- 1 Wan KH, Huang SS, Young AL, Lam DSC. Precautionary measures needed for ophthalmologists during pandemic of the coronavirus disease 2019 (COVID-19). *Acta Ophthalmol.* 2020;98:221-2. doi: 10.1111/aos.14438. PubMed PMID: 32223068; PubMed Central PMCID: PMC7540674.
- 2 Sohrabi C, Alsafi Z, O'Neill N, Khan M, Kerwan A, Al-Jabir A, et al. World Health Organization declares global emergency: A review of the 2019 novel coronavirus (COVID-19). *Int J Surg.* 2020;76:71-6. doi: 10.1016/j.ijsu.2020.02.034. PubMed PMID: 32112977; PubMed Central PMCID: PMC7105032.
- 3 Gilbert GL. Commentary: SARS, MERS and

- COVID-19-new threats; old lessons. *Int J Epidemiol.* 2020;49:726-8. doi: 10.1093/ije/dyaa061. PubMed PMID: 32361759; PubMed Central PMCID: PMC67197529.
- 4 Kinsman J, Angren J, Elgh F, Furberg M, Mosquera PA, Otero-Garcia L, et al. Preparedness and response against diseases with epidemic potential in the European Union: a qualitative case study of Middle East Respiratory Syndrome (MERS) and poliomyelitis in five member states. *BMC Health Serv Res.* 2018;18:528. doi: 10.1186/s12913-018-3326-0. PubMed PMID: 29976185; PubMed Central PMCID: PMC6034236.
 - 5 Chen KT, Twu SJ, Chang HL, Wu YC, Chen CT, Lin TH, et al. SARS in Taiwan: an overview and lessons learned. *Int J Infect Dis.* 2005;9:77-85. doi: 10.1016/j.ijid.2004.04.015. PubMed PMID: 15708322; PubMed Central PMCID: PMC67110635.
 - 6 Chen YC, Chen PJ, Chang SC, Kao CL, Wang SH, Wang LH, et al. Infection control and SARS transmission among healthcare workers, Taiwan. *Emerg Infect Dis.* 2004;10:895-8. doi: 10.3201/eid1005.030777. PubMed PMID: 15200825; PubMed Central PMCID: PMC67332327.
 - 7 Draper H, Wilson S, Ives J, Gratus C, Greenfield S, Parry J, et al. Healthcare workers' attitudes towards working during pandemic influenza: a multi method study. *BMC Public Health.* 2008;8:192. doi: 10.1186/1471-2458-8-192. PubMed PMID: 18518971; PubMed Central PMCID: PMC67242372.
 - 8 Petrosillo N, Viceconte G, Ergonul O, Ippolito G, Petersen E. COVID-19, SARS and MERS: are they closely related? *Clin Microbiol Infect.* 2020;26:729-34. doi: 10.1016/j.cmi.2020.03.026. PubMed PMID: 32234451; PubMed Central PMCID: PMC67176926.
 - 9 Zhu Z, Lian X, Su X, Wu W, Marraro GA, Zeng Y. From SARS and MERS to COVID-19: a brief summary and comparison of severe acute respiratory infections caused by three highly pathogenic human coronaviruses. *Respir Res.* 2020;21:224. doi: 10.1186/s12931-020-01479-w. PubMed PMID: 32854739; PubMed Central PMCID: PMC67450684.
 - 10 Linton NM, Kobayashi T, Yang Y, Hayashi K, Akhmetzhanov AR, Jung SM, et al. Incubation Period and Other Epidemiological Characteristics of 2019 Novel Coronavirus Infections with Right Truncation: A Statistical Analysis of Publicly Available Case Data. *J Clin Med.* 2020;9. doi: 10.3390/jcm9020538. PubMed PMID: 32079150; PubMed Central PMCID: PMC67074197.
 - 11 Farrar JJ. Stopping the Gaps in Epidemic Preparedness. *N Engl J Med.* 2019;380:1788-9. doi: 10.1056/NEJMp1902683. PubMed PMID: 31067366.
 - 12 Tekola B, Myers L, Lubroth J, Plee L, Calistri P, Pinto J. International health threats and global early warning and response mechanisms. *Rev Sci Tech.* 2017;36:657-70. doi: 10.20506/rst.36.2.2683. PubMed PMID: 30152454.
 - 13 Bloom DE, Cadarette D. Infectious Disease Threats in the Twenty-First Century: Strengthening the Global Response. *Front Immunol.* 2019;10:549. doi: 10.3389/fimmu.2019.00549. PubMed PMID: 30984169; PubMed Central PMCID: PMC67447676.
 - 14 Organization WH. Pandemic influenza risk management: a WHO guide to inform and harmonize national and international pandemic preparedness and response. Geneva: World Health Organization, 2017.
 - 15 Purohit V, Kudale A, Sundaram N, Joseph S, Schaetti C, Weiss MG. Public Health Policy and Experience of the 2009 H1N1 Influenza Pandemic in Pune, India. *Int J Health Policy Manag.* 2018;7:154-66. doi: 10.15171/ijhpm.2017.54. PubMed PMID: 29524939; PubMed Central PMCID: PMC675819375.
 - 16 Preparedness PI. Response: A WHO Guidance Document. Geneva: World Health Organization. 2009.
 - 17 Hawryluck L, Lapinsky SE, Stewart TE. Clinical review: SARS - lessons in disaster management. *Crit Care.* 2005;9:384-9. doi: 10.1186/cc3041. PubMed PMID: 16137388; PubMed Central PMCID: PMC671269424.
 - 18 Peters M, Godfrey C, Mclnerney P, Soares C, Khalil H, Parker D. The Joanna Briggs Institute reviewers' manual 2015: methodology for JBI scoping reviews. 2015.
 - 19 Arksey H, O'Malley L. Scoping studies: towards a methodological framework. *International journal of social research methodology.* 2005;8:19-32. doi: 10.1080/1364557032000119616.
 - 20 Munn Z, Peters MDJ, Stern C, Tufanaru C, McArthur A, Aromataris E. Systematic review or scoping review? Guidance for authors when choosing between a systematic or scoping review approach. *BMC Med Res Methodol.* 2018;18:143. doi: 10.1186/s12874-018-0611-x. PubMed PMID: 30453902; PubMed Central PMCID: PMC67245623.
 - 21 Singh J. Critical appraisal skills programme. *Journal of pharmacology and Pharmacotherapeutics.* 2013;4:76. doi: 10.4103/0976-500X.107697.

- 22 Nowell LS, Norris JM, White DE, Moules NJ. Thematic analysis: Striving to meet the trustworthiness criteria. *International journal of qualitative methods*. 2017;16:1609406917733847. doi: 10.1177/1609406917733847.
- 23 Thomas J, Harden A. Methods for the thematic synthesis of qualitative research in systematic reviews. *BMC Med Res Methodol*. 2008;8:45. doi: 10.1186/1471-2288-8-45. PubMed PMID: 18616818; PubMed Central PMCID: PMCPMC2478656.
- 24 Ung COL. Community pharmacist in public health emergencies: Quick to action against the coronavirus 2019-nCoV outbreak. *Res Social Adm Pharm*. 2020;16:583-6. doi: 10.1016/j.sapharm.2020.02.003. PubMed PMID: 32081569; PubMed Central PMCID: PMCPMC7129623.
- 25 Nicholas DB, Gearing RE, Koller D, Salter R, Selkirk EK. Pediatric epidemic crisis: Lessons for policy and practice development. *Health Policy*. 2008;88:200-8. doi: 10.1016/j.healthpol.2007.11.006. PubMed PMID: 18456367; PubMed Central PMCID: PMCPMC7132509.
- 26 Aslan D, Sayek I. We Need to Rethink on Medical Education for Pandemic Preparedness: Lessons Learnt From COVID-19. *Balkan Med J*. 2020;37:178-9. doi: 10.4274/balkanmedj.galenos.2020.2020.4.002. PubMed PMID: 32412201; PubMed Central PMCID: PMCPMC7285664.
- 27 Mase WA, Bickford B, Thomas CL, Jones SD, Bisesi M. After-action review of the 2009-10 H1N1 Influenza Outbreak Response: Ohio's Public Health System's performance. *J Emerg Manag*. 2017;15:325-34. doi: 10.5055/jem.2017.0340. PubMed PMID: 29165783.
- 28 Tambo E, El Dessouky AG, Khater EIM. Innovative Preventive and Resilience Approaches Against Aedes-linked Vector-borne Arboviral Diseases Threat and Epidemics Burden in Gulf Council Countries. *Oman Med J*. 2019;34:391-6. doi: 10.5001/omj.2019.73. PubMed PMID: 31555414; PubMed Central PMCID: PMCPMC6745427.
- 29 Lee M, Ju Y, You M. The Effects of Social Determinants on Public Health Emergency Preparedness Mediated by Health Communication: The 2015 MERS Outbreak in South Korea. *Health Commun*. 2020;35:1396-406. doi: 10.1080/10410236.2019.1636342. PubMed PMID: 31262197.
- 30 Attipoe-Dorcoo S, Delgado R, Gupta A, Bennet J, Oriol NE, Jain SH. Mobile health clinic model in the COVID-19 pandemic: lessons learned and opportunities for policy changes and innovation. *Int J Equity Health*. 2020;19:73. doi: 10.1186/s12939-020-01175-7. PubMed PMID: 32429920; PubMed Central PMCID: PMCPMC7236869.
- 31 Brown J, Guru S, Williams K, Florentino R, Miner J, Cagir B. Rural Healthcare Center Preparation and Readiness Response to Threat of COVID-19. *J Am Coll Surg*. 2020;230:1105-10. doi: 10.1016/j.jamcollsurg.2020.04.006. PubMed PMID: 32283269; PubMed Central PMCID: PMCPMC7146674.
- 32 Hernandez-Avila M, Alpuche-Aranda CM. Mexico: Lessons learned from the 2009 pandemic that help us fight COVID-19. *Healthc Manage Forum*. 2020;33:158-63. doi: 10.1177/0840470420921542. PubMed PMID: 32372664; PubMed Central PMCID: PMCPMC7218351.
- 33 Phua J, Weng L, Ling L, Egi M, Lim CM, Divatia JV, et al. Intensive care management of coronavirus disease 2019 (COVID-19): challenges and recommendations. *Lancet Respir Med*. 2020;8:506-17. doi: 10.1016/S2213-2600(20)30161-2. PubMed PMID: 32272080; PubMed Central PMCID: PMCPMC7198848.
- 34 Buliva E, Elhakim M, Tran Minh NN, Elkholy A, Mala P, Abubakar A, et al. Emerging and Reemerging Diseases in the World Health Organization (WHO) Eastern Mediterranean Region-Progress, Challenges, and WHO Initiatives. *Front Public Health*. 2017;5:276. doi: 10.3389/fpubh.2017.00276. PubMed PMID: 29098145; PubMed Central PMCID: PMCPMC5653925.
- 35 Son H, Lee WJ, Kim HS, Lee KS, You M. Examination of Hospital Workers' Emotional Responses to an Infectious Disease Outbreak: Lessons From the 2015 MERS Co-V Outbreak in South Korea. *Disaster Med Public Health Prep*. 2019;13:504-10. doi: 10.1017/dmp.2018.95. PubMed PMID: 30334501.
- 36 Singh SR, Coker R, Vrijhoef HJ, Leo YS, Chow A, Lim PL, et al. Mapping infectious disease hospital surge threats to lessons learnt in Singapore: a systems analysis and development of a framework to inform how to DECIDE on planning and response strategies. *BMC Health Serv Res*. 2017;17:622. doi: 10.1186/s12913-017-2552-1. PubMed PMID: 28870193; PubMed Central PMCID: PMCPMC5584534.
- 37 Syed AM, Hjarnoe L, Krumkamp R, Reintjes R, Aro AR. Developing policy options for SARS and SARS-like diseases - a Delphi

- study. *Glob Public Health*. 2010;5:663-75. doi: 10.1080/17441690903473220. PubMed PMID: 20162483.
- 38 Lee KM, Jung K. Factors Influencing the Response to Infectious Diseases: Focusing on the Case of SARS and MERS in South Korea. *Int J Environ Res Public Health*. 2019;16. doi: 10.3390/ijerph16081432. PubMed PMID: 31013648; PubMed Central PMCID: PMC6518241.
 - 39 Martin R, Conseil A, Longstaff A, Kodo J, Siegert J, Duguet AM, et al. Pandemic influenza control in Europe and the constraints resulting from incoherent public health laws. *BMC Public Health*. 2010;10:532. doi: 10.1186/1471-2458-10-532. PubMed PMID: 20815888; PubMed Central PMCID: PMC6518241.
 - 40 French S, Niculae C. Believe in the model: mishandle the emergency. *Journal of Homeland Security and Emergency Management*. 2005;2. doi: 10.2202/1547-7355.1108.
 - 41 Villanueva J, Schweitzer B, Odle M, Aden T. Detecting Emerging Infectious Diseases: An Overview of the Laboratory Response Network for Biological Threats. *Public Health Rep*. 2019;134:16S-21S. doi: 10.1177/0033354919874354. PubMed PMID: 31682559; PubMed Central PMCID: PMC6832029.
 - 42 Al-Tawfiq JA, Rothwell S, McGregor HA, Khouri ZA. A multi-faceted approach of a nursing led education in response to MERS-CoV infection. *J Infect Public Health*. 2018;11:260-4. doi: 10.1016/j.jiph.2017.08.006. PubMed PMID: 28869153; PubMed Central PMCID: PMC6518241.
 - 43 Peiffer-Smadja N, Lucet JC, Bendjelloul G, Bouadma L, Gerard S, Choquet C, et al. Challenges and issues about organizing a hospital to respond to the COVID-19 outbreak: experience from a French reference centre. *Clin Microbiol Infect*. 2020;26:669-72. doi: 10.1016/j.cmi.2020.04.002. PubMed PMID: 32278082; PubMed Central PMCID: PMC6518241.
 - 44 Kao HY, Ko HY, Guo P, Chen CH, Chou SM. Taiwan's Experience in Hospital Preparedness and Response for Emerging Infectious Diseases. *Health Secur*. 2017;15:175-84. doi: 10.1089/hs.2016.0105. PubMed PMID: 28418745; PubMed Central PMCID: PMC6518241.
 - 45 Kim G, Wang M, Pan H, G HD, Roxby AC, Neukirch J, et al. A Health System Response to COVID-19 in Long-Term Care and Post-Acute Care: A Three-Phase Approach. *J Am Geriatr Soc*. 2020;68:1155-61. doi: 10.1111/jgs.16513. PubMed PMID: 32343363; PubMed Central PMCID: PMC6518241.
 - 46 Lee VJ, Aguilera X, Heymann D, Wilder-Smith A, Lancet Infectious Diseases C. Preparedness for emerging epidemic threats: a Lancet Infectious Diseases Commission. *Lancet Infect Dis*. 2020;20:17-9. doi: 10.1016/S1473-3099(19)30674-7. PubMed PMID: 31876487; PubMed Central PMCID: PMC6518241.
 - 47 Li H, Zhang Z, Li P, Nie H. Challenges and Responses: A Tertiary Hospital in 2019-nCoV Epidemic. *Disaster Med Public Health Prep*. 2020:1-4. doi: 10.1017/dmp.2020.93. PubMed PMID: 32284090; PubMed Central PMCID: PMC6518241.
 - 48 Weiner JA, Swiatek PR, Johnson DJ, Louie PK, Harada GK, McCarthy MH, et al. Learning from the past: did experience with previous epidemics help mitigate the impact of COVID-19 among spine surgeons worldwide? *Eur Spine J*. 2020;29:1789-805. doi: 10.1007/s00586-020-06477-6. PubMed PMID: 32500177; PubMed Central PMCID: PMC6518241.
 - 49 Hasan Z, Narasimhan M. Preparing for the COVID-19 Pandemic: Our Experience in New York. *Chest*. 2020;157:1420-2. doi: 10.1016/j.chest.2020.03.027. PubMed PMID: 32222587; PubMed Central PMCID: PMC6518241.
 - 50 Tran BX, Hoang MT, Pham HQ, Hoang CL, Le HT, Latkin CA, et al. The operational readiness capacities of the grassroots health system in responses to epidemics: Implications for COVID-19 control in Vietnam. *J Glob Health*. 2020;10:011006. doi: 10.7189/jogh.10.011006. PubMed PMID: 32566168; PubMed Central PMCID: PMC6518241.
 - 51 Alabdali A, Almakhalas K, Alhusain F, Albaiz S, Almutairi K, Algerian N. The Middle East Respiratory Syndrome Coronavirus (MERS-CoV) Outbreak at King Abdul-Aziz Medical City-Riyadh from Emergency Medical Services Perspective. *Prehosp Disaster Med*. 2020;35:457-61. doi: 10.1017/S1049023X20000709. PubMed PMID: 32431260; PubMed Central PMCID: PMC6518241.
 - 52 La VP, Pham TH, Ho MT, Nguyen MH, P Nguyen KL, Vuong TT, et al. Policy response, social media and science journalism for the sustainability of the public health system amid the COVID-19 outbreak: The vietnam lessons. *Sustainability*. 2020;12:2931.
 - 53 Peeri NC, Shrestha N, Rahman MS, Zaki R, Tan Z, Bibi S, et al. The SARS, MERS and novel coronavirus (COVID-19) epidemics, the newest and biggest global health threats: what lessons have we learned? *Int*

- J Epidemiol. 2020;49:717-26. doi: 10.1093/ije/dyaa033. PubMed PMID: 32086938; PubMed Central PMCID: PMC7197734.
- 54 Leung CS, Ho MM, Kiss A, Gundlapalli AV, Hwang SW. Homelessness and the response to emerging infectious disease outbreaks: lessons from SARS. *J Urban Health*. 2008;85:402-10. doi: 10.1007/s11524-008-9270-2. PubMed PMID: 18347991; PubMed Central PMCID: PMC7197734.
 - 55 Maves RC, Jamros CM, Smith AG. Intensive Care Unit Preparedness During Pandemics and Other Biological Threats. *Crit Care Clin*. 2019;35:609-18. doi: 10.1016/j.ccc.2019.06.001. PubMed PMID: 31445608; PubMed Central PMCID: PMC7134984.
 - 56 Pediatric Committee MAoCPsLA, Editorial Committee of Chinese Journal of Contemporary P. [Emergency response plan for the neonatal intensive care unit during epidemic of 2019 novel coronavirus]. *Zhongguo Dang Dai Er Ke Za Zhi*. 2020;22:91-5. PubMed PMID: 32051072; PubMed Central PMCID: PMC7390008.
 - 57 Nuzzo JB, Meyer D, Snyder M, Ravi SJ, Lapascu A, Souleles J, et al. What makes health systems resilient against infectious disease outbreaks and natural hazards? Results from a scoping review. *BMC Public Health*. 2019;19:1310. doi: 10.1186/s12889-019-7707-z. PubMed PMID: 31623594; PubMed Central PMCID: PMC6798426.
 - 58 Cleary V, Balasegaram S, McCloskey B, Keeling D, Turbitt D. Pandemic (H1N1) 2009: setting up a multi-agency regional response centre--a toolkit for other public health emergencies. *J Bus Contin Emerg Plan*. 2010;4:154-64. PubMed PMID: 20494880.
 - 59 Beard L, Clark C. SARS: a health system's perspective. *Hosp Q*. 2003;6:55-8, 4. doi: 10.12927/hcq..16483. PubMed PMID: 14628532.
 - 60 Wilder-Smith A, Freedman DO. Isolation, quarantine, social distancing and community containment: pivotal role for old-style public health measures in the novel coronavirus (2019-nCoV) outbreak. *J Travel Med*. 2020;27. doi: 10.1093/jtm/taaa020. PubMed PMID: 32052841; PubMed Central PMCID: PMC7107565.
 - 61 Jalloh MF, Li W, Bunnell RE, Ethier KA, O'Leary A, Hageman KM, et al. Impact of Ebola experiences and risk perceptions on mental health in Sierra Leone, July 2015. *BMJ Glob Health*. 2018;3:e000471. doi: 10.1136/bmjgh-2017-000471. PubMed PMID: 29607096; PubMed Central PMCID: PMC5873549.
 - 62 Wong TW, Gao Y, Tam WWS. Anxiety among university students during the SARS epidemic in Hong Kong. *Stress and Health: Journal of the International Society for the Investigation of Stress*. 2007;23:31-5. doi: 10.1002/smi.1116.
 - 63 Mamelund SE, Shelley-Egan C, Rogeberg O. The association between socioeconomic status and pandemic influenza: protocol for a systematic review and meta-analysis. *Syst Rev*. 2019;8:5. doi: 10.1186/s13643-018-0931-2. PubMed PMID: 30609940; PubMed Central PMCID: PMC6318944.
 - 64 Zyaambo C, Siziya S, Fylkesnes K. Health status and socio-economic factors associated with health facility utilization in rural and urban areas in Zambia. *BMC Health Serv Res*. 2012;12:389. doi: 10.1186/1472-6963-12-389. PubMed PMID: 23145945; PubMed Central PMCID: PMC3536624.
 - 65 Liverani M, Hawkins B, Parkhurst JO. Political and institutional influences on the use of evidence in public health policy. A systematic review. *PLoS One*. 2013;8:e77404. doi: 10.1371/journal.pone.0077404. PubMed PMID: 24204823; PubMed Central PMCID: PMC3813708.
 - 66 Jerrett M, Eyles J, Dufournaud C, Birch S. Environmental influences on healthcare expenditures: an exploratory analysis from Ontario, Canada. *J Epidemiol Community Health*. 2003;57:334-8. doi: 10.1136/jech.57.5.334. PubMed PMID: 12700215; PubMed Central PMCID: PMC1732448.
 - 67 Samina M, Tabish S, Mufti S, Ajaz M, Rehana K, Panditha K. Role of Hospital in Pandemic: Our Experience. *JIMSA*. 2012;25:201-4.
 - 68 Henry B, Canadian Pandemic Influenza Preparedness Task G. Canada's Pandemic Influenza Preparedness: Surveillance strategy. *Can Commun Dis Rep*. 2018;44:14-7. doi: 10.14745/ccdr.v44i01a04. PubMed PMID: 29770093; PubMed Central PMCID: PMC5937067.
 - 69 Shearer FM, Moss R, McVernon J, Ross JV, McCaw JM. Infectious disease pandemic planning and response: Incorporating decision analysis. *PLoS Med*. 2020;17:e1003018. doi: 10.1371/journal.pmed.1003018. PubMed PMID: 31917786; PubMed Central PMCID: PMC6952100.
 - 70 Oppenheim B, Gallivan M, Madhav NK, Brown N, Serhiyenko V, Wolfe ND, et al. Assessing global preparedness for the next pandemic: development and application of an Epidemic Preparedness Index. *BMJ Glob Health*. 2019;4:e001157. doi: 10.1136/bmjgh-2018-001157. PubMed PMID: 30775006; PubMed Central PMCID: PMC6352812.