

Different Approaches to Confronting the Biological Epidemic; Prevention Tools with an Emphasis on COVID-19: A Systematized Study

Abstract

Background: The World Health Organization has identified COVID-19 as a public health emergency and is urging governments to stop the virus transmission by adopting appropriate policies. In this regard, authorities have taken different approaches to cutting the chain or controlling the spread of the disease. The aim of this study was to determine the approaches to biological epidemics and related prevention tools with emphasis on COVID-19 disease. **Methods:** The present study was a systematized study of publications related to the prevention strategies for Covid-19 disease. The study was carried out based on the PRISMA guidelines, CASP and AACODS. The data resources included ISI/WOS, PubMed, Scopus, science direct, Ovid and ProQuest. WHO website, published reports of countries, as well as the Worldometer website were evaluated. The time-frame of the study was from 1 December 2019 to 30 May 2020. **Results:** The study findings showed that in order to confronting the COVID-19 epidemic, in general, there are three approaches of “mitigation”, “active control”, and “suppression” and four strategies of “quarantine”, “isolation”, “social distance”, and “lockdown” in both individual and social dimensions to deal with epidemics. Selection and implementation of each approach requires specific strategies and has different effects when it comes to controlling and inhibiting the disease. **Conclusion:** One possible approach to control the disease is to change individual behavior and lifestyle. In addition to prevention strategies, use of masks, observance of personal hygiene principles such as regular hand washing and non-contact of contaminated hands with the face, as well as observance of public health principles such as sneezing and coughing etiquettes, safe extermination of personal protective equipment must be strictly observed. The use of the previous experiences in the world, along with the current experiences of countries, can be very helpful in choosing the accurate approach for each country in accordance with the characteristics of that country and lead to the reduction of possible costs at the national and international levels.

Keywords: Coronavirus, COVID-19, prevention and control

Introduction

In December 2019, the COVID-19 virus appeared in Wuhan, Hubei Province, in China. A biological outbreak whose evidence was linked to some seafood restaurants.^[1] Coronaviruses (CoV) are a large family of viruses that cause illness ranging from the common cold to more severe diseases like Middle East Respiratory Syndrome (MERS-CoV) and Severe Acute Respiratory Syndrome (SARS-CoV).^[2] The number of people infected with the new strain of corona virus is constantly increasing.^[2] As of September 25, 2020, there were 32,459,364 infected people and 988,530 deaths due to COVID-19 disease in the world.^[3]

The average of incubation period of COVID-19 is 3-5 days from the time

the virus enters the host body until it can be transmitted to another person.^[4] The average number of basic reproduction is 2-3 individuals and the effective reproduction number is less than three individuals. The number of the effective reproduction varies severely from one society to another. It depends upon the level of previous preparation, having a plan, adequate authority, and success of the government as well as the health system, and on the other hand, it depends on the people's cooperation with the government and the health system. When it reaches the number below one, the epidemic is controlled.^[5] The infection period is 10-14 days after the onset of symptoms. The interval between two consecutive cases is 5-7 days and the rate of hospitalization is 18-20%.^[6] Moreover, the average time of the onset of symptoms

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How to cite this article: Hadian M, Mazaheri E, Jabbari A. Different approaches to confronting the biological epidemic; prevention tools with an emphasis on COVID-19: A systematized study. *Int J Prev Med* 2021;12:127.

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Access this article online

Website:
www.ijpvmjournal.net/www.ijpvm.ir

DOI:
10.4103/ijpvm.IJPVM_634_20

Quick Response Code:



to shortness of breath and respiratory distress that requires special care is between 6-7 days and 7-8 days, respectively.^[7] Finally, the average time from onset of the symptoms to death is 10-12 days.^[7,8] On March 12, 2020, the World Health Organization (WHO) proclaimed COVID-19 disease as a pandemic in the world and it has created many health, economic, social, security, and international challenges for all governments and individuals. Currently, the spread of the disease is unstoppable, affecting 213 countries and territories all around the world.^[9]

According to WHO, COVID-19 disease is a common enemy of humanity and is a public health emergency. This international organization advises governments to stop the virus transmission cycle by considering proper policies.^[10] In this regard, countries have taken different approaches to cutting the chain or controlling the spread of the disease. Now the question is what are these approaches and what tools should be used to implement each of these approaches and what is the effectiveness of each of them in dealing with this epidemic? Knowing these approaches and the degree of responsiveness of each in disease prevention can be of great help to policy makers. To answer these questions, the present study carried out to determine the approaches to biological epidemics and related prevention tools with an emphasis on COVID-19 disease.

Methods

The present study is a systematic review of publications related to the prevention strategies and approaches for COVID-19 disease. This systematic review attempt to include elements of systematic review process while stopping short of systematic review.^[11] The study was performed based on the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines and Critical Appraisal Skills Program (CASP) for articles and AACODS (Authority, Accuracy, Coverage, Objectivity, Date, Significance) for gray literature (provides five criteria for judging the quality of grey information).^[12,13]

Information sources

This study was conducted during 1 December 2019 to 30 May 2020 and reviewed published papers in English and Persian-language on the topic of prevention strategies for Covid-19 disease. In addition to the published articles, some unpublished reports, programs, and documents have also been included in the study. These are referred to as “the gray studies”. For this purpose, we studied databases including ISI web of science, PubMed, Scopus, science direct, Ovid and ProQuest, and for the gray studies, some reliable websites such as WHO website, the credible websites depicting reports of the involved countries, as well as the Worldometer website were used.

Search protocol

The search strategies include: **#1.** (covid-19 OR novel corona virus), **#2.** (prevent* OR strategy OR control

OR Approach OR manage OR tool), **#3.** #1 AND #2). All synonyms of the keywords were searched using MESH strategies. For example, using the Search Strategy Search ((covid-19[Title] OR novel corona virus [Title])) AND (prevent*[Title] OR strategy [Title] OR control[Title] OR Approach[Title] OR manage[Title] OR tool[Title]). Filters: Publication date from 2019/11/30 to 2020/05/30, 608 articles were found on the PubMed database.

Eligibility criteria

We searched papers that: (1) mentioned infectious disease prevention strategies and approaches and based on it the screening of CASP criteria and ACCODS criteria was corrected; (2) papers in English or Persian language; (3) papers with full text accessibility; and: (4) papers published since 2019.

Selection of articles and documents

Independent reviewers (MH and EM) screened abstracts and titles for eligibility. When the reviewers felt that the abstract or title was potentially useful, full copies of the article were retrieved and considered for eligibility. If discrepancies occurred between reviewers, the reasons were identified and a final decision was made based on the third reviewer (AJ) agreement. Two authors (MH and EM) assessed the methodological quality and grade of evidence of the included studies with the CASP tools. The CASP tools use a systematic approach to appraise different study designs from the following domains: study validity, methodology quality, presentation of results, and external validity and all the items from the checklists were judged with yes (low risk of bias, score 1), no (high risk of bias), or cannot tell (unclear or unknown risk of bias, score 0). Total scores were used to grade the methodological quality of the each study assessed.^[12]

Study of the quality assessment

Quality assessment of the included studies was done using the “CASP” for an article and “ACCODS” tools for gray literature. The score of the quantitative studies ranged from two to nine. The majority of the quantitative studies did not provide any ethical statement, study design, sampling, and reflexivity related to the research process.

Findings

Database search

The initial electronic database search of the literature resulted in a total of 1780 documents. In the next step, duplicate documents were eliminated and the number decreased to 1180 articles. Using systematic screening, the titles were reviewed to find those related to prevention strategies and 395 documents were selected. In the next step, abstracts of the documents were studied and 367 documents were selected to be fully reviewed. In this step, 339 documents were excluded. After that, all of the

selected documents were studied in details and on the basis of the inclusion criteria only 28 documents were selected. Figure 1 shows the strategy for searching and selecting the documents.

Main findings

According to the thematic analysis performed, different approaches have been taken to cut the COVID-19 transmission chain. The findings showed that there are generally three approaches [Figure 2] and four tools [Figure 3] available to prevent COVID-19 epidemics, and that the selection of each approach requires definite conditions and has various impacts when comes to disease control and inhibition.

Mitigation approach

Mitigation Strategy is based on the theory of “herd immunity” used in medical history, which means that in history, humans and animals have come and gone based on the principle of “natural selection” and with the destruction of part of the population (herd), while others were safe.^[14]

According to Figure 4, in this approach, voluntary separation of symptomatic patients and slowing down of the epidemic process was taken into consideration in order to give treatment systems sufficient opportunities to accept patients and provide opportunities for vaccine or drug production. In this approach, 60-70% of the individuals get the disease to control the epidemic by creating herd immunity.^[14,15] The strategy used in this approach is optional isolation and optional social distancing tools.^[16] This approach is less expensive but will extend the duration of the epidemic.^[14] Determining the time to return the condition to normal cannot be easily estimated in this approach. There is a possibility of emergence of a more aggressive type of virus and it has many social, psychological, and economic consequences.^[17] Herd immunity cannot be the governments’ solution to fight against corona for the death of a significant portion of the population. Successful performance of China and other countries, especially the three countries of Taiwan, South Korea and Thailand, prove

that the virus is inhibitable; no need to infect a significant part of society, and strong government management can save lives.^[18,19]

Contamination (active control)

In this approach, governments rely on extensive laboratory tests to accurately find out the number of infected individuals, tracking and following them, and actively reducing the number of transmissions to decrease the number of infected individuals and their contacts during the maximum incubation period of the disease, which is two weeks for the novel coronavirus, as well as the obligation to take the laboratory test.^[20] After diagnosis, all patients are identified and required to stay at home or in the designated locations through coding, GSP, and so on. The strategy behind this approach is home and pre-hospital obligatory isolation, if required, post-hospital obligatory isolation and recovery, accompanied with voluntary or obligatory social distancing.^[19] Isolation at home is possible in the following situations:

- The patients are well enough to receive care at home;
- They have appropriate caregivers at home;
- There is a separate bedroom where they can recover without sharing an immediate space with others;
- They have access to food and other necessities;
- They (and anyone who lives in the same home) have access to the recommended personal protective equipment (at a minimum, gloves, and mask); and
- They do not live with household members who may be at increased risk of complications from novel coronavirus infection (e.g., people over the age of 65, young children, pregnant women, people who are immunocompromised or who have chronic heart, lung, or kidney conditions). Being isolated at home means that people need to stay at home. A person in isolation cannot leave to attend public places, including work, school, childcare, or university. Only people who usually live in the household should be in the home. Do not accept visitors.^[21-23]

If the above-mentioned conditions are not available at the individual’s home, pre-hospital isolation should be used. In this strategy, businesses are not closed during this period but violators are fined.

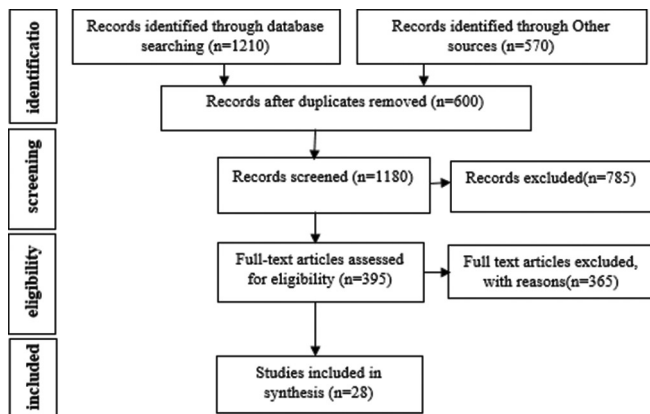


Figure 1: Selection process

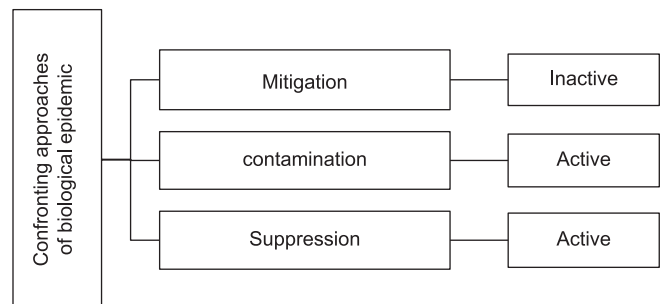


Figure 2: Confronting approaches of biological epidemic

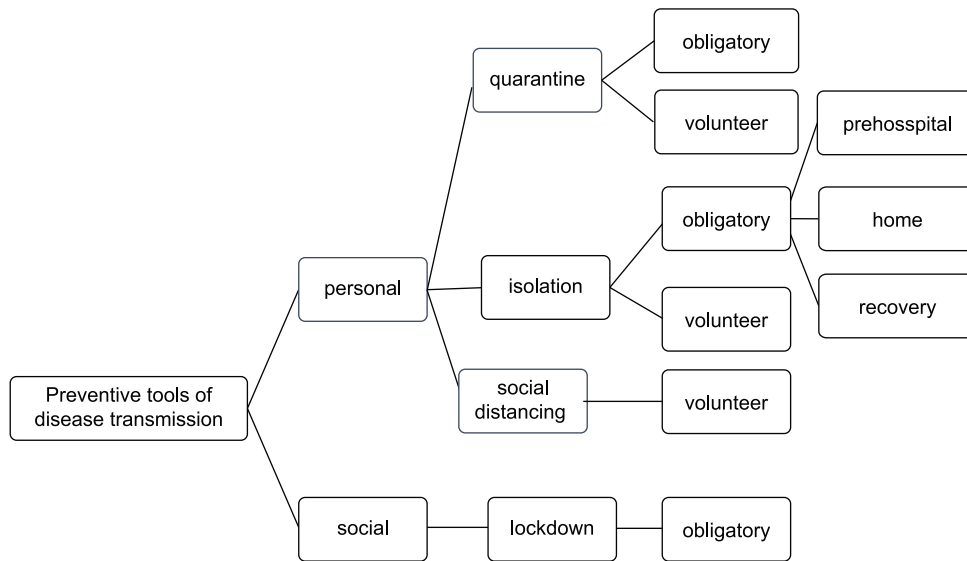


Figure 3: Preventive strategies of disease transmission

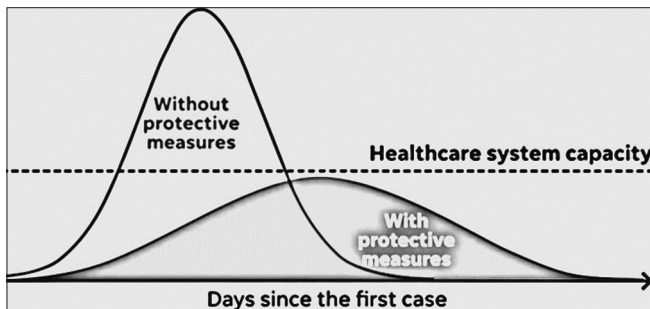


Figure 4: Mitigation strategy to avoid burnout of the treatment system, slowing down the incidence of the majority of society and achieving natural immunity against the disease

Suppression approach

In this approach, the key point is to close businesses and force people to stay at home (e.g., military quarantine).^[24] Businesses are completely closed (except the essential ones), and there is hope that within a reasonable time, the growth rate of the disease and its prevalence will reach zero and economic activity will resume.^[25] The strategy used for this approach is the lockdown strategy with obligatory social distancing. This approach sees the complete quarantine as the only way to fight the disease and cut the chain so that the virus does not spread from point “A” to point “B”. Based on this strategy, many governments require public to “stay at home”. The government can only propose the executive protocols in this strategy, and offenders and those who break the rules serving simple sentence that may be extended up to one-month imprisonment or to a monetary fine.^[26] The important point in Figure 5 is to consider the sustainability of such actions. These interventions are likely to continue along with high quality of monitoring and rapid separation to prevent a possible re-emergence of the epidemic.^[27]

WHO recommends taking a combination of all three strategies mentioned above in a timely manner to control the disease.^[1]

Discussion

The results of the present study show that, in general, there are 3 approaches and 4 strategies for the prevention of infectious diseases. These approaches include: Mitigation, active control or contamination, and Suppression. Also, the strategies used for prevention include quarantine, isolation, social distancing, and lockdown.

In COVID-19 pandemic, a person can transmit the virus to others about 5 days encountering the disease.^[2] The contagious period can last up to 10 days.^[4] However, in a few days, it can be transmitted to others without any symptoms. At the beginning of the pandemic, or a few days later, if the health policies are not implemented properly, or if people do not have the necessary support of the health system, each person will infect more than two people during this period.^[7] About 20% of patients will be hospitalized within the next 6-7 days and about 7-10% will die. The reaction of the countries in the coming weeks will be important at the national epidemic level.^[8] As of September 25, 2020, there were 32,459,364 infected people and 988,530 deaths due to COVID-19 disease in the world.^[3] The United States, Spain, Italy, France, Germany, the United Kingdom, Turkey, Iran, China, and Russia are ranked first to tenth countries in the world for COVID-19, respectively. The highest number of casualties reported thus far was in the United States, Italy, Spain, France, Britain, Belgium, Germany, Iran, China, and the Netherlands.^[28]

Among the global experiences, Italy was the first country in the world to put itself in a national quarantine-like condition to prevent the outbreak of the coronavirus due to the widespread prevalence of the disease and the high mortality rate.^[29] The Chinese government chose to suppress the disease with complete quarantine as its main approach, and with this strategy, it was able to stop the virus transmission cycle in about 8-9 weeks.^[1] South Korea’s control strategy

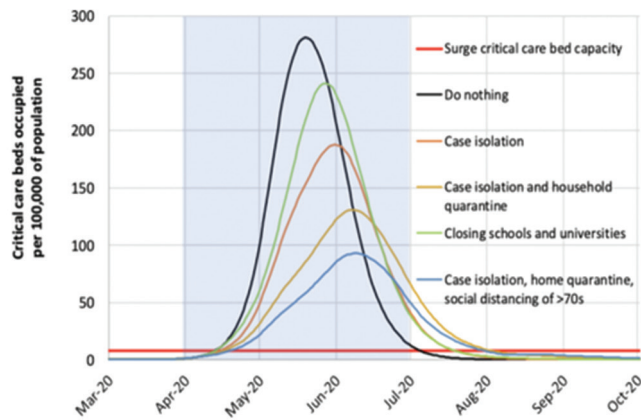


Figure 5: Suppression strategy to control the COVID-19 epidemic

was mass screening and identifying infected individuals and healthy transmitters, tracking the infected person's contacts over the past two weeks, diagnosing and treating them.^[30] The British government implemented a “herd immunity” policy, but they also realized that this method was not appropriate, so they moved towards full quarantine. The government, which initially sought a bizarre strategy by avoiding quarantine in order to gain natural immunity by at least 60 percent of the population, faced widespread criticism for the death of 250,000 to 300,000 individuals and as a result withdrew this program. Finally, on March 16, 2020, it was forced to formally give up its position in favor of a “suppressive approach” and adopt effective and striking strategies.^[27,28]

The Netherlands and Canada, which have been pursuing a “mitigation strategy” since March 23, 2020, have adopted a “suppression strategy”, and announced some striking actions based on the “social avoidance”. The result of a three-month policy of “herd immunity” and “mitigation strategy” adopted by the governments of Canada and the Netherlands was the spread of the disease. The United States initially opposed quarantine because it believed that quarantine would lead to economic collapse. Consequently, between the economy and the possibility of limited casualties, the US authorities preferred to choose the second one.^[27] However, as the number of people infected with the virus increased in the United States and thousands of people lost their lives, they concluded that the treatment system would be in short supply, so that the economy would collapse and the deaths would increase, therefore, Trump's policy changed and sought a complete quarantine strategy.^[31]

The same was true in Iran where the government officials initially thought that they did not have the budget to support people's living and economic pressure will make people's life difficult. Consequently, they were not able to implement full quarantine, but as the virus spread, they gradually shifted to complete quarantine; the same action happened in China and India. However, in Iran, neither

of the two policies have been implemented properly; i.e., neither urban quarantine (in general or in outbreaks centers) has been seriously pursued, nor has the policy of maximum testing/screening and isolation.^[27]

Germany has announced strict regulations for dealing with the corona virus. The federal government does not intend to implement quarantine; however, they decided that leaving home must be kept to a minimum and no more than two people must be together in public places. Contrary to expectations, the German government has not announced a complete quarantine and ban on transportation in the country, but has urged citizens to leave the house only to meet basic needs and to minimize contacts with other individuals outdoor.^[27,32]

Singapore has had many useful experiences with infectious diseases. The country quickly began laboratory testing for COVID-19, and, in parallel, increased the production of the equipment needed for the tests, as well as strict controls on the entry and exit to and from the country. The government subsidizes people especially unemployed persons in order to cover some of their living costs and to encourage them to stay home and fines people who do not obey the rules. Another action is to keep medical staff away from each other and to separate different patients physically, which will reduce the prevalence of the disease.^[32]

In a study conducted by Li *et al.* (2020), the findings showed that quarantine strategy is very effective in reducing the spread of the disease and it can reduce 89.7% of cases. Implementing strict strategies such as home quarantine, travel bans, control of urban and intercity traffic, closure of public places, prevention of ceremonies and gatherings, asking people to do home-based work as much as possible will significantly reduce the transmission of the infection in society.^[33] Another study by Li *et al.* (2020) showed that epidemic size could probably be reduced from 87% to 100% due to quarantine in Hubei Province, China.^[34] Although the optimal rate of quarantine use is not easily possible, these analyses show the possible effectiveness of the recent quarantine. In Hubei Province, quarantine rates fell by 25% and 57.3% respectively, with one and two weeks of quarantine. However, with a one-week delay in quarantine, the number of cases increased by 10%.^[34] Another study by Xiao using the SEIO (MH) model showed that Wuhan's lockdown moderately reduced the basic reproduction rate (R_0) from 2.65 to 1.98 (each person infects 2-3 people by the time the infection is over). It is also predicted that with the implementation of the hard city lockdown in the first 7 days, the total number of infected people will be reduced by 72%. Delaying 1 – 6 days would expand the epidemic size by even 5-times, while with 7 days of postponing lockdown implementation, the epidemic would be out of control.^[35]

In another study by Ai *et al.* showed that as a result of a complete lockdown, it would decrease 687 and 1420 items in 1 and 2 days, respectively. Moreover, if this lockdown

is postponed for 1 and 2 days, we will have 722 and 1462 new cases, respectively.^[36]

Limitation

The limitation of the present study was the existence of studies in languages other than English.

Conclusion

Health and non-health authorities and officials around the world have now comprehend that the case of Corona virus COVID-19 is different from other infectious diseases such as the flu and it is very serious. We don't have vaccines, drugs, or treatments, and the only way to control the disease is to change individuals' behavior and lifestyle. However, the effective use of the mentioned approaches requires adequate knowledge about the disease, its ways of transmission, its mortality rate, its consequences on the health system, the health sector capacity, economic status, public co-operation, integration of countries' political systems, population size, population density, especially in communicable diseases which can be transmitted via the respiratory system. The world experience has shown that quick action and suppressive approaches are more effective and do not in any way recommend slowing down or mitigation approach to controlling and inhibiting the novel coronavirus disease. Some countries using the previous experiences took the appropriate approach to control the novel coronavirus disease and were successful in inhibiting the disease. Consequently, in order to bear lower costs at the national and international levels, it is recommended that countries take advantage of previous world experiences as well as the capability of the successful countries to take the appropriate approach. In addition, there are some other strategies such as, using masks, observing personal health principles like regular hand washing and non-contact of unclean hands with the face, as well as observing the public health principles such as controlling sneezing and coughing, removing personal protective equipment safely, that were not included in the category of prevention tools; however, they have a significant influence on the control of the epidemic, especially in the case of the novel coronavirus.

Acknowledgement

This study was supported by Vice Chancellor for Research and Technology, Isfahan, Iran (IR.MUI.NUREMA.REC.1400.072).

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

Received: 17 Oct 20 **Accepted:** 20 Dec 20

Published: 29 Sep 21

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