



# Changes in incidence and mortality trend due to COVID-19 in southern Iran, from 2020 to 2021: based on Cochran–Armitage trend test

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## Abstract

**Background** In 2020, COVID-19 spread rapidly in Iran and other parts of the world. Some of the epidemiological aspects of this disease remain unknown; therefore, the present study was designed with the aim of determining the trend of incidence and mortality of COVID-19 from February 2020 to July 2021 in southern Iran.

**Methods** The present study was a cross-sectional analytical study that included all people who had COVID-19 in the period from February 2020 to July 2021 and whose information had been registered in the Infectious Diseases Center of Larestan city and MCMC unit. The study area included the cities of Larestan, Evaz, and Khonj, located in the south of Fars province in southern Iran.

**Results** Since the emergence of COVID-19 until July 2021, a total of 23,246 new cases of infection were reported in the southern region of Fars province. The average age of patients was  $39.90 \pm 18.30$  years and the range of ages varied from 1 to 103 years. The results of the Cochran–Armitage trend test showed that the trend of the disease in 2020 was completely upward. The first positive case of COVID-19 was recorded on February 27, 2020. The incidence curve in 2021 is sinusoidal, but in general, the results of the Cochran–Armitage trend test showed that the incidence of the disease increased significantly ( $P$ -trend < 0.001). Most cases were reported in July, April, and the end of March.

**Conclusion** In general, the incidence rate of COVID-19 has varied sinusoidally from 2020 to mid-2021. Although the incidence of the disease increased, the number of deaths has fallen. It seems that the increase in the number of diagnostic tests and the implementation of the national COVID-19 immunization program have been effective in changing the trend of the disease.

**Keywords** COVID-19 · Incidence rate · Mortality · Iran

## Introduction

In December 2019, several cases of pneumonia of unknown etiology were seen in Wuhan, Hubei Province, China, which were later identified as being caused by a beta-coronavirus (Delam et al. 2022; Xie and Chen 2020). These patients had an epidemiological link to an extensive seafood market (Rothan and Byrareddy 2020). This virus is a common human–animal coronavirus that is highly genetically similar (96.3%) to the RaTG13 bat coronavirus (Paraskevis et al. 2020). This is not the first time that a coronavirus has created an epidemic and threatened global health (Di Gennaro et al. 2020). This is the third case of coronavirus pneumonia in the world in the past 20 years. For the first time in 2002, a beta-coronavirus caused acute respiratory syndrome coronavirus (SARS-CoV) in China and led to 8000 infections and 774 victims in 37 countries.

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Again in 2012, it gave rise to the Middle East Respiratory Syndrome (MERS-CoV) virus, which was discovered in Saudi Arabia, with 2494 infections and 858 deaths (De Wit et al. 2016; Otuonye et al. 2020).

After China, COVID-19 spread rapidly around the world and covered all continents and regions worldwide (Lai et al. 2020). The first confirmed case of COVID-19 outside of China was found on January 13, 2020, in Bangkok, Thailand (Di Gennaro et al. 2020). Italy, the United States of America, Iran, Turkey, Canada, South Korea, and Brazil are the countries which, in addition to China, have faced a major epidemic of this disease (Antonelli et al. 2020). Two risk factors can be mentioned for the spread of COVID-19, one is traveling to an area with a history of infection in the community in the past 14 days, and the other is having close relationships with people infected with the virus (Antonelli et al. 2020). This disease began in Iran on February 19, 2020, in the city of Qom in the center of Iran, and after a short period of time, it spread widely across all provinces (Salimi et al. 2020). The World Health Organization has declared that COVID-19 is a recognized public health concern. This epidemic is the sixth public emergency of international concern after H1N1 (2002), polio (2014), Ebola in West Africa (2014), Zika (2016), and Ebola in the Democratic Republic of Congo (2019) (Bazrafshan et al. 2020a, b; Delam and Eidi 2020). COVID-19 causes severe respiratory tract infections in humans. The most common symptoms at the beginning of the disease are fever, cough, shortness of breath, and fatigue. In addition, according to the results of the computed tomography (CT) diagnostic test, it was shown that there was abnormality and turbidity in the chest of all patients (Lake 2020; Zhai et al. 2020). Underlying diseases such as obesity, high blood pressure, diabetes, cardiovascular diseases, and chronic obstructive pulmonary disease (COPD) can affect the progression of the disease and the resulting weakness (Antonelli et al. 2020; Kang et al. 2020; Park et al. 2020). In the first days of the onset of the disease, the mean incubation period of the disease was 5.2 days (It varied from 1 to 19 days.) (Bulut and Kato 2020; Wilder-Smith and Freedman 2020). One of the classic public health measures to contain the epidemic of this disease was quarantine and social distancing (Wilder-Smith and Freedman 2020). In the wake of the pandemic, China imposed one of the largest lockdowns in history, including shutting down public transportation such as buses, trains, ferries, and airports (Zhai et al. 2020). In Iran, schools, educational institutions, and religious places were closed, gatherings were stopped, and a travel ban was imposed (Salimi et al. 2020).

Epidemiological investigation of diseases can play a valuable role in controlling epidemics and provide solid evidence to health policymakers so that they can plan timely and effectively to control epidemics. In this study, the researchers intend to comprehensively investigate the epidemiological aspects of

COVID-19 in southern Iran in the period of February 2020 to July 2021.

## Methods

### Type of study

The present study was a cross-sectional analytical study.

### Study group

This study included all people who had COVID-19 in the period from February 2020 to July 2021 whose information had been registered in the Infectious Diseases Center of Larestan city and MCMC unit.

### Study area

The study area included the cities of Larestan, Evaz and Khonj, which are located in the south of Fars province, in the south of Iran. According to the latest population statistics registered in the apple system of the Ministry of Health, Treatment and Medical Education of Iran, the covered population in these three cities is approximately 272,000 people. In terms of climate, Larestan, Evaz, and Khonj are considered as arid regions, and the average annual rainfall in these regions from 2003 to 2010 was approximately 151.8 mm (Bazrafshan et al. 2020a, b). Larestan city is the largest city in the province of Fars in terms of area, which is located in the southern part of this province (Delam et al. 2020).

### Ethical considerations

During all stages (completing a checklist and entering data into the software), the patients' information was kept confidential.

### Data collection

The researchers investigated all records of COVID-19 cases in the Centre for Communicable Diseases of Larestan between February 2020 and July 2021 from daily visits. This center records data pertaining to three cities in the south of Fars province: Larestan, Evaz, and Khonj.

### Statistical analysis

After completing the checklists, the data were entered into SPSS, version 25. Descriptive and analytical statistics of the variables are represented by tables and figures. Frequency (percentage) was used to measure qualitative variables. The trend of COVID-19 incidence during these years was

analyzed using the Cochran–Armitage trend test. A *P*-value less than 0.05 was considered significant.

## Results

### Descriptive statistics

#### New cases

Since the appearance of COVID-19 until July 2021, a total of 23,246 new cases of infection were reported in the southern region of Fars province. The mean age of patients was  $39.90 \pm 18.30$  years and the range of ages varied from 1 to 103 years. Most cases were female (50.2%), but there was no significant difference between men and women in terms of contracting the disease. Approximately 1351 cases (5.8 %) of all patients were admitted to the hospital due to worsening of their physical condition. Only 12.9% of patients had an underlying disease, and the majority of cases were residents of urban areas (Table 1).

#### Mortality

A total of 343 people died due to COVID-19. The mean age of the deceased was approximately  $70.94 \pm 16.95$  years. The majority of deceased cases were men (58.9%). In terms of nationality, 94.8% of the deceased were Iranian and 5.2% were Afghan, and 66.8% had one or more underlying diseases (Table 2).

**Table 1** Descriptive statistics of COVID-19 cases in the period from 2020 to July 2021

Variables	Descriptive statistics
Age, mean $\pm$ SD*	39.90 $\pm$ 18.30
Gender, n (%)	
Male	11566 (49.80)
Female	11680 (50.20)
Patient status, n (%)	
Hospitalization	1351 (5.80)
Outpatients	21985 (94.20)
Contact with positive patient, n (%)	
Have	4134 (17.80)
Do not have	19112 (82.20)
Underlying disease, n (%)	
Have	3004 (12.90)
Do not have	20242 (87.10)
Place of residence, n (%)	
City	15676 (67.40)
Village	7570 (32.60)

\*Standard deviation

**Table 2** Descriptive statistics of deaths caused by COVID-19 in the period from 2020 to July 2021

Variables	Descriptive statistics
Age, mean $\pm$ SD	70.94 $\pm$ 16.95
Gender, n (%)	
Male	202 (58.90)
Female	141 (41.10)
Nationality, n (%)	
Iranian	325 (94.80)
Afghan	18 (5.20)
Underlying disease, n (%)	
Have	229 (66.80)
Do not have	114 (33.20)

## Trends

### Incidence in 2020

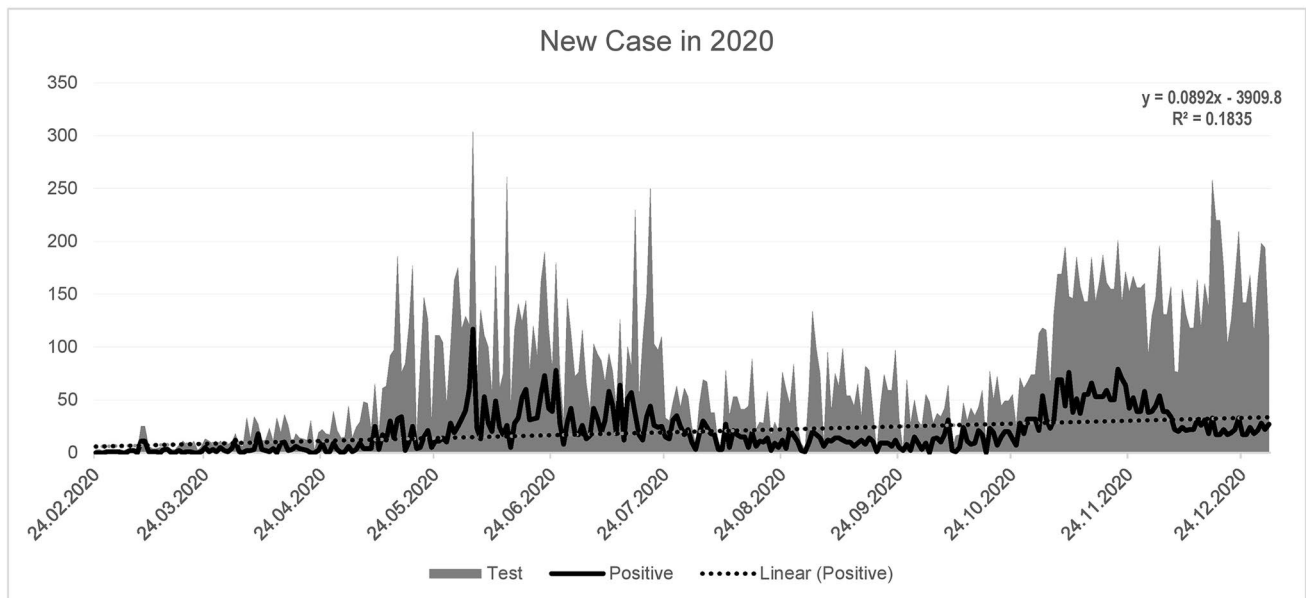
The results of the Cochran–Armitage trend test showed that the trend of the disease in 2020 was completely upward. The first positive case of COVID-19 was recorded on February 27, 2020. Over time and with the increase in the number of diagnostic tests, on June 03, the highest number of newly identified cases of COVID-19 were recorded. In general, we saw widespread epidemics in these areas in June and July. From the beginning of August to the end of October, the cases showed a significant decrease, but again in November, the cases increased rapidly. In general, the incidence of COVID-19 increased significantly in 2020 (*P*-trend < 0.001) (Fig. 1).

### Incidence in 2021

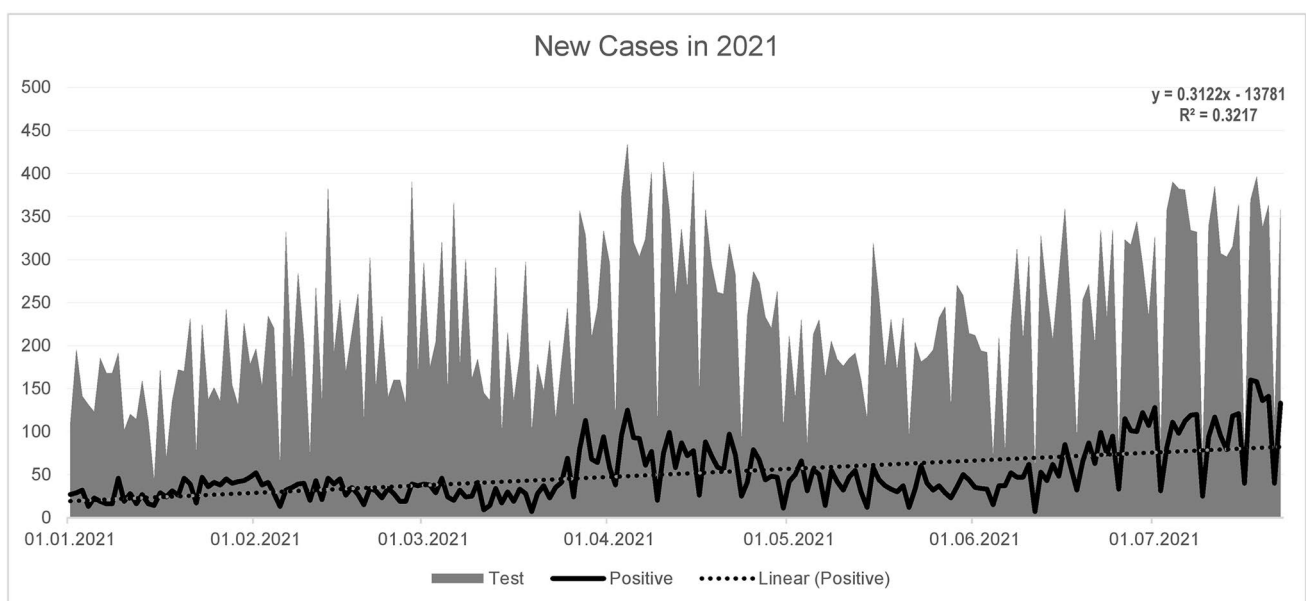
With the increase in diagnostic tests, especially rapid diagnostic tests, positive cases also increased. With the increase in diagnostic tests, especially rapid diagnostic tests, positive cases also increased. The incidence curve in 2021 is sinusoidal, but in general, the results of the Cochran–Armitage trend test showed that the incidence of the disease has increased significantly (*P*-trend < 0.001). Most cases were observed in July, April, and late March (Fig. 2).

### Mortality in 2020

The first death due to the disease was recorded on March 21, 2020. The highest number of deaths was reported on August 15. The results of the Cochran–Armitage trend test



**Fig. 1** Changes in the incidence of COVID-19 in southern Iran in 2020



**Fig. 2** Changes in the incidence of COVID-19 in southern Iran in 2021

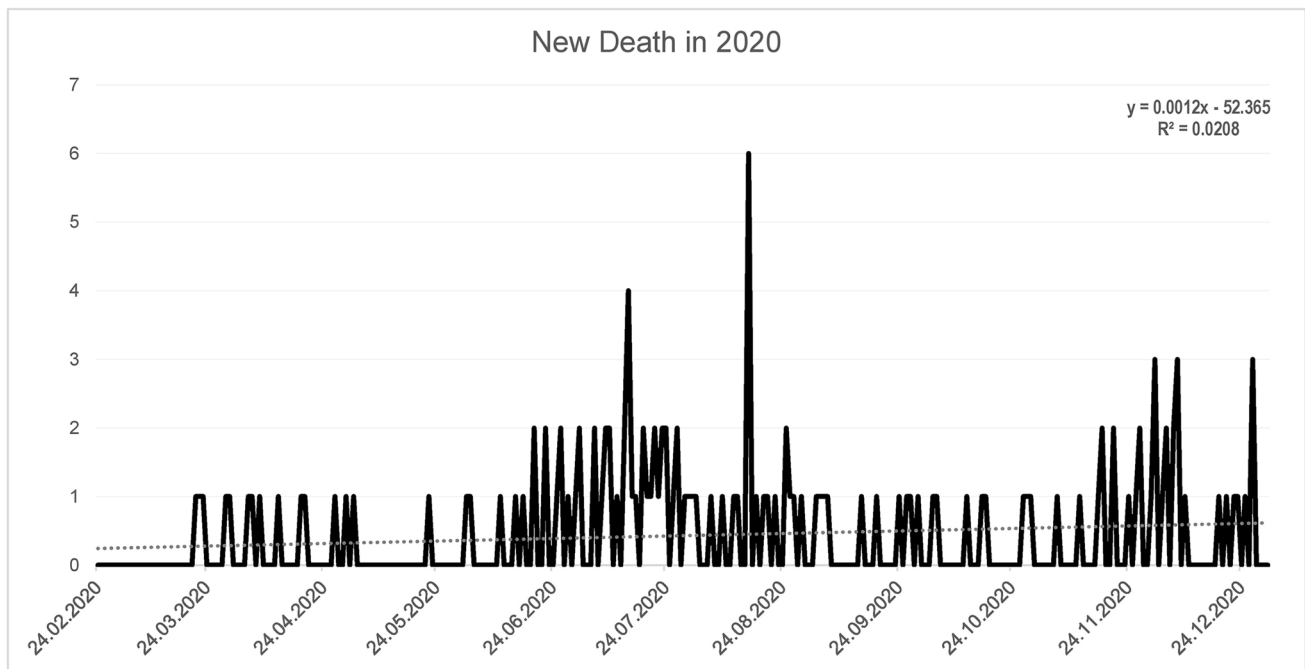
for mortality in 2020 showed that mortality due to COVID-19 increased significantly ( $P$ -trend < 0.001) (Fig. 3).

#### Mortality in 2021

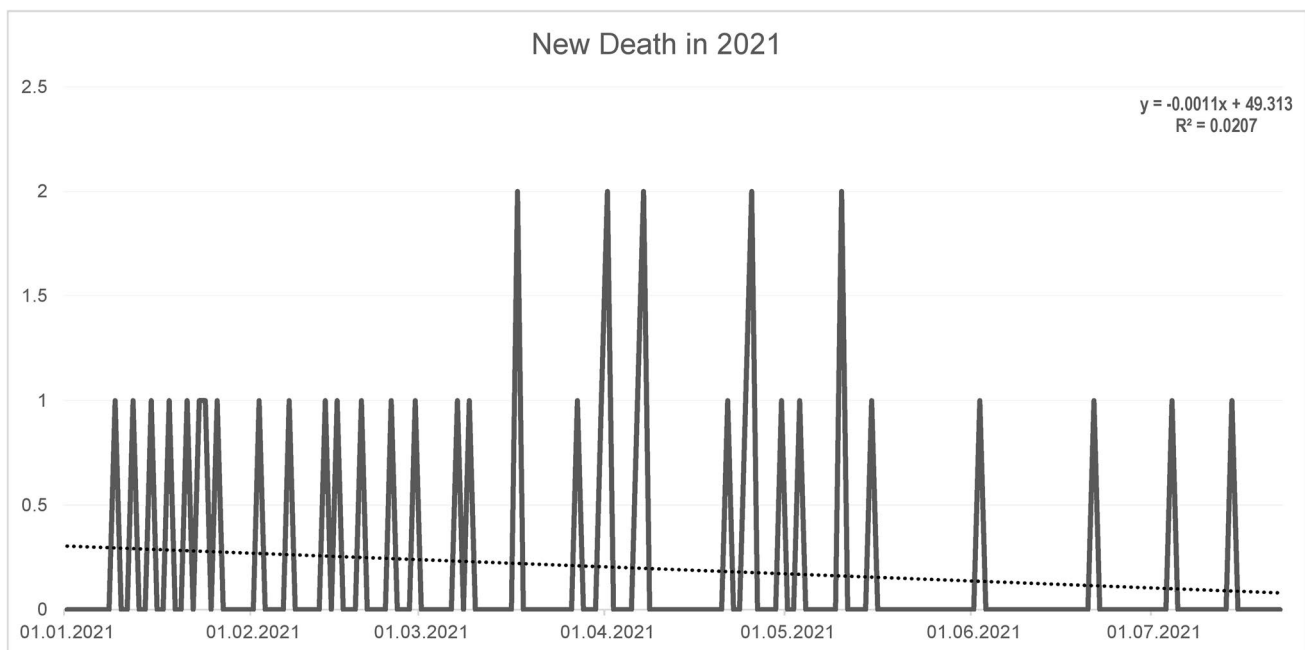
The first death in 2021 was observed on January 9. Contrary to the trend of deaths in 2020, in 2021 the trend of deaths was decreasing ( $P$ -trend = 0.518) (Fig. 4).

#### Discussion

The present study was designed with the aim of identifying the epidemiological characteristics of COVID-19 in the southern region of Fars province in southern Iran. The results of the study showed that women were more often infected with COVID-19 than men, although this percentage was not statistically significant. Gomes et al.



**Fig. 3** Changes in the mortality of COVID-19 in southern Iran in 2020



**Fig. 4** Changes in the mortality of COVID-19 in southern Iran in 2021

(2021), as well as Tan et al. (2021), reported in their studies that women were more affected than men. It seems that the higher percentage of the disease in women is due to the fact that more women go to health-treatment centers to receive health care, and this causes the disease to be diagnosed in them earlier. In our study, men accounted for 58.90% of all deaths, showing men had higher mortality despite the lower incidence rate. Studies by Li et al.

(2020), Rajabinejad and Asgarian-Omran (2021), Chen et al. (2020), Ejaz et al. (2021), and the report of the Epidemiology Working Team of the Chinese Center for Disease Control and Prevention (Team 2020) also reported a higher mortality rate in men. These statistics can be due to the fact that there are more ACE2 receptors in the lungs and hearts of men and people with heart disease, diabetes, and high blood pressure (these diseases are also more

common in men) and this makes them more vulnerable to some diseases, including COVID-19 (Sama et al. 2020). Of course, in this statistical difference, sex hormones and the adaptive immune system may also play a significant role because the testosterone hormone in men suppresses the immune system, and the sex hormone estrogen helps women to fight viral infections (Jaillon et al. 2019; Klein et al. 2015; Salciccia et al. 2021). Also, women's adaptive immune system has more CD4+ T cells (Abdullah et al. 2012). It seems that usually men go to health centers when the disease has progressed, and they have serious problems (Banks 2001). In 2020, the highest incidence occurred between May to July and from November to September. The incidence rate of COVID-19 in general in Iran also increased very rapidly between November 1 and December 30, 2020, so that the number of patients reached 1,200,000 from about 600,000 (Leite Junior et al. 2019). In the period from May to July 2020, there were events such as Muslim holidays and Ramadan, when people go to visit relatives and religious gatherings. Also, the closeness of the Nowruz holiday date to this period and the fact that weddings in these areas often take place during the period of Nowruz until the end of June may also explain this increasing trend in the incidence rate. The high incidence of the disease between September and November may also be due to the cold weather and gathering of people in homes, which can increase contacts and cause an outbreak of the disease. On the other hand, during this interval, the incidence of viral diseases such as influenza increases, which can lead to a decrease in the strength of the immune system and make people susceptible to other infections, including COVID-19. In 2020, the highest number of deaths was reported on August 15. The results of the 2020 Cochrane–Armitage mortality trends test showed that deaths due to COVID-19 had an upward trend, which may be because there were not many strategies to treat, control, and prevent the disease and the extent and availability of diagnostic kits was also limited. Contrary to the trend of deaths in 2020, in 2021 the trend of deaths was decreasing.

It seems that the downward trend of the disease in 2021 was due to the ease and extent of access to diagnostic tests for COVID-19 (identifying the disease earlier and in the early stages), more experience of health professionals, and vaccination against COVID-19.

## Limitations of the study

One of the major limitations of the study was the lack of access to the clinical information of COVID-19 patients, which could help in identifying the epidemiological status of the disease. Also, another limitation of the study was the high number of missing data, which forced us to remove some variables.

## Conclusion

In general, the incidence rate of COVID-19 varied sinusoidally from 2020 to mid-2021. Although the incidence of the disease increased, the number of deaths has fallen. It seems that the increase in the number of diagnostic tests and the implementation of the national COVID-19 immunization program have been effective in changing the trend of the disease. Therefore, it seems that educating the community in the field of health care and equipping the diagnostic centers for COVID-19 with more advanced diagnostic tests can help in early diagnosis of the disease and reducing severe cases. Also, the continuous implementation of the vaccination program can greatly reduce the incidence of disease or death caused by it. The trend of the disease shows that there is a possibility of an epidemic at any moment of time; therefore, it is still necessary for the health and medical personnel to be prepared and for the people to follow the health guidelines.

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**Authors' contributions** HD and BR: designed the study. ASH, ArE, KhS, and RSh: screened and analyzed the data. HD, BZ, and ZK: drafted the manuscript. HD, ASH, and MA: critically revised the text of the manuscript. All authors read and approved the final manuscript.

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## Declarations

**Ethical approval and consent to participate** The present study with the code of IR.LARUMS.REC.1400.003 was approved by the ethics committee of Larestan University of Medical Sciences. Patient information remained confidential throughout the study.

**Ethical considerations** During all stages (completing a checklist and entering data into the software), the patients' information was kept confidential.

**Consent to participate** Not applicable.

**Consent for publication** Not applicable.

**Conflict of interest** There is no conflict of interest.

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