Original Article

A Cross-Sectional Comparative Study of Morbidity and Mortality of COVID-19 Disease in four Cities of Northern Khorasan Province using Ratio of Coefficient of Variation

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Abstract

Background: In December 2019, the spread of a new infectious disease was reported in Wuhan, caused by a new coronavirus named COVID-19 by the World Health Organization. This study aims to compare the dispersion of COVID-19 disease among four Iranian cities in North Khorasan named Bojnord, Farooj, Jajarm, and Shirvan.

Materials and Methods: This cross-sectional study includes information about the daily morbidity and mortality of COVID-19 in 1124 patients from March to May 2021. The analysis of variance method, Scheffe *post hoc* technique and Leven's test are used to compare the means and the variances of daily morbidity and mortality of these cities. Finally, the coefficients of variation (CVs) of the morbidity and mortality are compared.

Results: The means of daily morbidity in Bojnord, Farooj, Jajarm, and Shirvan cities are 6.387, 0.946, 1.150, and 2.193, respectively. Furthermore, the means of daily mortality in Bajnourd, Farooj, Jajarm, and Shirvan are 0.763, 0.193, 0.161, and 0.290, respectively. The means and the variances of both daily mortality and morbidity are significantly different in all four cities ($P < 0.05$). Furthermore, CVs of daily morbidity in the cities of Bojnord, Farooj, Jajarm, and Shirvan are 0.665, 1.026, 1.032, and 0.787, respectively. The CVs of daily mortality in these cities are 1.196, 2.052, 2.468, and 1.728, respectively. The CVs of both daily mortality and morbidity are significantly different in all four cities ($P < 0.05$).

Conclusion: The ratio of CVs is a good option for comparing the spread of COVID-19 in different regions with different means and variances.

Keywords: Cross-sectional study, COVID-19, morbidity, mortality, Iran, multiphasic screenings, ratio, risk, research design

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Introduction

By early 2020, the world stepped into an unexpected crisis known as the corona crisis or COVID-19, starting in Wuhan, China. Coronavirus disease or COVID-19 is a contagious respiratory illness disease caused by acute respiratory (SARS-CoV-2) syndrome.[1] This disease initiated the 2019 coronavirus pandemic and infected millions of people around the world. Infected people with coronavirus commonly show symptoms such as fever, cough, shortness of breath, and in some cases, the loss of smell. Reports also show other less common symptoms as follows: sore muscles, sputum, sore throat, tastelessness, and red eyes. Although most infected cases show mild symptoms, some cases progress to pneumonia and multiple organ failure with an approximate daily mortality rate between 1% and 5%, this number varies with age and other underlying health conditions.[2] The disease is mainly transmitted to other people

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through the respiratory droplets of infected people when they cough or sneeze. The time between exposure to the disease and the onset of symptoms is between 2 and 14 days. Preventative measures such as washing hands and other hygiene measures can stop the virus's transmission and spread.[3]

According to the literature, to explain a data set (random variable), three fundamental traits contain central tendencies, shape tendencies, and dispersion tendencies. In other words, three essential criteria are introduced to summarize a set of data; criteria for central, dispersion, and shape. One of the tools related to dispersion tendency is the coefficient of variation (CV). CV is obtained by dividing the mean population's standard deviation, CV = σ/μ, an applicable and suitable statistic for evaluating relative variability. This statistic is used to compare the dispersion of several groups of data collected with different units of measurement.[4] CV is a free parameter used in many sciences such as agriculture, biology, engineering, finance, medicine, and many others to indicate reliability or variability.[5-7] In many cases, relating standard deviation to the level of measurement is of great importance to researchers. For this reason, CV is widely used to measure dispersion. Researchers are interested in better understanding the structure and shape of data. Therefore, they use the CV to compare their CVs to compare the dispersions of populations. If the means or variances of the two populations are the same, analysis of variance (ANOVA) and Leven's tests can be used to examine the equality of the population's CVs.[8] In practice, the researchers may intend to compare the parameters of two independent populations; for example, proportions,[9] means,[10] variances,[11] correlations,[12] skewnesses.[13] In most comparative tests, the difference between the sample coefficients is used. However, the statistics obtained from the difference between the sample's coefficients are not very useful because the difference between the two coefficients may be slight and not very noticeable and therefore do not have a clear and definite interpretation. While if we use the ratio of two CV, a better result can be obtained. For example, suppose that in two populations, the CV is 0.1 and 0.01, respectively. Their difference is a small amount of 0.09, but their ratio is a relatively large amount of 10.[14] Yue and Baleanu[15] used asymptotic methods to test the hypothesis and construct the confidence interval about two CVs' ratios.

This study aimed to investigate the dispersion value of daily morbidity and mortality due to COVID-19 in 4 cities of Bojnord, Farooj, Jajarm, and Shirvan in North Khorasan province. For this purpose, the index ratio of coefficients of variation has been used. This method has been used due to its advantages compared to the "difference coefficients of variation" index.

Materials and Methods

For this study, a dataset containing COVID-19 disease in Northern Khorasan province has been used along with different statistical methods. Furthermore, in this article, software R 3.3.2 is used. Only the Stat package is used and programming is written in all sections. The full description of both cases is as below.

Data

The data used in this study were extracted from the "Syndromic Care System against COVID-19" under the supervision of the Department of Infectious Diseases of Iran's Ministry of Health. The dataset includes information about the daily morbidity and mortality of coronavirus (COVID-19) in four Iranian cities (Bojnord, Farooj, Jajarm, and Shirvan), starting from March to the end of May. The source of information includes Northern Khorasan University of Medical Sciences and hospitals under this university's supervision, shown in Table 1. Table 1 is in the appendix.[16]

Statistical methods

ANOVA

ANOVA method is one of the statistical methods used to study the difference between several populations' means. Here, the ANOVA method has been used to investigate the significant difference between the means of daily morbidity and mortality of COVID-19 in Bojnord, Farooj, Jajarm, and Shirvan cities. Different methods, such as Scheffe's method, can be used for pairwise comparisons.

Leven's test

One of the inferential methods for comparing the variances in several independent populations is Leven's statistic and performing a test called "Levene's Test." This test was used and examined to compare the equality of variances of daily morbidity and mortality of COVID-19 in four cities in pairs. The same method was used to compare the equality of mortality variances. Different methods, such as Scheffe's method, can be used to compare the means more accurately. Furthermore, the question of which difference of means between the two cities has become significant is answered by similar methods.

Ratio of coefficients of variations test

In cases where there are several populations with mean and different variances and equal CVs, the CV ratio is a good option for comparing populations' dispersion. Due to the possible minor differences of several CVs and the lack of solid interpretation, the CVs ratio is more accurate than the CVs difference. In this research, we used the method given by Yue and Baleanu. The outline of their method is as follows:

Consider the two uncorrelated variables X and Y, with nonzero means μ_X and μ_Y, respectively.

Assume two samples $X_1,\ldots, X_m$ distributed from X, and $Y_1,\ldots, Y_n$ distributed from Y.

As mentioned earlier in the introduction, the parameter of the ratio of the two CVs is as follows:

$$\gamma = \frac{CV_Y}{CV_X},$$

where CV_X is the CV of the variable X and CV_Y is the CV of the variable Y.

Table 1: The daily morbidity of coronavirus and daily mortality of coronavirus in four Iranian states (Bojnord, Farooj, Jajarm, and Shirvan) from March 2020 to May 2020

Month/day/year	Daily morbidity of coronavirus				Daily mortality of coronavirus			
	Bojnord	Farooj	Jajarm	Shirvan	Bojnord	Farooj	Jajarm	Shirvan
March 01, 2020	3	1	2	1	0	0	0	0
March 02, 2020	0	0	0	0	0	0	0	0
March 03, 2020	2	1	1	1	0	1	0	1
March 04, 2020	4	2	1	1	0	0	0	0
March 05, 2020	1	0	0	1	1	0	0	0
March 06, 2020	1	0	0	0	0	0	0	0
March 07, 2020	11	0	1	0	0	0	0	0
March 08, 2020	6	1	1	2	0	0	0	0
March 09, 2020	9	2	1	1	3	0	0	0
March 10, 2020	9	0	1	1	2	0	0	1
March 11, 2020	5	1	0	2	2	0	0	0
March 12, 2020	10	0	0	2	0	0	0	0
March 13, 2020	2	0	3	3	0	0	1	0
March 14, 2020	13	0	1	1	3	0	0	0
March 15, 2020	20	0	0	0	2	0	0	2
March 16, 2020	8	1	1	3	2	0	0	0
March 17, 2020	7	0	5	3	1	0	0	0
March 18, 2020	12	0	2	1	1	0	0	1
March 19, 2020	2	1	1	0	0	0	0	0
March 20, 2020	13	0	2	4	0	0	0	0
March 21, 2020	6	0	3	8	1	0	0	0
March 22, 2020	15	0	0	1	2	1	0	0
March 23, 2020	3	1	2	6	2	0	0	1
March 24, 2020	25	1	3	5	2	0	2	1
March 25, 2020	11	1	2	2	1	1	1	0
March 26, 2020	0	0	0	0	0	1	0	0
March 27, 2020	7	0	0	2	1	0	1	0
March 28, 2020	12	1	3	3	3	1	0	0
March 29, 2020	16	1	0	4	2	0	0	0
March 30, 2020	13	2	0	3	2	0	0	1
March 31, 2020	6	0	1	0	1	0	1	1
April 01, 2020	5	0	3	1	2	0	0	1
April 02, 2020	5	2	1	3	2	0	0	1
April 03, 2020	4	3	2	1	1	0	0	1
April 04, 2020	4	1	2	7	0	0	0	0
April 05, 2020	9	0	3	1	1	1	0	0
April 06, 2020	10	0	2	2	1	0	1	1
April 07, 2020	4	4	3	3	1	0	0	0
April 08, 2020	6	0	5	3	0	0	0	0
April 09, 2020	5	0	1	1	0	1	1	1
April 10, 2020	2	0	2	4	0	0	0	0
April 11, 2020	3	1	1	0	0	0	0	0
April 12, 2020	4	0	2	5	2	0	0	0
April 13, 2020	3	1	1	1	0	0	1	0
April 14, 2020	7	2	0	1	1	0	0	0
April 15, 2020	6	0	0	4	0	0	0	0
April 16, 2020	2	1	2	2	0	0	0	1
April 17, 2020	1	0	2	2	0	0	0	1
April 18, 2020	6	3	1	0	0	0	0	0
April 19, 2020	5	1	0	1	0	1	0	1
April 20, 2020	8	0	0	3	1	0	0	1

Contd...

Table 1: Contd...

Month/day/year	Daily morbidity of coronavirus				Daily mortality of coronavirus			
	Bojnord	Farooj	Jajarm	Shirvan	Bojnord	Farooj	Jajarm	Shirvan
April 21, 2020	5	0	0	1	0	0	0	0
April 22, 2020	7	1	0	2	0	0	0	0
April 23, 2020	6	3	0	1	0	0	1	0
April 24, 2020	3	1	0	1	0	0	0	0
April 25, 2020	3	0	4	1	0	0	0	0
April 26, 2020	3	0	2	1	0	0	0	0
April 27, 2020	2	0	2	4	0	0	0	0
April 28, 2020	2	0	1	1	0	0	0	0
April 29, 2020	8	1	0	2	0	0	1	1
April 30, 2020	7	1	1	4	0	0	0	0
April 31, 2020	0	0	0	0	0	0	0	0
May 01, 2020	7	1	0	2	0	0	0	1
May 02, 2020	4	1	3	3	1	1	0	1
May 03, 2020	12	2	0	0	0	0	0	0
May 04, 2020	5	0	1	4	1	0	0	0
May 05, 2020	5	0	0	1	1	0	0	0
May 06, 2020	7	2	2	1	0	0	0	0
May 07, 2020	8	0	0	2	1	0	0	0
May 08, 2020	3	1	1	0	2	0	0	1
May 09, 2020	3	3	2	1	2	1	0	0
May 10, 2020	5	1	3	2	2	0	1	0
May 11, 2020	14	0	0	2	0	0	0	0
May 12, 2020	5	1	0	4	1	0	0	0
May 13, 2020	7	2	1	1	3	0	0	0
May 14, 2020	7	2	0	2	0	0	1	1
May 15, 2020	4	1	0	2	1	0	1	0
May 16, 2020	3	1	2	1	0	1	0	0
May 17, 2020	10	1	1	5	1	1	0	1
May 18, 2020	5	2	0	3	0	1	0	0
May 19, 2020	6	2	2	1	2	1	0	0
May 20, 2020	9	1	0	3	0	0	0	0
May 21, 2020	7	2	0	3	0	1	0	0
May 22, 2020	5	3	2	2	1	0	0	0
May 23, 2020	5	2	1	6	0	0	0	0
May 24, 2020	3	1	0	5	2	0	0	1
May 25, 2020	8	2	0	4	0	0	0	0
May 26, 2020	9	1	1	2	0	0	1	0
May 27, 2020	5	2	2	1	1	1	0	2
May 28, 2020	7	3	1	3	0	1	0	0
May 29, 2020	4	2	0	5	2	0	0	0
May 30, 2020	8	2	1	4	1	0	0	0
May 31, 2020	7	1	1	5	0	1	0	0

Therefore, it is clear that

$$\hat{\gamma} = \frac{\hat{C}V_Y}{\hat{C}V_X}$$

Can be logically estimated the parameter γ.[15,17]

Yue and Baleanu showed

$$\hat{\gamma} - \frac{\hat{\lambda}}{\sqrt{n}} z_{\frac{\alpha}{2}}, \hat{\gamma} + \frac{\hat{\lambda}}{\sqrt{n}} z_{\frac{\alpha}{2}}$$

is a 100 (1–α)% confidence interval for the parameter γ, where

$$\lambda^2 = \frac{1}{CV_X^2}\left(\gamma^2 \delta_X^2 + \delta_Y^2\right).$$

Moreover, they showed that the test statistic

$$T_0 = \sqrt{n}\left(\frac{\hat{\gamma} - \gamma_0}{\lambda^*}\right)$$

Is a suitable statistic to test H_0: $\gamma=\gamma_0$, where

$$\lambda^{*2} = \frac{1}{\hat{C}V_X^2}\left(\gamma_0^2 \hat{\delta}_X^2 + \hat{\delta}_Y^2\right).$$

Yue and Baleanu proved that the asymptotic distribution of T_0 is standard normal.

Multiple testing

Multiple testing is the situation when we wish to investigate many hypotheses simultaneously.[18-21]

Multiple testing occurs when a statistical analysis consists of several simultaneous statistical tests, each of which can produce a "discovery" from a similar or dependent dataset. The stated confidence level is usually considered for each test only, but it is often desirable to have a confidence level for the whole family of simultaneous tests.[21] Failure to compensate for multiple comparisons can have significant real-world consequences. For example, if a test is performed at the 5% level and the corresponding null hypothesis is correct, there is only a 5% chance of rejecting the null hypothesis. However, if 100 tests are performed and all the corresponding null hypotheses are correct, the Type I errors is 0.05. If the tests are statistically independent of each other, the probability of at least one incorrect rejection is 99.4%.[20,21]

As mentioned above, we can then generalize the results to the equality of the CV of several communities using different methods of multiple tests such as Bonferroni Q-value and FDR. These tests are simple methods based on *P* value values and do not require a normality condition. In the Bonferroni method, if we have *M* test, then the *P* values are arranged based on the larger-sized order and multiplied by the number of tests, i.e. *M*. Now, the null hypothesis of number i is rejected if only if $M*P_i < \alpha$. That is, α is divided by *M*, and in fact, we use $\frac{\alpha}{M}$ in the ionferon method.[21] The local FDR (LFDR) is the probability that the hypothesis comes from the null at a specific value of the statistic.[20] The Q-value provides a means to control the positive false discovery rate (pFDR).[22] Just as the *P* value gives the expected false-positive rate obtained by rejecting the null hypothesis for any result with an equal or smaller *P* value, the Q-value gives the expected pFDR obtained by rejecting the null hypothesis an equal or smaller Q-value.[20,22]

To test the equality of the CVs of populations, we must test the null hypothesis

H_0:$\gamma_2=\gamma_3=\ldots=\gamma_k = 1$,

where

$$\gamma_i = \frac{CV_1}{CV_i},\ i = 2,\ldots,k.$$

Results

Descriptive statistics

As mentioned earlier, the present study is to compare daily morbidity and mortality from 4 cities (Bojnord, Farooj, Jajarm, and Shirvan) in Northern Khorasan Province. Table 2 summarizes the dataset's descriptive statistics containing the means, the standard deviations, and the CVs. It can be observed that Farooj and Bojnord have the minimum and the maximum daily morbidity of coronavirus. Furthermore, Jajarm and Bojonord have the minimum and the maximum daily mortality of COVID-19. It can be seen that the means of daily morbidity in Bojnord, Farooj, Jajarm, and Shirvan cities are 6.387, 0.946, 1.150, and 2.193, respectively. Furthermore, the means of daily mortality in these cities are 0.763, 0.193, 0.161, and 0.290, respectively. The standard deviations of daily morbidity in Bojnord, Farooj, Jajarm, and Shirvan are 4.250, 0.970, 1.188, and 1.727, respectively. Furthermore, the standard deviations of daily mortality in these cities are 0.913, 0.397, 0.399, and 0.501, respectively. Finally, it is observed that the CVs of daily morbidity in the cities of Bojnord, Farooj, Jajarm, and Shirvan are 0.665, 1.026, 1.032, and 0.787, respectively. Besides, the CVs of daily Mortality in these cities are 1.196, 2.052, 2.468, and 1.728, respectively.

Variance comparison

To compare the variances of daily mortality and morbidity in cities studied, Leven's test was used. Table 3 summarizes

Table 2: The descriptive statistics about the daily morbidity of coronavirus and daily mortality of coronavirus in four Iranian cities (Bojnord, Farooj, Jajarm, and Shirvan) from March to May of 2020

State	Number of population	Mean	SD	CV
Daily morbidity of coronavirus				
Bojnord	594	6.387	4.250	0.665
Farooj	88	0.946	0.970	1.026
Jajarm	107	1.150	1.188	1.032
Shirvan	104	2.193	1.727	0.787
Daily mortality of coronavirus				
Bojnord	71	0.763	0.913	1.196
Farooj	18	0.193	0.397	2.052
Jajarm	15	0.161	0.399	2.468
Shirvan	27	0.290	0.501	1.728

SD: Standard deviation, CV: Coefficients of variation

Table 3: Leven's tests for daily morbidity and mortality from COVID-19 in four Iranian cities (Bojnord, Farooj, Jajarm, and Shirvan) from March 2020 to May 2020

City	SD	
	Daily morbidity	Daily mortality
Bojnord	4.250[c]	0.913[c]
Farooj	0.970[a]	0.397[a]
Jajarm	1.188[a]	0.399[a]
Shirvan	1.727[b]	0.501[b]

*The cities with different letters have significant difference ([a]Low, [b]Medium, [c]High). SD: Standard deviation the results. As it can be seen, the variances of both daily mortality and morbidity are significantly different in all four cities ($P < 0.05$).

The results indicate that the dispersions of daily morbidity and mortality in Farooj and Jajarm are significantly less than in Shirvan ($P < 0.05$). Moreover, the dispersions of daily morbidity and mortality in Shirvan are significantly less than in Bojnord ($P < 0.05$). Furthermore, there are no significant differences between the dispersions of both daily morbidity and mortality in Farooj and Jajarm ($P > 0.05$).

Mean comparison

To compare the means of daily mortality and morbidity in cities studied, an ANOVA test was used. Table 4 summarizes the results. As it can be seen, the means of both daily mortality and morbidity are significantly different in all four cities. The *P* value of the ANOVA in the daily morbidity variable is <0.05. The *P* value of the ANOVA in the daily mortality variable is also <0.05. Therefore, the hypothesis of the means of four cities in the daily morbidity and mortality variables is rejected.

The results indicate that the means of both daily morbidity and mortality in Farooj and Jajarm are significantly less than in Shirvan ($P < 0.05$). Moreover, the means of both daily morbidity and mortality in Shirvan are significantly less than in Bojnord ($P < 0.05$). Furthermore, there are no significant differences between the means of both daily morbidity and mortality in Farooj and Jajarm ($P > 0.05$).

Table 4: ANOVA and Scheffe test results for daily morbidity and mortality from COVID-19 in four Iranian cities (Bojnord, Farooj, Jajarm, and Shirvan) from March 2020 to May 2020

City	Mean	
	Daily morbidity	Daily mortality
Bojnord	6.39[c]	0.760[c]
Farooj	0.95[a]	0.190[a]
Jajarm	1.15[a]	0.160[a]
Shirvan	2.19[b]	0.290[b]
P of ANOVA	<0.001	<0.001

*The cities with different letters have significant difference ([a]Low, [b]Medium, [c]High)

Coefficients of variation comparison

Yu gave the method, and Baleanu was used to compare the CVs of daily mortality and morbidity in cities studied. Table 5 summarizes the results. We observe that all the Q-values and LFDR values are <0.05. Therefore, the null hypothesis H_0: $\gamma_2 = \gamma_3 = \gamma_4 = 1$ is rejected at the size 0.05 by this method. Therefore, the CVs of both daily morbidity and mortality are significantly different in all four cities.

The results in Table 6 indicate that the CVs of both daily morbidity and mortality in Farooj and Jajarm are significantly less than in Shirvan ($P < 0.05$). Moreover, the CVs of both daily morbidity and Mortality in Shirvan are significantly less than in Bojnord ($P < 0.05$). Furthermore, there are no significant differences between the CV of both daily morbidity and mortality in Farooj and Jajarm ($P > 0.05$).

Discussion

The present study was performed to compare the prevalence of daily mortality and morbidity of COVID-19 disease in 4 cities of Bojnord, Farooj, Jajarm, and Shirvan from Northern Khorasan province. For this purpose, the "ratio of coefficient of variation" statistic was used.

The data used in this study, due to having independent populations, to better understand the structure of the data and examine the value of the dispersion of daily morbidity and mortality, suggests the use of the ratio of CVs. The analysis also confirmed that the ratio of CVs is better and more accurate than the "difference between coefficients of variation."

In this study, the method introduced by Yue *et al*. was used in a large sample size. According to the hypotheses presented and the statistics specified in the article by Yue *et al*., as well as using the multiple testing methods, the ratio of CV of Bojnord to Farooj, Bojnord to Shirvan, Bojnord to Jajarm was obtained. As observed, the assumption of the equality of "coefficient of variation coefficient" in all four cities was rejected.

One of the reasons for the difference in daily morbidity of Farooj and Jajarm cities with Bojnord and Shirvan can be

Table 5: Comparison of the COVID-19 ratio of the coefficients of variations of the daily morbidity and mortality in Bojnord concerning Farooj, in Bojnord concerning Jajarm, in Bojnord respect to Shirvan from March 2020 to May 2020

Morbidity and mortality of coronavirus	Ratio of CVs	Ratio	Test statistic	*P*	LFDR	*Q*	Lower bound	Upper bound
Daily morbidity of coronavirus	Bojnord respect to Farooj	1.541	17.411	<0.001	<0.001	<0.001	1.368	1.715
	Bojnord respect to Jajarm	1.551	11.816	<0.001	<0.001	<0.001	1.294	1.809
	Bojnord respect to Shirvan	1.183	9.135	<0.001	<0.001	<0.001	0.929	1.437
Daily mortality of coronavirus	Bojnord respect to Farooj	1.714	9.898	<0.001	<0.001	<0.001	1.375	2.054
	Bojnord respect to Jajarm	2.062	4.643	<0.001	<0.001	<0.001	1.191	2.933
	Bojnord respect to Shirvan	1.444	6.959	<0.001	<0.001	<0.001	1.037	1.850

LFDRs: Local false discovery rates, CVs: Coefficients of variations

Table 6: Pairwise comparison of coefficients of variations of the daily morbidity and mortality in Bojnord concerning Farooj, in Bojnord concerning Jajarm, in Bojnord respect to Shirvan from March 2020 to May 2020

City	CV	
	Daily morbidity	Daily mortality
Bojnord	0.665[c]	1.196[c]
Farooj	1.026[a]	2.052[a]
Jajarm	1.032[a]	2.468[a]
Shirvan	0.787[b]	1.728[b]

*The cities with different letters have significant difference ([a]Low, [b]Medium, [c]High). CV: Coefficients of variation

due to the higher population in Bojnord and Shirvan cities. Bojnord city has a population of 330,000 and Shirvan has a population of 154,000, while Farooj has a population of 47,000 and Jajarm has a population of 38,000. The higher the population, the greater the chance of people being exposed indoors, and direct contact is the main route of transmission of COVID-19 disease.

In North Khorasan province, only 3 hospitals in Bojnord, Shirvan, and Jajarm have been assigned to hospitalize COVID-19 patients. Patients in Farooj and Shirvan counties are admitted to Ayatollah Hashemi Rafsanjani Hospital in Shirvan and patients in Jajarm are admitted to Jajarm Hospital, and one of the reasons for the difference in daily morbidity could be the different quality of services in these hospitals.

The validity of this method is affected by the large sample size. Therefore, in cases where a small amount of data is available, this research method's choice, i.e. the use of "ratio of coefficients of variations" will not be appropriate.

Conclusion

COVID-19 is a widespread viral disease that has affected many people around the world. The ability to compare this epidemic in cities or different treatment centers is beneficial for implementing treatment plans. One of the most accessible and most useful statistical techniques for comparing independent populations in most research areas is the CV. In many cases, it is possible to have several populations with different means and variances but with a CV. In other words, researchers may intend to examine the equivalence of CVs in different populations to understand the data structure. In this study, due to several CVs' possible minor differences and the lack of solid interpretation, the CV ratio is more accurate than the CV difference. These findings can be exploited in any situation where predictions of outcomes are needed. Our results could be applied with caution to other cities with a high sample size like these cities.

Comparing the coefficient of morbidity changes between the studied cities can help the executive officials of the health system in identifying the places where the disease is more likely to circulate in order to prevent the spread of the disease by intervening in these cities.

In the mortality debate, comparing the CV can give officials the idea to identify high-risk areas in terms of mortality and apply the necessary interventions, given the nature of the disease and the expectation of the same mortality among the cities of a province. Furthermore, to measure the effectiveness of these interventions in the cities under intervention, we can use the comparison of the CV between the cities under intervention and other cities.

For future works, the authors suggest comparing the COVID-19 datasets of more regions based on this technique or apply this technique to compare the regions for other epidemic or pandemic diseases.

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Conflicts of interest

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