

Years of life lost (YLL) associated with COVID-19 deaths in Khorasan-RAZAVI province, Iran

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ABSTRACT

Background The number of deaths among people with coronavirus disease 2019 (COVID-19) does not show the true impact of the disease on communities. Therefore, this study aimed to calculate years of life lost (YLL) due to premature death in patients with COVID-19.

Methods We performed a descriptive cross-sectional study based on data from one of the largest provinces of Iran, in the period 13 February 2020 to 17 May 2021. We used WHO proposed guidelines for the calculation of the burden of diseases to calculate the YLL among patients with COVID-19, taking into consideration gender in different age groups.

Results Findings showed that 13 628 deaths were due to COVID-19 with associated 249 309 YLL. The study reported higher mortality among men (1222 cases) in the age group over 85 years than in women (840) of the same age group. The minimum number of YLL for men was 1749 in the 5–9 years age group and that for women was 1551 years in the 14–10 years age group.

Conclusion The high number of deaths due to COVID-19 has led to high YLL due to premature death. The provision of adequate health care and appropriate policies will bring about a decrease in YLL due to COVID-19.

Keywords burden of disease, COVID-19, Iran, YLL

Background

In December 2019, a lung disease emerged in Wuhan, China, with high rates of spread and mortality. Patients affected had symptoms similar to pneumonia. On 11 March 2020, the World Health Organization declared this disease a pandemic.^{1–3} Since the beginning of the pandemic, one important issue that caught the attention of clinicians and public health professionals was the severity of the disease, which markedly affects disease prognosis, patient grading and treatment decisions. On the other hand, the direct and indirect effects of coronavirus disease 2019 (COVID-19) necessitate the provision of appropriate policy responses to minimize the short-term effects of the disease as well as its medium- and long-term damage to society.⁴

One of the key indicators considered as an input parameter for planning and policy-making against this pandemic is the mortality due to COVID-19.⁴ Although the understanding of epidemiological features of COVID-19-attributable death is hazy, studies in China^{5,6} and Italy⁷ revealed that the symp-

toms of the disease range from mild to severe. Other factors such as old age and underlying disease increase the risk of death⁸.

In another study, the death rate due to COVID-19 ranges from 0.06% in Qatar to 16.25% in Belgium.⁹ Changes in mortality rates across countries may be due to differences in the capacity of health care services or the epidemiological characteristics of patients. The frequency of diagnostic screening in asymptomatic or mildly symptomatic patients may also affect mortality.¹⁰ Also, the rapid spread of this disease and its high pathogenicity rate has led to high mortality rates.¹¹ If mortality from COVID-19 continues to rise, it could affect life expectancy. Previous epidemics such as the influenza pandemic in 1918 and the Ebola virus outbreak in 2014 reduced life expectancy in countries affected by these

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diseases.^{12,13} COVID-19 deaths in severely affected countries have resulted in significant years of life lost (YLL).¹¹ Contrastingly, with the higher prevalence of this disease in the elderly, the number of YLL is less than expected. Currently, the impact of COVID-19 on the population's life expectancy is not clear.¹⁴

Incidence, prevalence and mortality rates are commonly used to measure the impact of a disease. WHO and most countries use these indicators to report the pandemic status of COVID-19. The death rate does not reflect the YLL, therefore cannot reflect the true impact of a disease on society.¹⁵ Mortality is an incomplete measure because it does not provide insight into the age distribution of mortality or how the level of risk varies with age. Thus, the number of deaths cannot provide sufficient information about the several YLL due to disease.^{16,17} YLL estimates the years that people would have lived if they had not contracted a disease or died prematurely.^{18–21} The higher number of YLL can be due to higher mortality or mortality in younger people or both.^{17,22}

Few studies have examined the YLL due to COVID-19, considering that Iran is one of the countries that are being severely afflicted by COVID-19, and Khorasan Razavi province being one of the largest provinces in the country.

Objectives

This study aims to investigate the YLL due to premature death among patients affected with COVID-19 in the Khorasan Razavi province of Iran.

Methods

This descriptive cross-sectional study calculated the YLL due to premature death among patients with COVID-19 based on the WHO guideline for calculating the burden of diseases. This study was performed on the COVID-19 mortality data in Khorasan Razavi province, Iran. Khorasan province is one of the 31 provinces of Iran with Mashhad as its capital city. It has an area of 118 854 square kilometers and a population of 6 434 501, according to the general population and housing census (2016), making it the second-most populous province in Iran. Death data for patients with COVID-19 were recorded in the Medical Care Monitoring System (MCMC), a nationally created platform aimed to improve the processes of treatment (prehospital emergency and hospital services) and to establish effective and coordinated communication at all levels of health care services.²³ Death data for patients with COVID-19 were recorded daily in this system. The registration process was such that after announcing the

death and confirming the positive polymerase chain reaction test result for the patient, all data related to age, sex and demographic variables of the patient would be recorded immediately in the system.

The data for this study were recorded for COVID-19 patients from 13 February 2020, to 17 May 2021. After retrieving data from the system, statistical methods were used to calculate frequency, mean and standard deviation, and a box plot drawn, paying attention to the accuracy of the entered data. Missing data were identified. Finally, the data were prepared for the final analysis.

To identify the peaks of the disease outbreak based on the available data, first, a trend chart of the number of patients with the disease in the study period was drawn. Relative minimum points (lowest values of disease within the graph) were then identified. The intervals between these values were considered as the peaks of the disease outbreak. The period 13 February 2020 to 27 May 2020 was considered the first peak, 28 May 2020 to 21 September 2020 the second peak, 22 September 2020 to 11 March 2021 the third peak and 12 March 2021 to 17 May 2021 was identified as the fourth peak of the disease.

We used the standard life expectancy table published by WHO to calculate the number of YLL.²⁴ This table identifies the standard life expectancy for 19 age groups by gender from birth to over 85 years. To calculate the number of YLL, the number of deaths in each age group was multiplied by the standard life expectancy of the same age group. Finally, the number of YLL was calculated by gender and belonging to 30 different groups during the period of disease outbreak and by different peaks of the disease. All calculations were performed in Microsoft Excel 2016 software.

Results

From 21 January 2020 to 17 May 2021, out of 97 200 people with COVID-19, 13 628 died. Of these, 7854 (57%) were male and 5774 (43%) were female. The mean age of patients was 55 ± 23 . Also, the mean age of the deceased was 67 ± 18 . As shown in Fig. 1, the highest number of admissions per day was 489 cases; the highest number of males was 248, and that of females was 249 cases per day, respectively. Also, the highest number of deaths per day was 57 and 42 for men and women, respectively. A total of 490 147 days of hospitalization occurred for all patients, of which 99 199 days of hospitalization were for patients who died.

According to the findings of this study, the highest mortality was 1740 in the age group 75–79 years, 1708 death in the 80–84 years age group and 2062 deaths occurred

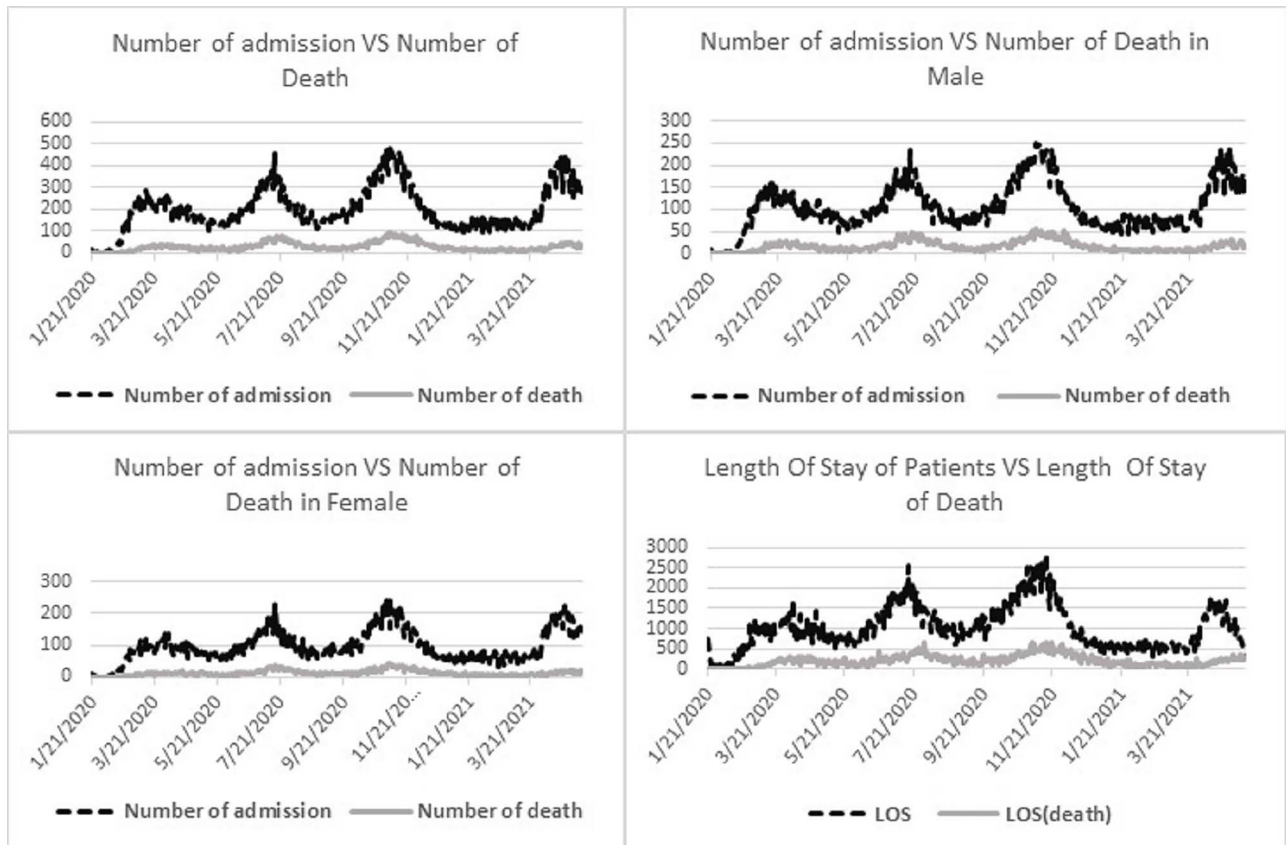


Fig. 1 Using the available data, the frequency of admission and death of Covid-19 patients were shown separately for men and women. The length of stay of patients and patients who died during the study period were also shown.

among those above 85 years of age. The highest number of deaths (1222) was in men aged over 85 years and 840 in women of the same age group. As demonstrated in Table 1, the lowest numbers of deaths were 48 in the 5–9 years age group, 49 in 10–14 years and 59 in 15–19 years age group. The lowest number of deaths was 22 in men in the age group of 14–10 years and 24 in women in the age group of 5–9 years.

We calculated the sum of 249 309 YLL and found the highest number of YLL in the age groups 55–59 (25 086), 60–64 (30 357) and 65–69 (28 108). For men, we found the highest number of YLL in the 60–64 age group with 16 844 YLL; also, the same age group recorded the highest number of YLL for women (13 513). The lowest numbers of YLL were in the age groups 5–9 (3561), 10–14 (3385) and 15–19 (3786). The lowest number of YLL for men was in the age group 5–9 with 1749 years, and for women in the age group 14–10 with 1551 years.

In our study, we evaluate the prevalence of the disease at different peaks. The highest number of deaths occurred in the third peak of COVID-19: 3314 among men and 370

among women. In all disease peaks, the highest number of mortalities occurred among the elderly age group >85 years. The lowest mortality rate was documented during the fourth peak of COVID-19 with 957 deaths among men and 769 deaths among women. The lowest mortality rate was recorded in the age group of 5–9 years with four cases during the first peak of COVID-19. Also, the lowest number of female mortality dated to the first peak of COVID-19, with one infant mortality amid the fourth peak and one death among the 10–14 years age group in the same peak.

As shown in Table 2, the highest number of YLL befalls the third peak of COVID-19 with 58 174 YLL for men and 46 740 years for women. The lowest number of YLL for men was registered as 16 593 YLL at the fourth peak and 15 181 YLL among women at the first peak of COVID-19. In the first peak, men between the ages of 60 and 64 account for 2909 YLL, which is the highest figure in the first peak of COVID-19. However, for women YLL occurred among the 65–69 years age group with 2162 mortalities in the first peak. Also, the lowest number of YLL in the first peak of

Table 1 The amount of YLD based on gender and age group in Khorasan-Razavi province

Age group	Number of death						Number of YLL					
	Male		Female		Total		Male		Female		Total	
	number	per 10 000	number	per 10 000	number	per 10 000	number	per 10 000	number	per 10 000	number	per 10 000
0	70	10	58	9	128	20	5596	812	4781	735	10 377	775
1–4	50	2	34	1	84	3	3888	142	2730	105	6618	124
5–9	24	1	24	1	48	2	1749	60	1811	66	3561	63
10–14	27	1	22	1	49	2	1833	72	1551	64	3385	68
15–19	31	1	28	1	59	3	1951	84	1835	80	3786	82
20–24	56	2	30	1	86	3	3245	128	1819	72	5064	100
25–29	48	1	38	1	86	3	2544	78	2117	66	4661	72
30–34	116	3	83	2	199	6	5572	164	4218	127	9791	146
35–39	196	7	98	4	294	11	8448	304	4504	166	12 952	236
40–44	235	11	150	7	385	19	8978	422	6169	296	15147	360
45–49	266	15	179	10	445	25	8879	498	6508	366	15 386	432
50–54	376	26	276	19	652	45	10 775	745	8744	606	19 518	676
55–59	619	49	376	29	995	77	14 897	1182	10 190	785	25 086	981
60–64	857	95	597	62	1454	152	16 844	1871	13 513	1411	30 357	1634
65–69	940	177	737	119	1677	271	14 606	2748	13 502	2186	28 108	2446
70–74	788	169	689	138	1477	296	9355	2011	9811	1964	19 166	1987
75–79	953	285	787	238	1740	527	8393	2510	8334	2525	16 727	2518
80–84	980	363	728	303	1708	712	6216	2300	5504	2294	11 719	2297
85+	1222	742	840	581	2062	1427	4331	2628	3570	2470	7901	2554
Total	7854	1961	5774.0	1530	13 628	3603	138098	18 761	11 1211	16 385	24 9309	17 550

COVID-19 was among 5–9 (292) years age group for men and 10–14 (71) years age group for women. In the second peak, the highest number of YLL for both men and women was reported among the 60–64 years age group with 4933 and 4029 YLL, respectively. Further, the lowest number of YLL in the second peak of COVID-19 among men belongs to the 19–15 (440) years age group and for women the 24–20 (606) years age group.

In the third peak of the disease, the highest number of YLL for both men and women was among the 60–64 years age group, with 6899 years for men and 5840 years for women. The lowest number of YLL registered for men and women in the age group 10–14 years was 475 and 564 years, respectively. At the fourth peak of the disease, the highest number of YLL for men was 2044 in the age group 64–60 years, and for women it was 1869 YLL in the age group 65–69 years. The lowest number of YLL at this peak (fourth) of the COVID-19 outbreak was in the age group 10–14 years: 68 years for men and 141 years for women.

Comparing the different peaks of the COVID-19 outbreak, the lowest number of YLL was documented in the fourth peak among the 14–10 years age group due to single mortality among the male population. Likewise, the highest number of YLL was associated with the third peak in the age group of 60–64 years due to 351 deaths among the male population. As depicted in Fig. 2, based on the frequency distribution of mortality among different age groups and during the pandemic period of COVID-19, the highest mortality occurred in the extremity of life, but the number of YLL is more frequent among the middle ages: 50–69.

Discussion

In this study, we calculated the YLL among patients with COVID-19 in one of the major provinces of Iran, based on sex and age groups. Here, we employed WHO guidelines in calculating the burden of COVID-19. Cumulatively, 13 628 deaths and 249 309 YLL were calculated, that is, on average, about 18 YLL per mortality due to COVID-19. It should be

Table 2 Number of YLL (Number of death)

Age group	First peak		Second peak		Third peak		Fourth peak	
	male	female	male	female	male	female	male	female
	0	799(10)	82(1)	879(11)	907(11)	3357(142)	2555 ³¹	560(7)
1–4	778(10)	401(5)	1089 ¹⁴	963(12)	1400 ¹⁸	1124 ¹⁴	622(8)	241(3)
5–9	292(4)	302(4)	510(7)	679(9)	729(10)	679(9)	219(3)	151(2)
10–14	407(6)	71(1)	883(13)	776(11)	475(7)	564(8)	68(1)	141(2)
15–19	566(9)	197(3)	440(7)	656(10)	755(12)	590(9)	189(3)	393(6)
20–24	406(7)	243(4)	1391 ²⁴	606(10)	1275 ²²	788(13)	174(3)	182(3)
25–29	424(8)	279(5)	477(9)	613(11)	1378 ²⁶	947(170)	265(5)	279(5)
30–34	1105 ²³	610(12)	1729(36)	864(17)	2114(44)	2084(41)	625(13)	661(13)
35–39	1293 ³⁰	551(12)	2629(61)	1654(36)	3534(82)	1884(41)	991(23)	414(9)
40–44	1452(38)	699(17)	2560(67)	2139(52)	3629(95)	2591(63)	1299 ³⁴	740(18)
45–49	1569(47)	836(23)	2370(71)	2145(59)	3471(104)	2472(68)	1435(43)	1018 ²⁸
50–54	1949(68)	982(31)	3209(112)	2946(93)	4470(156)	3453(109)	1118(39)	1362(43)
55–59	2719(113)	1653(61)	4163(173)	3117(115)	6450(268)	4038(149)	1564(65)	1382(51)
60–64	2909(148)	1811(80)	4933(251)	4029(178)	6899(351)	5840(258)	2064(105)	1788(79)
65–69	2191(141)	2162(118)	4288(276)	3866(211)	6262(403)	5569(304)	1833(118)	1869(102)
70–74	1318(111)	1638(115)	2861(241)	3104(218)	3918(330)	3944(277)	1235(104)	1096(77)
75–79	1198(136)	1260(119)	2466(280)	2287(216)	3664(416)	3632(343)	1057(120)	1133(107)
80–84	1015(160)	839(111)	1884(297)	1497(198)	2505(395)	2412(319)	780(123)	726(96)
85+	712(201)	565(133)	1216(343)	948(223)	1889(533)	1573(370)	496(140)	468(110)
Total	23 101(1270)	15 181(855)	39 978(2293)	33 795(1690)	58 174(3314)	46 740(2443)	16 593(957)	15 280(769)

borne in mind that from a public health perspective, the YLL assesses how much life has been reduced for the population affected by the disease.²⁵

The findings of the study showed that death was higher among male patients than female patients. High mortality among men due to COVID-19 raises the question of whether men are more vulnerable than women. Studies have shown that men are more likely to die from diseases such as heart disease, diabetes, liver disease and cancer.²⁶ Furthermore, some evidence points to women's longevity being more than that of men, even in severe weather conditions such as famine.²⁶

Meanwhile, the death rate from severe acute respiratory syndrome coronavirus (SARS-CoV) was high in 2002–2003; similarly, the virus had led to more deaths in men than in women population. Also, SARS-CoV confers more mortality among the studied male mice.²⁷ In general, men are more prone to life-threatening diseases such as cardiovascular disease, while women tend to suffer from chronic nonfatal diseases such as migraines, musculoskeletal diseases, autoimmunity and physical limitations.²⁷ Another possible reason for the difference in death between men and women with

COVID-19 is due to differences in lifestyle, such as smoking and alcohol consumption, which is commoner among men.²⁸ In addition, men are more likely to refuse wearing facemasks than women.

According to our findings, the impact of COVID-19's death is colossal, not only in terms of deaths rates but also in terms of YLL. We showed that YLL due to COVID-19 was also higher among men than women; 55% of the total number of YLL were ascribed to men. These findings are consistent with those reported in Germany, which reported that men were more likely than women to die from COVID-19 and more likely to die before the age of 70.²⁹

In contrast, a study in Korea found that women lost more YLL than men in terms of gender and age groups. It was also noted that the older the age group, the higher the risk of COVID-19 and the resulting death.³⁰ On the other hand, the findings of an earlier study on Middle East respiratory syndrome (MERS) showed that among all age groups, the number of YLL was higher among men (10 702 years) compared with women (3817.5 years). Previous research has also shown a significant difference in MERS-related mortality between

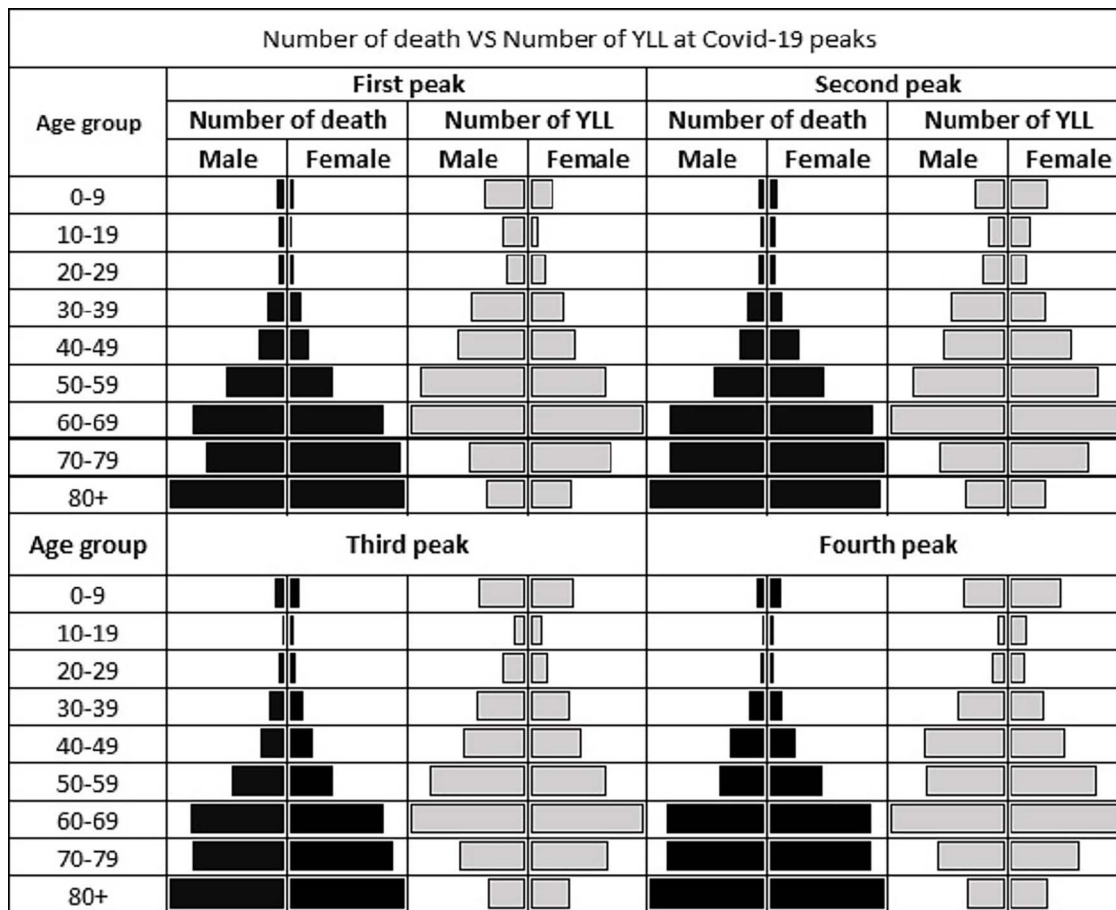


Fig. 2 Using the available data, the number of deaths and years of life lost of Covid-19 patients by gender during the study period and the peaks that occurred were shown.

men and women.³¹ Notwithstanding, the rate of economic participation of men is higher than that of women in Iran. This means the high share of mortality and YLL among men leads to the loss of a large part of the active population of the country.

Here, we reported the highest number of YLL among COVID-19 patients in the age group of 64–60 years. While patients with MERS in the age range of 59–30 years had the highest lost years of standard life,³¹ findings from a study of seasonal flu patients showed that adults aged 20–59 were severely affected by the epidemic. In contrast, 60-year-olds and 5-year-olds were less affected by the seasonal flu.³²

We found in this study, the YLL to be more concentrated among the elderly population, which represents one of the most vulnerable age groups. Older people are more likely to have underlying conditions such as diabetes and chronic obstructive pulmonary diseases and may be more vulnerable to COVID-19 due to their smaller lung capacity. Other studies have reported a strong association between COVID-19 and underlying diseases.³³ Factors affecting COVID-19 mortality

are similar to those reported for SARS and MERS. Gender, laboratory parameters and age characteristics of infected individuals can predict death from coronavirus infections.³⁴ However, the mean age of patients who died or survived due to COVID-19 was higher than SARS and MERS.³⁴

The death rate from COVID-19 is dependent on the prevalence of the disease. As the prevalence dramatically increases, the demand for therapeutic care becomes enormous and due to overstretched resources and facilities to meet this demand, the death rate from the virus increases. Accordingly, the death rate due to COVID-19 is likely to increase with a higher prevalence. The risk of dying from the virus is related to the performance of health care providers, both in terms of accessibility and in terms of the quality of services available. The results of the study in Iran showed that COVID-19 had an extremely high cost. It is estimated that the high prevalence of COVID-19 directly imposes a heavy economic burden on the country and the health system, which may lead to fixed allocations or constrained expenditure approaches to managing resources.³⁵

Conclusions

The burden of COVID-19 in Iran is increasing, especially its effects on mortality and YLL. Mortality among patients with the disease increases with age, although the YLL are higher among men than women, but in the age group of 60–64 YLL are the highest in both sexes. Furthermore, the YLL is closely related to the prevalence and mortality of COVID-19. Laboratory tests are essential for timely diagnosis and treatment; besides adequate provision for personal protective equipment, practicing preventive behaviors and social distancing are among the paramount measures in managing and controlling COVID-19. Because the risk of death from this disease is unpredictable, the expansion of public vaccination to cut the transmission chain, as well as the creation and development of the necessary infrastructure to provide the required medical services, should be a priority on the agenda of the health system policymakers.

Limitations

This study has several limitations. The analysis of the study was limited to one of the provinces of Iran, and therefore may limit the possibility of generalization to other provinces. The YLL were calculated based on confirmed deaths from patients, but deaths associated with COVID-19, especially among the elderly, may not be confirmed by laboratory test results, because not all cases of COVID-19 have been diagnosed (tested), or virologically confirmed. One of the major limitations of this study was that the pandemic is still active and new data are being generated daily. The current death data in this study may not reflect the latest data and the exact weight of the epidemic problem. Also, people who die from COVID-19 may be a high-risk population whose life expectancy is lower than that of the general population. This methodological concern is probably valid, and as a result, our estimate of the total number of YLL due to COVID-19 may be overestimated.

Conflict of interest

The authors declare that they have no conflict of interest regarding the publication of this study.

Ethical considerations:

This research is part of a larger project (code No.990116). The study protocol was approved by the Ethics Committee of Mashhad University of Medical Sciences, Mashhad, Iran (IR.MUMS.REC.1399.109).

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