# Estimating the Years of Life Lost and Mortality Caused By COVID-19 in Mashhad, the Second-Largest City in Iran

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| ARTICLEINFO | ABSTRACT |
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| *Article type:*<br>Research Paper | **Introduction:** The disability-adjusted life years (DALY) may provide a better indicator of the burden of disease than mortality. This study provides the estimates of both Years of Life Lost (YLL) and COVID-19 mortality in Mashhad. |
| | **Methods:** This cross-sectional study was carried out in Mashhad, the second-most populous city in Iran. The mortality data in the population served by Mashhad University of Medical Sciences (MUMS) were extracted from the national mortality data system. In this system, all deaths in the whole of the country are recorded based on the International Classification of Diseases, tenth edition (ICD10). The data in the current study comprised all cases of death recorded in the population under the auspices of MUMS from January 21st to April 19th 2019 and 2020 which were transferred to SPSS software after sorting. The method recommended by the World Health Organization (WHO) was used for the estimation of YLL. |
| | **Results:** The YLL per 1000 caused by COVID-19 was 1.2 years and increased with age, and was higher in men (1.6 years) compared to women (0.9 years). The incidence of COVID-19 was higher in the urban area (9.8%) compared to rural areas (4.8%). During the study period, COVID-19 was the fourth most prevalent cause of death in Mashhad after cardiovascular disease (35.4%), cancer (12.9%) and respiratory disease (10.6%). |
| | **Conclusions:** The YLL per 1000 caused by COVID-19 was 1.2 years, increased with age and was greater in males than in females. |

## Introduction

The spread of coronavirus disease 2019 (COVID-19) in Wuhan, China, has swiftly grown into a worldwide public health crisis, which was declared as a pandemic by the WHO. COVID-19 is caused by the SARS-CoV-2 virus, from the same family as the coronaviruses that previously caused severe acute respiratory syndrome (SARS-CoV) and Middle East respiratory syndrome (MERS-CoV). COVID-19 is a large virus (120 nm) and is enveloped, with a positive-sense single-stranded RNA. It is a highly transmittable

virus that has spread quickly and efficiently. The majority of patients with the COVID-19 virus will endure minor to moderate breathing problems that improve without any specific treatment. However, the senile citizens and people with underlying diseases like chronic respiratory disease, diabetes, cardiovascular disease and cancer are more likely to develop serious illnesses. More than six million cases have been confirmed globally, and the number of deaths now exceeds 391,000. The pandemic has caused severe strain to health systems, and in some countries, there have been deficiencies in critical supplies. At present, there is no specific treatment for the disease, although steroid treatment and antiviral therapies have been shown to reduce mortality, and research teams around the world have joined forces to develop an effective vaccine (1).

The World Health Organization (WHO) initially estimated the mortality rate from COVID-19 to be 2% at a press conference on Wednesday, January 29, and then revised this to, about 3.4% of reported COVID-19 cases (2). However, the reported case mortality rates for COVID-19 vary from 0.27% to 10%, possibly dependent on the testing strategy, demographic differences and the presence of underlying co-morbidities (3).

Researchers at Johns Hopkins University have estimated the rate of death of COVID-19, or the known deaths divided by confirmed cases, was more than ten percent in Belgium, France, Italy, United Kingdom, Hungary, Netherlands, Sweden, Spain and Mexico (4).

Iran is a developing country in the Middle East, at the intersection between Europe and Asia (5). In the Iranian population, the main causes of death include motor vehicle accidents, cardiovascular diseases, intentional and unintentional injuries and cancers. Globally, cardiovascular disease (CVDs), cancer, diabetes and chronic lung diseases are the major causes of death (6).

According to a report of WHO from Feb 19 to 3 Oct 2020, more than 464,596 confirmed cases of COVID-19 with 26,567 deaths were recorded in the Islamic Republic of Iran (7). In Iran, the first case of coronavirus was diagnosed on 19 February 2020, in the city of Qom (8). The virus may have been brought into the country by a trader from Qom who had journeyed to China (9). By March 22, 2020, Tehran had the highest rate of infection among Iranian cities with 5,098 confirmed cases, followed by Isfahan with 1,979,

Mazandaran with 1700, Gilan with 1191, Qom with 1178, and Alborz with 1177 cases (10).

According to WHO, mortality does not give the best overall estimate of the disease burden of individuals in various demographic groups. The overall disease burden is measured by the disability-adjusted life year (DALY). A time-based indicator, it merges years of life lost due to early death (YLLs) and years of life lost due to ill-health or disability (YLDs) (11). It developed in the 1990s by the Harvard School of Public Health, the WHO and the World Bank, it is assessed as the DALYs (12).

This study seeks to present an estimate of the years of life lost and mortality induced by COVID-19 to date in Mashhad, as the second-most populated Iranian city and the capital of Khorasan Razavi province in the northeast of Iran with a population of approximately 5085000 people.

## Material and Methods

This cross-sectional study was confirmed by the Research Council of the Mashhad University of Medical Sciences, Mashhad, Iran (ID: 990171). Moreover, the Ethical Committee of Mashhad University of Medical Sciences endorsed the study (IR.MUMS.REC.1399.239)

### Study Population

Mortality data in the population served by the Mashhad University of Medical Sciences (MUMS) were extracted from the national mortality data system. In this system, all deaths in the whole of the country will be recorded after completing the death registration form by trained physicians and determining the primary, secondary and final cause based on the International Classification of Diseases, tenth edition (ICD10) by medical record experts. The data of this study included all cases of death recorded in the population under the auspices of MUMS from January 21th to April 19th in 2019 and 2020 which was extracted from the database as an Excel file.

### *DALY Calculation*

The methods of the World Health Organization for estimation of Years of Life Lost (YLL) were used in the current study (13, 14). As a summary indicator of premature mortality, YLL evaluates the potential years of life lost as a result of premature mortalities. This measure also accounts for the age of death, assigning further weight to deaths at a younger age (15). In other

words, YLL is obtained by multiplying the number of deaths by normal life expectancy at the age of death. The normal life expectancy used of YLL for different age groups is similar to deaths in all parts of the world, which is also adopted to estimate Disability Adjusted Life Years (DALY). Additionally, for the latter, non-uniform age weights (lower weight assigned to years lived at young and old ages) and 3% time discounting were used. In this way, the death of a newborn is identical to 33 YLL, and deaths at ages 5 to 20 corresponds to approximately 36 YLL (16). The formula used for estimation of the YLL for a given cause, sex or age, is:

YLL = N x L

Where: N is number of deaths and L is standard life expectancy at age of death (in years)

The number of deaths due to COVID 19 in the target population served by MUMS were extracted from the national mortality data system. The L values used in the above formula were available in disease burden studies as standard for the whole of the world (16) which is also used in the current study.

The indicators were calculated after cleaning and modifying the obtained data and having all the items using Excel software (version 2017). WHO declares that the Global Burden of Disease (GBD) methods could be utilized at national or sub-national scales and relative to the health values of that country (17). So the standard DALY calculation template was obtained from WHO (18) which considers the standard life expectancy for five-year age groups suggested by WHO, standard age weights (beta=0.04), standard discount rate (0.03), and standard age weights (C=0.1658).

SPSS16.0 software was used for statistical analyses (SPSS Inc., Chicago, Ill., USA). Descriptive analysis involved percentage and frequency for qualitative variables and standard deviation and mean for the quantitative variable. For the comparison of the death rates in 2019-2020 period, Chi-square test was used. A p-value< 0.05 was considered significant.

**Table 1.** The years of life lost (YLL) due to Coronavirus disease 2019 in Khorasan Razavi Province

| Age Groups (years) | Males | | Females | | Total | |
|---|---|---|---|---|---|---|
| | YLL (years) | YLL per 1000 | YLL (years) | YLL per 1000 | YLL (years) | YLL per 1000 |
| **0-4** | 30 | 0.1 | 31 | 0.1 | 61 | 0.1 |
| **5-14** | - | - | - | - | - | - |
| **15-29** | 108 | 0.2 | 113 | 0.2 | 221 | 0.2 |
| **30-44** | 737 | 1.0 | 125 | 0.2 | 861 | 0.6 |
| **45-59** | 1,042 | 2.9 | 531 | 1.5 | 1,573 | 2.2 |
| **60-69** | 1,089 | 8.5 | 752 | 5.5 | 1,841 | 7.0 |
| **70-79** | 643 | 11.2 | 476 | 7.7 | 1,119 | 9.4 |
| **80+** | 436 | 11.8 | 253 | 7.2 | 690 | 9.6 |
| **Total** | 4,086 | 1.6 | 2,280 | 0.9 | 6,365 | 1.2 |

YLL: years of life lost

**Table 2.** Comparison of the causes of death in 2019 and 2020 in Khorasan Razavi Province

| The reasons for death | | January 21th to April 19th in 2019 | January 21th to April 19th in 2020 | P-Value* |
|---|---|---|---|---|
| **Total** | Other reasons | 5446(100.0) | 5399(91.2) | <0.001 |
| | Covid-19 | 0(0.0) | 518(8.8) | |
| **Rural areas** | Other reasons | 1200(100.0) | 1144(95.2) | <0.001 |
| | Covid-19 | 0(0.0) | 58(4.8) | |
| **Urban areas** | Other reasons | 4214(100.0) | 4164(90.2) | <0.001 |
| | Covid-19 | 0(0.0) | 454(9.8) | |
| **Male** | Other reasons | 3102(100.0) | 3066(90.0) | <0.001 |
| | Covid-19 | 0(0.0) | 340(10.0) | |
| **Female** | Other reasons | 2342(100.0) | 2330(92.9) | <0.001 |
| | Covid-19 | 0(0.0) | 178(7.1) | |

*Data represented as Frequency (percentage); Statistical comparison was done with Chi-square test*

**Table 3.** Ranking of major causes of death in Khorasan Razavi Province

| The reasons for death | January 21th to April 19th in 2019 | | January 21th to April 19th in 2020 | |
|---|---|---|---|---|
| | Frequency | Percentage | Frequency | Percentage |
| Cancer | 822 | 15.1 | 764 | 12.9 |
| Endocrine, nutritional and metabolic diseases | 318 | 5.8 | 263 | 4.4 |
| Diseases of the circulatory system | 1992 | 36.6 | 2093 | 35.4 |
| Diseases of the respiratory system | 575 | 10.6 | 629 | 10.6 |
| Certain conditions originating in the perinatal period | 345 | 6.3 | 269 | 4.5 |
| COVID-19 | - | - | 518 | 8.8 |
| Other diseases | 1394 | 25.6 | 1381 | 23.4 |
| Total | 5446 | 100 | 5917 | 100 |

## Results

We found that the overall YLL per 1000 caused by COVID-19 was 1.2 years. This increased with age and was higher in men (1.6 years) compared to women (0.9 years). However, the YLL was the same in males and females aged <30 years old, whereas it was higher in men than women >30 years old (Table 1).

A total of 5917 people deceased in the target population under MUMS supervision from January 21st to April 19th, 2020. Of this figure, 8.8% (n=518) was attributable to COVID-19. The results showed that the COVID-19 incidence was higher in the urban area (9.8%) than rural ones (4.8%) (Table 2). During the same period in 2019, the mortality was 5,446 individuals in Mashhad.

As shown in Table 3, COVID-19 was the fourth most common cause of death in Mashhad after cardiovascular disease (35.4%), cancer (12.9%) and respiratory disease (10.6%).

## Discussion

A total of 5917 subjects have died in Mashhad from January 21th to April 19th in 2020 out of whom 8.8% (n=518) was due to COVID-19. In the current study, COVID-19 was the fourth major cause of death in Mashhad after cardiovascular disease, cancer and respiratory disease. The results showed that the COVID-19 incidence was greater in the urban area (9.8%) than in rural areas (4.8%). The results showed that YLL per 1000 caused by COVID-19 was 1.2 years. In addition, it has been augmented by aging. YLL per 1000 caused by COVID-19 was higher in men (1.6 years) compared to women (0.9 years).

Since the start of the COVID-19 pandemic, there have been limited data regarding its' disease burden. Among the few published studies, Nurchis et al., have assessed the socio-economic effect of COVID-19 in Italy using the estimation of DALYs. The total DALYs was 2.01 per 1000 persons. These results, similar to our findings, reported the highest DALY rate in subjects in the age group of 80-89 years (19). In Italy in the first quarter of 2020, 54% (13,710) of additional deaths were attributed to COVID-19 diagnosed deaths (20). In Italy, about 85% of all COVID-19-caused deaths were in subjects aged ≥ 70 years. Only 1.1% of the deaths were reported in at ages < 50 years. The potential years of life lost (PYLLs) was more significant in the age group of 60–69 years.

The PYLLs were 5 times higher in the US than in Italy. In Germany, the PYLLs were 4 times higher than in Italy. In Germany, the older age groups had the greatest mortality rate too. The total PYLL in Germany was also lower than in Italy and the USA (21). The standardized PYLL rates suggested that the PYLL rates were approximately 4 times higher in Italy. In the US, they were 23, 25, and 18 times higher at age 70, 75, and 80 years, respectively, as opposed to Germany (21).

The use of DALYs to assess the burden of disease may be used to support Governments to determine resource allocation and health policy planning made to deter emergency incidents of such a grand scale [19].

As far as the authors' are concerned, this is the first study regarding the COVID-19 burden of disease from eastern of Iran. Although the results can provide a clear picture of the existing condition, they are highly prone to variations due to incidence peaks of COVID-19 in society. Therefore, calculating these indices at the anniversary of COVID emergence is highly suggested.

## Conclusions

The YLL per 1000 attributed to COVID-19 in Mashhad was 1.2 years which increased with age and was higher in men than women.

## Conflicts of Interest

The authors confirm no conflict of interest.

## Acknowledgement

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