Original Article

# Overview of COVID-19 mortality in Zoram Medical College, Mizoram: A hospital-based study

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## Abstract

**Background:** Mizoram is a small state in the northeastern part of India and recorded its first case of coronavirus disease 2019 (COVID-19) on March 24, 2020. The first registered death because of COVID-19 in the state was on October 28, 2020 at Zoram Medical College (ZMC), which is a dedicated COVID hospital in Mizoram. COVID-19 cases from different districts in the state were referred to ZMC according to severity of symptoms. NCDIR-ICMR e-Mortality Cell was first started as a project at ZMC in 2019. Since then, all hospital deaths are recorded using a structured questionnaire developed by NCDIR which has also strengthened the data for COVID-19 mortality statistics in the state. The objective of this study is to determine the association of in-hospital COVID-19 mortality in relation to age, sex, vaccine status, and underlying co-morbidities and highlight the utility of ICMR-NCDIR e-Mortality software in the hospital. **Methods:** Data on COVID-19-associated deaths from October 2020 to October 2021 at ZMC were collected from the hospital e-Mortality software and Medical Records Department (MRD). This includes patients' demographic characteristics including age, sex, vaccination status, and underlying co-morbidities if any. Appropriate statistical analysis was performed to evaluate the correlation between variables. **Results:** From October 2020 to October 2021, a total of 324 deaths related to COVID-19 was recorded at ZMC, Mizoram. The majority of the deaths were distributed in the age group 65 years and above and accounts for 49.1% in all age groups. Out of the total deaths, 64.2% (208) were males and 81.48% had an associated underlying co-morbidity besides COVID-19. The most common co-morbidities were hypertension, type 2 diabetes mellitus, cancer, and chronic obstructive pulmonary disease. More than half, 59.6%, had no vaccination history, and all the cases had no history of taking a booster vaccination dose. A statistically significant correlation between delay in time to admission and length of hospital stay ($p = 0.017$) was also seen. **Conclusions:** COVID-19 is more severe in the older age group above 65 years of age and in males, particularly in the presence of underlying co-morbidities. Mortality was also higher in patients with no history of vaccination as compared with patients vaccinated. Also, delay in hospital admission increases the length of hospital stay and mortality.

**Keywords:** COVID-19, Mizoram, mortality, Zoram medical college

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## Introduction

On December 31, 2019, the World Health Organization (WHO) was informed about outbreak of pneumonia of an unknown cause in Wuhan City, China, and was temporarily named "2019-nCoV".[1] It was later declared out-break by a public health



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emergency of international concern (PHEIC). The new virus was subsequently named "COVID-19" (coronavirus disease 2019) on February 11, 2020 by the WHO and was declared as a pandemic on March 11, 2020.[2]

Since the declaration of COVID-19 pandemic until October 31, 2021, India has reported over 4.5 lakhs of death because of COVID-19.[3] Mizoram is a small state in the north-eastern part of India with a population of 13.32 lakhs (2021 census). The first case of COVID-19 in Mizoram was recorded on March 24, 2020.[4] The first registered death because of COVID-19 in the state was on October 28, 2020 at Zoram Medical College (ZMC), which is a dedicated COVID hospital (DCH) in Mizoram.[5] From the first recorded death on October 28, 2020 till October 31, 2021, the mortality related to COVID-19 as recorded by the state government was 432 and out of these deaths, 324 occurred during their stay at ZMC.

NCDIR-ICMR e-Mortality Project was first started as a project at ZMC in 2019. Since then, all hospital deaths are recorded using a structured questionnaire developed by NCDIR. The treating medical officer filled the Death Certificate along with the cause of death. All data collected using the questionnaire are entered in electronic forms using the e-Mor software. The project has provided technical assistance and strengthened the data quality related to the underlying cause of death and the Medical Certification of Cause of Death (MCCD) system in the hospital.

According to the ICD-10-CM Official Coding and Reporting Guidelines, only a confirmed case of COVID-19 meeting the definition of principal diagnosis must be coded, code U07.1:COVD-19, and should be sequenced first, followed by the appropriate codes for associated manifestations and underlying causes of death, except in the case of obstetrics patients.[6]

A previous systemic review and meta-analysis on association of sex, age, and co-morbidities with mortality in COVID-19 patients by Biswas *et al.*[7] reported that male patients with COVID-19 were associated with significantly increased risk of mortality compared to females and patients with an age of 50 years and above were at a significantly higher risk of mortality compared to those aged below 50 years. In addition, mortality was also found to be significantly higher among patients with co-morbidities.[8] However, no study related to COVID-19 mortality has been recorded in Mizoram, and it is not known whether the findings in other parts of the country will also be similar for the state.

The objective of this study is to determine the association of in-hospital COVID-19 mortality in relation to age, sex, vaccine status, and underlying co-morbidities as acquired from the e-Mor data and hospital medical records collected at ZMC and also highlight the utility of e-Mor software in the hospital.

## Materials and Methods

### Study setting and duration

The study was conducted at ZMC, Mizoram, India, from October 1, 2019 to October 31, 2020.

Inclusion criteria: All hospital deaths related to COVID-19 at ZMC from October 2020 to October 2021.

Exclusion criteria: Hospital deaths because of conditions unrelated with COVID-19.

### Study design

This was a retrospective cross-sectional study.

### Data collection

A pre-structured NCDIR e-Mor questionnaire form developed by ICMR-NCDIR, Bangalore, was distributed to all wards including the intensive care unit (ICU) in the hospital. All hospital deaths were recorded in accordance with the MCCD form and certified with the cause of death by the treating medical doctor using the ICMR-NCDIR e-Mor Core Form. Investigators of the project then collected the forms. Each form was then analyzed and scrutinized before submission in the ICMR-NCDIR e-Mortality Record Software. The software then generates MCCD Form 4 and Death Report No. 2, both of which are necessary for death registration, as stipulated by the Registrar General of India. The software also provides a quality check report where missing variables, consistency check, range check, and date check are performed automatically.

Ethical clearance for the e-Mor project was taken from the institutional ethics committee.

The ICMR-NCDIR e-Mor form has the following information:

i) Hospital information, ii) deceased information, iii) family/informant information, iv) death information, v) cause of death, vi) manner of death, vii) habits, and viii) doctor information. Mandatory fields are denoted by the red star (*) mark in the software.

The hospital medical records section has also been recording all hospital admissions and deaths. Patient files with medical records are all maintained by the department. Additional COVID-19 mortality data including date of diagnosis and vaccination status were collected from the medical records section. In case of any discrepancy, patients' files were retrieved for confirmation.

For the purpose of the present study, we retrieved data from the e-Mor Core Form and data analysis reports provided by ICMR-NCDIR e-Mor software and the hospital medical records. The data analysis report feature provided in the e-Mor software includes demographic characteristics such as age, sex, date of hospital admission, date of death and underlying co-morbidities,

and antecedent causes of death. Data from the hospital records included date of COVID-19 diagnosis and vaccination status. To evaluate the association between delay in hospital admission and duration of hospital stay, date of COVID-19 diagnosis, date of hospital admission, and date of death were analyzed.

## Statistical analysis

All data gathered from the ICMR-NCDIR e-Mor Core Form were entered in the e-Mor software, and data analysis reports were generated using the ICMR-NCDIR e-Mortality report software. Data acquired from the hospital medical records were analyzed using Statistical Package for the Social Sciences (SPSS) version 21. Additional statistical analysis was performed to evaluate the correlation and association between variables, and Chi square, Pearson's correlation, and t-test were applied as appropriate.

## Results

From October 1, 2019 to October 31, 2020, a total of 324 deaths were recorded at ZMC e-Mor Center and the hospital Medical Records Department. Age was grouped according to the age classification in the e-Mor software. The highest frequency of mortality was seen in the age group ≥65 years (49.1%), and 64.2% were males and five maternal deaths were seen. The majority of the cases (70.76%) were urban dwellers. In addition, the majority, (81.5%) had an associated co-morbidity, and among these deaths, more than half, that is, 59.6%, were unvaccinated [Tables 1 and 2].

The majority of COVD-19 deaths had an associated co-morbidity. The four most common co-morbidities were hypertension, type 2 diabetes mellitus, cancer, and chronic obstructive pulmonary disease (COPD), Figure 1.

The presence of co-morbidities was significantly found to be more among men when compared to females, $P = 0.02$. The vaccination rate was significantly higher among females compared to males, $P = 0.003$. However, there was no difference between the length of hospital stay and gender, Table 3.

There was a positive correlation between age and length of hospital stay. With the increase of age, the length of hospital stay increases, and this was found to be statistically significant, $P = 0.022$. However, it was found that age does not have any effect on the presence of co-morbidities and the presence of co-morbidities does not affect the length of hospital stay. A positive correlation between delay in time to admission and length of hospital stay was found to be statistically significant, $P = 0.017$, Table 4.

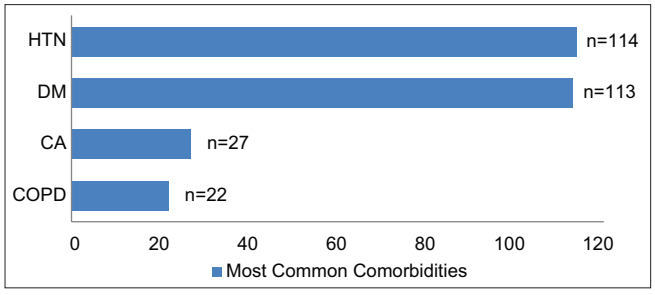


**Figure 1:** Presence of co-morbidities among COVID-19-related deaths

## Discussion

In public health, mortality statistics is one of the cornerstones in formulating health plans and policies for prevention and reduction of pre-mature mortality and improvement of quality

**Table 1: Distribution of COVID-19-Related Deaths According to Age Group**

| Age Group | Frequency | Percent % |
|---|---|---|
| <1 | 1 | 0.3 |
| 1-14 | 1 | 0.3 |
| 15-24 | 8 | 2.5 |
| 25-34 | 18 | 5.6 |
| 35-44 | 41 | 12.7 |
| 45-54 | 34 | 10.5 |
| 55-64 | 63 | 19.4 |
| >=65 | 158 | 48.8 |
| Total | 324 | 100.0 |

**Table 2: Characteristics of the Study Population**

| Parameter | *n*=324 (%) |
|---|---|
| Gender | |
| Male | 208 (64.2%) |
| Female | 116 (35.8%) |
| Rural | 100 (29.23%) |
| Urban | 242 (70.76%) |
| Co-morbidity | |
| Present | 264 (81.5%) |
| Absent | 60 (18.5%) |
| Vaccination Status | |
| Not vaccinated | 193 (59.6%) |
| 1 dose | 74 (22.8%) |
| 2 dose | 56 (17.3%) |
| Not known | 1 (0.3%) |
| Death during pregnancy | 3 (0.92%) |
| Death within 6 weeks after pregnancy | 2 (0.61%) |

**Table 3: Association of Gender with Variables**

| Gender | *n* | Co-morbidity | | *P* (Chi square) |
|---|---|---|---|---|
| | | Yes | No | |
| Male | 208 | 162 (77.9%) | 46 (22.1%) | 0.026 |
| Female | 116 | 102 (87.9%) | 14 (12.1%) | |
| | | Vaccination Status | | *P* (Chi square) |
| | | Unvaccinated | 1 dose / 2 dose | |
| Male | 208 | 111 (53.6%) | 50 (24.2%) / 46 (22.2%) | 0.03 |
| Female | 116 | 82 (70.7%) | 24 (20.7%) / 10 (8.6%) | |
| | | Mean hospital stay (in days) | | *P* (*t*-test) |
| Male | 208 | 208±11.81 | | 0.704 |
| Female | 116 | 116±11.41 | | |

**Table 4: Association with other parameters**

| Correlation between age and length of hospital stay | | |
|---|---|---|
| **Parameter** | **Mean Age** | ***P*[1] (Pearson correlation)** |
| Age | 61.91±19.352 | 0.022 |
| Hospital days | 11.66±9.13 | |
| **Association of co-morbidities with age** | | |
| **Co-morbidities** | **Mean Age** | ***P*[2] (t-test)** |
| Yes (n=264) | 62.73±18.41 | 0.113 |
| No (n=60) | 58.33±22.86 | |
| **Association of co-morbidities with hospital stay** | | |
| **Co-morbidities** | **Mean hospital stay in days** | ***P*[2] (t test)** |
| Yes (n=264) | 11.45±8.86 | 0.388 |
| No (n=60) | 12.58±10.29 | |
| **Correlation between delay in time to admission and hospital stay** | | |
| **Parameters** | **Mean** | ***P*[1] (Pearson correlation)** |
| Delay in admission | 1.97±3.19 | 0.017 |
| Hospital days | 11.66±9.13 | |

of life when used to systematically assess and monitor the health status of a community. The emergence of COVID-19 pandemic has greatly affected people globally in all aspects of life including global economy and the main emphasis was taking extensive hygiene protocol. It is therefore important to identify the risk factors associated with fatal outcome for better precaution and reduction of mortality.

ZMC has been functioning as the only DCH in the state of Mizoram since the start of the pandemic. From the first recorded death on October 28, 2020 to October 31, 2021, the mortality because of COVID-19 recorded was 324. The hospital medical records department has been keeping all death records; however, the need for strengthening the record system was realized. The ICMR-NCDIR e-Mor project was started on 2019 at ZMC, and since then, all deaths in the hospital have been electronically recorded and the data are collected using the e-Mor form, which is a pre-prescribed format provided by ICMR-NCDIR e-Mor.

In the present study, 49.1% of COVID-19 mortality was seen in patients ≥65 years of age. A statistically significant positive correlation between age and length of hospital stay was also seen (p = 0.022), indicating that with the advance of age, the length of hospital stay increases. Similarly, Cueto-Manzano AM *et al.*[9] also found that severity of disease was significantly worse in non-survivors, who were significantly older (65 vs. 45 years, respectively). Also, Bogam *et al.*[10] found that the median age of those who died was 65 years with almost half of the deaths reported between 65 and 86 years of age. Also, similar to their findings, mortality was the lowest among children. This may be because older people are particularly prone to develop more infections as the natural immunity declines gradually with aging.[11]

Studies have also shown male gender to be a poor prognostic factor in COVID-19 infection. In the present study, 64.2% of the total deaths because of COVID-19 were males. Similarly, Bogam P *et al* [10] also found higher mortality among men. La Vignera *et al.*[12] stated that male patients might have higher expression of angiotensin-converting enzyme 2 (ACE2), which may be regulated by male sex hormones, leading to more risk for SARS-CoV-2 infection and poorer clinical outcome.[12]

From the data, patients were analyzed according to their address recorded at the time of admission. Patients residing at Aizawl, the state capital, and other district capitals were entered as urban dwellers, whereas patients residing in villages outside the capital were entered as rural dwellers. Among COVID-19-related deaths at ZMC, 70.76% were from urban areas. This may be because of a higher population density in urban areas. In addition, people in the district capitals are more likely to reside and migrate out of the state for educational and occupational purposes, and as the pandemic surges, they may have returned to their hometown from various states in India and abroad, which may have resulted in the influx of the disease. This trend in urban to rural state-wise COVID-19 progression in India was seen by Sahoo *et al.*[13] in their study, where reactive policy decisions led to mass exodus of migrants packed into different forms of transportation, bringing the disease back to their homes.

Muthukrishnan *et al.*[14] in their hospital-based cross-sectional study found that vaccination with two doses of COVISHIELD® was associated with lower odds of mortality among hospitalized patients with moderate to severe COVID-19 infections. According to Watson *et al.*,[15] the estimated deaths averted in the first year of COVID-19 vaccination worldwide based on fits to excess mortality in the South-East Asian region was 31.29 per 10,000 vaccines. In Mizoram, COVISHIELD® is the main vaccine administered under the government. In the present study, 59.6% had not received vaccination, 22.8% had received one dose of vaccine, and 17.3% had received two doses of vaccine. One patient had no records of taking vaccine and could not be traced. None of the patients had received a booster vaccine dose. It was also found that the vaccination rate was significantly higher among females as compared to males, $P = 0.003$.

In a multi-national cohort study conducted by Villar *et al.*,[16] they found that COVID-19 infection during pregnancy was associated with substantial risk of morbidity and mortality during post-partum and their infants worldwide, especially if these individuals were symptomatic or with co-morbidities as compared to non-infected pregnant women. Karimi *et al.*[17] also concluded that COVID-19 infection in pregnant women is associated with higher rates of cesarean section and mortality. In the present study, five cases of maternal death because of COVID-19 were observed, which comprise 1.54% of all COVID-19 deaths in the hospital. Because the present study was focused only on mortality, data for the overall maternal rates of infection in the state were not retrieved for comparison.

A co-morbidity is defined as "any distinct additional entity that has existed or may occur during the clinical course of a patient who has the index disease under study."[18] The presence of a co-morbidity is known to be associated with impaired immune functions.[19] The most commonly reported co-morbidities with COVID-19 are hypertension, obesity, chronic lung disease, diabetes mellitus, and cardiovascular disease.[20] In the present study, 81.5% of all COVID-19 mortalities had an associated co-morbidity. The four most common co-morbidities were hypertension, type 2 diabetes mellitus, cancer, and COPD. The majority, 70.6%, had more than one associated co-morbidity. In addition, out of the total 324 deaths, ten cases had tuberculosis and nine patients had an associated human immuno-deficiency infection. The presence of co-morbidities was significantly found to be more common among men as compared to females, $P = 0.02$. However, it was found that age does not have any effect on the presence of co-morbidities and the presence of co-morbidities does not affect the length of hospital stay.

Studies have also shown that delay in admission is a significant predictor of mortality in patients with severe/critical COVID-19.[21] From the collected data, date of diagnosis and date of hospital admission were analyzed to find out delay in admission. There was a significant positive correlation between delay in time to admission and length of hospital stay. This indicates that with further delay in admission, the length of hospital stay increases and this was found to be statistically significant, $P = 0.017$. Our finding was in accordance with the findings of Alaa A *et al.*,[22] who found that timing of hospital admission was an independent predictor of mortality and that each additional day between symptom onset and hospital admission was associated with a 1% increase in mortality risk.[22]

## Limitations of the study

There were certain limitations in the present study; for example, the data are collected from a pre-structured ICMR-NCDIR e-Mor form and the clinicians filling the form may under-report some health conditions. Incomplete documentations in the forms were also seen, which made it difficult to retrieve complete information in certain patients. Variables such as sex, age, and co-morbidities were not adjusted; therefore, results presented in this study may vary if results were adjusted along with other variables affecting clinical outcome. The study includes COVID-19 mortality exclusively at ZMC, which is a DHC, and hence, extrapolation of the results with other hospitals may not be possible.

# Conclusions

In conclusion, we demonstrated that male patients with COVID-19 have higher rates of mortality compared with females. Patients with age ≥65 years have higher rates of mortality because of COVID-19 as compared with other age groups. Mortality is also higher in patients with co-morbidities and unvaccinated patients. Also, implementation of ICMR-NCDIR e-Mor provided technical assistance and help ease the retrieval of mortality data in the hospital. The process of investigating and learning from hospital mortality helps in quality improvement initiatives and a better understanding of the disease and must not be neglected.

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## Authors contribution

Dr. Laltlanzovi: Analyzed and scrutinized e-Mor data, conceived the concept and executed the manuscript paper.

Dr. Vankhuma: Analyzed and scrutinized e-Mor data, supervise, and proofread the paper manuscript.

Dr. Vanlalduhsaki: Statistical analysis of data extracted from the hospital data and e-Mor software.

Miss Diana Lalrinsiami Chhakchhuak: Collection and analysis of e-Mor data.

Mr. JC Zothanzauva: Collection and entry of e-Mor data into e-Mor software from NCDIR e-Mor forms gathered from various wards in the hospital.

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## Conflicts of interest

There are no conflicts of interest.

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