

Descriptive epidemiology of COVID-19 deaths in the first, second, and third pandemic waves: A comparative study from Southern India



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ABSTRACT

Background: India has seen a three-wave pattern of COVID-19 infections. With the looming threat of recurrent waves with mutated strains, it is important to understand the demographic and clinical characteristics of the deceased COVID-19 patients in these three waves to identify the vulnerable population and guide public health interventions to decrease COVID-19-related mortality. **Aims and Objectives:** The study was done to compare the age distribution, mean duration of illness, clinical characteristics, coexisting comorbidities, and causes of COVID-19-related deaths during the three pandemic waves. **Materials and Methods:** We obtained COVID-19 death summaries from the medical records of a large tertiary health-care center in North Kerala, India. Three groups of COVID-19 deaths were selected: The first group included patients who died in the first wave between July 01, 2020, and December 31, 2020 (n=311), the second group included those who died in the second wave between March 01, 2021, and June 30, 2021 (n=431), and the third group included those who died in the third wave between January 01, 2022, and March 15, 2022 (n=76). **Results:** The mean age of the deceased was significantly higher for the third wave (P<0.001). The mortality in young patients (≤ 50 years) was higher for the second wave and that in elderly patients (≥ 80 years) was higher for the third wave (P<0.001). Males were predominantly affected in all three waves (P=0.29). The average duration from symptom onset to death significantly decreased in the third wave (5 days, P<0.001). There was an increased proportion of COVID-19-related deaths in patients with diabetes in the second wave (59.4%; P=0.006). Maternal mortality and deaths without any coexisting comorbidities were higher in the second wave. The main cause of death was respiratory failure due to COVID-19 pneumonia in all three waves. **Conclusion:** The comparative characteristics of the descriptive epidemiology of three pandemic waves differed significantly. The second COVID-19 wave was different from the first wave and third wave, with more deaths in the young, and increases in the proportions of deaths with diabetes, maternal deaths, and deaths in those without any preexisting comorbidities. The third-wave had more deaths in the elderly and a shorter duration from symptom onset to death.

Key words: COVID-19; Epidemiology; India; Mortality; Pandemic; SARS-CoV-2

INTRODUCTION

Covid-19, with its high infectivity, has spread all over the world, with significant morbidity and mortality. India has seen a three-wave pattern of COVID-19 infection¹ and is one of the countries badly affected by the pandemic.

It is the nature of pandemics to come in waves. The deadliest epidemic in the past 120 years – the Spanish flu pandemic of 1918, is described as having several waves.² Many countries, such as Malaysia and Japan, had multiple COVID-19 waves.^{3,4} India is anticipating a possible fourth COVID-19 wave. The causative agent for the first wave was the wild or alpha strain; the second wave was mutant

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strains primarily the delta variant (B.1.617.2) and for the third wave, the main agent was the Omicron variant (B.1.1.529 lineage).⁵

Although all strains produce predominant respiratory symptoms, they differ in their spread and lethality. The COVID-19 deaths in these pandemics also may differ in their demographic profile, clinical manifestations, and causes of death, but data are scarce. The comparative characteristics of these waves remain largely unknown. We conducted this study to fill this research gap.

Aims and objectives

The study was done to compare the age distribution, mean duration of illness, clinical characteristics, co-existing comorbidities and causes of COVID-19 related deaths during the three COVID-19 pandemic waves.

MATERIALS AND METHODS

Study design

We performed a retrospective analysis of mortality parameters of COVID-19 deaths during the three waves of the COVID-19 pandemic in Kerala, South India.

Ethical committee

The study received approval from the Institutional Ethics Committee with IEC No.15/2022/GMCK. A waiver of written informed consent was obtained due to the rapid emergence and highly infectious nature of the disease, as well as being a record-based study with anonymized data and confidentiality maintained.

Settings and sample

The study was conducted in a tertiary care teaching institute with 1300 beds in Kerala, India.

The peak of the first wave of the COVID-19 pandemic in India was on September 16, 2020, with a gradual decline, with the nadir reached on February 01, 2021, after which cases again started increasing with the next peak on May 08, 2021. Another wave was seen by the 1st week of January, 2022, extending into the 2nd week of March 2022.⁴ Based on this, three groups of COVID-19 deaths were selected, corresponding to the first wave, second wave, and third pandemic wave. First group was COVID-19 deaths between July 01, 2020, and December 31, 2020 (6 months), corresponding to first wave deaths, second group was COVID-19 deaths between March 01, 2021, and June 30, 2021 (4 months), corresponding to second wave deaths; and the third group was COVID-19 deaths from January 01, 2022, to March 15, 2022, corresponding to third-wave deaths. A gap of a few months was maintained between groups to decrease overlap between waves. The dataset for the first wave was

frozen on December 31, 2020, for the second wave on June 30, 2021, and for the third wave on March 15, 2022.

All deceased patients with laboratory-confirmed COVID-19 infection during their hospital stay during the specified study period were included in the study. Patients who died due to causes other than COVID-19, such as suicide or accidents, were excluded from the study. Patients who were deceased upon arrival at the hospital were excluded from the study.

All patients were confirmed for COVID-19 by real-time polymerase chain reaction or a rapid antigen test performed according to the World Health Organization guidelines. All patients received routine comprehensive treatments including intravenous antibiotics, assisted oxygenation, specific treatment for the underlying diseases, and supportive treatments as per the prevailing state government treatment guidelines.

The duration of illness was defined as the period from the 1st day of symptom onset to the day of death. COVID-19 death is defined as the death of a patient admitted to the assigned COVID-19 wards or intensive care units with laboratory-confirmed COVID-19 infection during their hospital stay with any cause other than due to accident or suicide. All deaths from 50 years of age or below were considered young deaths. Special categories such as maternal deaths, deaths without preexisting comorbidities, young deaths, and deaths in elderly patients in all groups were identified and compared.

Data extraction

Data abstraction forms included demographic data, clinical presentation, associated comorbidities, chest X-ray and computed tomography findings, complications, and cause of death. Data were then reviewed and double-checked independently by two experienced physicians. For missing or vague data, direct communication with the attending doctors and other health-care providers was conducted. Reports which could not be retrieved were excluded from the mortality analysis.

Statistical analysis

Categorical data are presented as frequency and proportions and continuous data as mean, median, and standard deviation as appropriate. $P < 0.05$ was used as a cutoff for statistical significance. Microsoft Excel (Microsoft, Redmond, WA) and SPSS Statistics version 24 (IBM, Armonk, NY) were used for analysis.

Quantitative variables following normal distribution were analyzed using the one-way analysis of variance test. Kruskal–Wallis test was used for ordinal variables and

quantitative variables not normally distributed. Categorical variables were analyzed by the Chi-square test.

RESULTS

A total of 858 COVID-19 deaths occurred during the study period, of which 818 met the inclusion criteria. This study included 311 COVID-19 deaths in the first wave, 431 COVID-19 deaths in the second wave, and 76 COVID-19 deaths in the third wave. There was 3295, 2722, and 724 hospital admissions with COVID-19 during the first, second waves, and third waves, respectively. The in-hospital mortality rates for the first, second, and third waves were 9.4%, 15.83% and 10.47%, respectively.

The demographic characteristics of deaths in the three pandemic waves are summarized in Table 1.

Age distribution of deceased in the three waves

From Table 1, it is seen that there is a significant difference in the median age of the patients who died due to COVID in the three waves. *Post hoc* analysis revealed that age increased significantly in Wave 3 compared to Wave 1 and Wave 2.

Figure 1 shows the age distribution of deaths; proportionately more deaths occurred in extremes of age in the second wave. A steep decline in mortality was noticed as age decreased from 50 years in all waves. Among 818 deaths in the study group, there were only 4 deaths in those aged <10 years. The youngest death in the study group was a 7-month-old female without any comorbidity who developed severe COVID pneumonia and septicemia.

Gender impact on the deceased in the three waves

Most of the deceased were male. There was no statistically significant association of COVID-19 deaths in the three waves with sex of the deceased patients.

Duration of illness

There was a significant difference in the median duration (in days) between symptom onset to admission in the three waves, with *post hoc* analysis showing a significant decrease in the median duration of days between symptom onset to admission in the third wave compared to the first and the second waves. With respect to the median duration (in days) between admissions to death, there was a significant difference in the three waves, *post hoc* analysis revealed a significant decrease in the duration from admission to death with each passing wave. The same pattern was observed for the total duration (in days) between symptom onset to death; there was a significant decrease in the median duration between symptom onset to death from the first wave toward the third wave. There were more deaths on the 1st day of admission in the second wave.

Comorbidities

As shown in Table 1, among the comorbidities, diabetes was seen to have a significant association with the different waves; that is, a significantly higher proportion was observed in the second wave compared to the first and the third waves. A similar trend was observed for coronary artery disease. In chronic kidney disease, a significantly higher proportion was observed in wave 1 compared to the other two waves. In chronic obstructive pulmonary disease cases, it was observed that there was a significantly higher

Table 1: Demographic and clinical characteristics of deceased with COVID-19 in the three pandemic waves

Characteristic	Wave 1 (July 1–December 31, 2020) (n=311)	Wave 2 (March 1–June 30, 2021) (n=431)	Wave 3 (January 1–March 31, 2022) (n=76)	P-value
Age (in years)				
Mean±SD	65.02±13.21	65.64±14.62	72.20±15.50	<0.001 ^a
Median (Interquartile Range)	65 (15)	67 (18)	74.5 (18)	
Sex: No. (%)				
Male	222 (71.4)	285 (66.1)	50 (65.8)	0.290 ^b
Female	89 (28.6)	146 (33.9)	26 (34.2)	
Duration (in days): Median (Interquartile Range)				
Symptom onset to admission	4 (5)	4 (4)	2 (2)	<0.001 ^a
Admission to death	7 (8)	6 (7)	2.5 (4)	<0.001 ^a
Total duration	12 (10)	11 (9)	5 (6)	<0.001 ^a
Comorbidities: No. (%)				
Hypertension	166 (53.4)	216 (50.1)	40 (52.6)	0.669 ^b
Diabetes	159 (51.1)	256 (59.4)	32 (42.1)	0.006 ^b
Coronary artery disease	74 (23.8)	83 (19.3)	27 (35.5)	0.006 ^b
Chronic kidney disease	76 (24.4)	68 (15.8)	15 (19.7)	0.013 ^b
Chronic liver disease	18 (5.8)	23 (5.3)	3 (3.93)	0.815 ^b
Chronic respiratory illness	39 (12.5)	44 (10.2)	16 (21.1)	0.027 ^b
Stroke	29 (9.3)	25 (5.8)	23 (30.3)	<0.001 ^b
Malignancy	20 (6.4)	15 (3.5)	3 (3.9)	0.162 ^b

^aKruskal–Wallis test, ^bChi-square test

proportion of cases in the third wave compared to the first and the second wave. Similarly, stroke patients were seen to be significantly higher in the third wave. Hypertension, chronic liver disease, and malignancy were not significantly associated with the three waves.

Vaccination status of deceased in the three pandemic waves

Fourteen deceased patients in the second wave were vaccinated with one dose of a vaccine and one deceased patient had taken both doses of the COVISHIELD vaccine. Among the 76 deceased in the third wave, 28 were not vaccinated; 3 deceased took only one dose, and 39 deceased took two doses. Vaccination status of 6 patients could not be retrieved from records.

Figure 2 shows the vaccination status of the deceased in third wave.

Clinical characteristics

The symptoms on presentation to our hospital are shown in Table 2.

Most deaths occurred due to respiratory failure. The other main causes of death were septicemia, renal failure, and cardiac failure. From Table 2, there was a significant association between the presence of cough in the three waves; it was significantly lower in the third wave compared to the other two waves. There was no significant association between any of the other variables with the different waves.

Mortality in special categories

Mortalities in special categories are summarized in Table 3.

From Table 3, a significant association was observed between mortality in very old people with the different waves, in that the proportion of deaths among those aged

more than 80 years in the third wave was significantly higher than the first or second wave. None of the mortalities in the remaining special categories were found to have any significant association with the waves.

Mortality in young patients (≤ 50 years) was higher in the second wave. Even among the deceased young patients, most had comorbidities. In the first wave, 24 out of 30 (80%) young patients had comorbidities, and 37 out of 51 (72.5%) patients had comorbidities in the second wave. In other words, there were more deaths in young people who were healthy in the second wave.

Mortality in the elderly age group (≥ 70 years) was 3.14% higher in the second wave. This difference became more marked (7.7%) with advanced age (≥ 80 years). Of the elderly patients, relatively healthy people (without preexisting comorbidities) were more affected in the second wave (91.9% vs. 89.5%).

There was one maternal death in the first wave; four maternal deaths in the second wave, and none in third wave. Of the total five maternal deaths, four were older than 35 years, had diabetes, and were multiparous. Only one 24-year-old maternal death had no comorbidities.

Chest X-ray findings consistent with COVID pneumonia were found in 93.6% (236/252) of deaths in the first wave and 95% (387/407) of deaths in the second wave and 90% in third wave.

DISCUSSION

In the present study, total admissions and COVID-19 deaths were lowest in the third wave. This was likely to be due to increased vaccination. By January 01, 2022, when the third wave started, 98% of the eligible population was

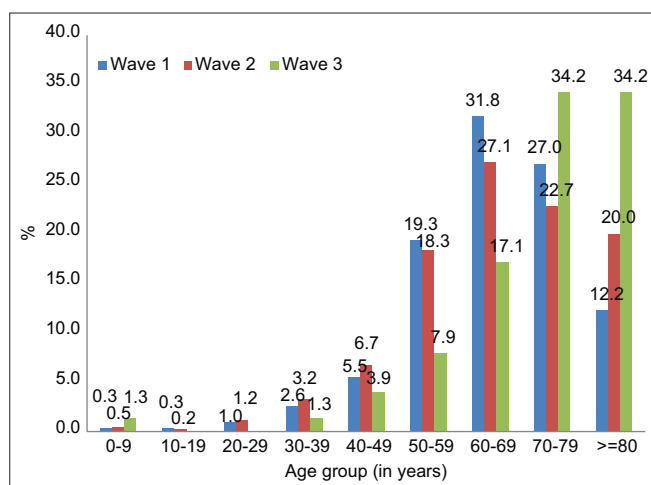


Figure 1: Age distribution of deceased in the three pandemic waves

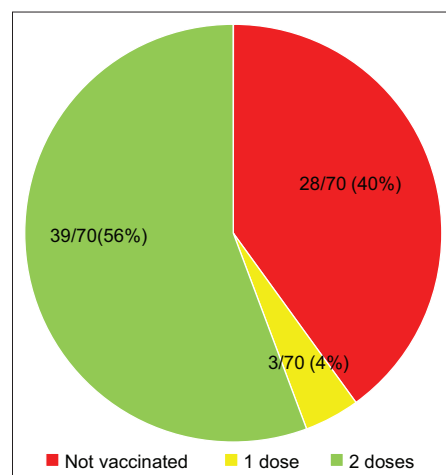


Figure 2: Vaccination status of the deceased in third wave

Table 2: Symptoms and causes of death of deceased with COVID-19 in the three pandemic waves

Characteristics	Wave 1 (July 1–December 31, 2020) (n=311)		Wave 2 (March 1–June 30, 2021) (n=431)		Wave 3 (January 1–March 31, 2022) (n=76)		P-value*
	n	%	n	%	n	%	
Clinical symptoms							
Fever	168	54	237	55	31	40.8	0.069
Cough	121	38.9	159	36.9	12	15.8	0.001
Breathlessness	193	62.1	295	68.4	57	75	0.051
Diarrhea	16	5.1	29	6.7	2	2.6	0.311
Cause of death							
Respiratory failure	275	88.4	368	85.4	68	89	0.372
Sepsis	50	16.1	78	18.1	14	18.3	0.759
Renal failure	121	38.9	169	39.2	26	34.6	0.706
Cardiac failure	81	26	104	24.1	17	22.3	0.749

*Chi-square test

Table 3: Mortality in special categories

Characteristic	Wave 1 n=311 (%)	Wave 2 n=431 (%)	Wave 3 n=76 (%)	P-value*
Mortality in young (<50 years)	30 (9.6)	51 (11.8)	5 (6.6)	0.317
Mortality in very old (≥80 years)	38 (12.2)	86 (20.0)	26 (34.2)	<0.001
Deaths with no pre-existing co morbidities	22 (7.1)	46 (10.7)	3 (3.9)	0.07
Maternal mortality	1 (0.3)	5 (1.2)	0 (0)	0.307
Mortality in children <18 years	2 (0.6)	3 (0.7)	1 (1.3)	0.820

*Chi-square test

vaccinated with a single dose of vaccine (26,158,413) and 79% with a double dose of vaccine (21,174,411) in Kerala state of South India, where this study was conducted.⁶ It should be noted that only 2% of eligible population were unvaccinated at the beginning of third wave and 40% of deaths (n=28/70) during third wave were in the unvaccinated group. Although the previous infection and vaccination offer little or no protection against infection with the omicron variant, they partially protect against hospitalization and severe disease.⁷ Better understanding of the disease and better treatment modalities are other causes contributing to the low mortality in the third wave.

The in-hospital mortality rates for the first, second, and third waves were 9.4%, 15.83%, and 10.47%, respectively. This in-hospital mortality rate was similar to the rate of 13.2% in a study done in Mumbai in a tertiary care center by Londhey et al.,⁸ during first wave and lower compared to the rate of 28% in a retrospective cohort study from China during early first wave.⁹

The in-hospital mortality rate was highest for the second wave in our study. Likewise, the number of deaths in the second wave was higher in India, as shown by the daily positivity rate and steep rise in the absolute number of cases.¹ This pattern of higher mortality has been observed in most other countries.¹⁰ In a study by Pednekar et al., in Mumbai, the in-hospital mortality rate among elderly during the second wave was 39.8%.¹¹ This could be due to

increased transmission or virulence of mutant viruses as well as due to the resource crunch at many areas during the second wave. The circulating variants in the second wave of COVID-19 in India, B.1.1.7 and B.1.617, are considered more transmissible and more virulent.¹²

In our study, the mean age of the deceased in both the first and second waves was similar (65 years) but was significantly higher in the third wave (75 years). Age stratification of the deaths differed in the three waves. COVID-19 has an extremely steep risk gradient for death across different age groups.¹⁰ In the present study, more young deaths (≤50 years) occurred in the second wave, and deaths among very old (≥80 years) were more in the third wave. There were significantly more deaths among the elderly in all three waves (aged ≥60 years) which was highest for the third wave (85%). This increase was more marked in those aged ≥80 years. However, these rates are low when compared to COVID-19 deaths in the elderly among total COVID-19 deaths occurring in high-income countries.¹⁰ This could be due to the predominantly younger population in India and higher life expectancy in high-income countries.

In our study, men were affected more than women during the three waves. Similar findings were noted in a study on first and second waves by the Indian Council of Medical Research (ICMR).¹³ These gender differences could have been due to immunological and lifestyle behaviors such

as smoking, health-related self-care, or other factors that could have changed the gendered impacts of the epidemic.¹⁴

The average duration of illness (symptom onset to death) was lower in the third wave. This could be due to increased mean age and comorbidities in the deceased with COVID-19 during the third wave. Mortality in COVID-19 was strongly influenced by preexisting comorbidities.¹⁵ Hypertension was the leading comorbidity in the first wave and third wave and diabetes in the second wave in our study. In our study, 91.3% of the deceased had comorbidities (n=747/818), especially in third wave (96%, n=73/76). This shows that following a healthy lifestyle and preventing lifestyle diseases such as diabetes and hypertension can be an effective preventive strategy and drastically lower mortality.

There were more deaths without preexisting comorbidities in the second wave in our study. Similar findings were noted in a study by the ICMR.¹⁰ This shows that the mutant viruses in the second wave were more capable of producing negative outcomes in healthy people.

There were five deceased with pregnancy in our study. Of these, four maternal deaths occurred in the second wave and none in the third wave. Four of the five maternal mortalities in our study had diabetes. The association between diabetes and COVID-19 deaths in pregnancy needs further evaluation. Only one deceased was younger than 35 years. This may indicate that age and diabetes are significant risk factors for COVID-19 mortality during pregnancy.

Mortality in children was very low in all three waves, consistent with other studies on age and mortality in COVID-19,¹⁶ but without a significant difference between waves.

The clinical presentation was similar in the three waves. Breathlessness was the most common presentation, followed by fever. Our findings were inconsistent with those of population-based studies where fever was the most common symptom. This may be due to the preferential referral of dyspneic patients from first- and second-line COVID-19 treatment centers to our center. Our center is the only major public tertiary health-care center for a large geographic area, has strict admission criteria, and caters mostly to patients requiring advanced care.

The strengths of our study include its single-center design with similar types of patients, admission criteria, and management by the same team during both waves, making the comparison relevant. The novelty of this study is the

comparison of the demography and clinical aspects of COVID-19 deaths in the three pandemic waves in India, as the data available is very limited, at the time, this paper is written.

Limitations of the study

Many known risk factors for COVID-19 mortality, such as obesity, socioeconomic status, and behavioral risk factors, such as smoking and alcohol addiction, could not be analyzed due to logistic difficulties.

CONCLUSION

The present comparative study shows that the three pandemic waves differ in their demographic and clinical characteristics. The second wave of COVID-19 differed from the first wave in the age distribution of COVID-19 deaths, with more deaths occurring in young (≤ 50 years of age) and in the third wave, there were more deaths in very old (≥ 80 years of age). Males were more affected in all waves, though the gender impact was statistically not significant among the three waves. The duration of disease from symptom onset to death was shorter in the third wave. Most of the deceased had comorbidities, hypertension being the most common comorbidity in the first and third waves and diabetes in the second wave. Maternal mortality and mortality in those without any preexisting comorbidities were higher in the second wave. Identifying those at higher risk for mortality, enhancing the vaccination drive and immunizing vulnerable populations quickly, and promoting healthy lifestyles to decrease comorbidities would be the most important strategy to prevent further deadly waves of COVID-19.

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REFERENCES

1. Ministry of Health and Family Welfare. Home. Available from: <https://www.mohfw.gov.in> [Last accessed on 10 May 2022]
2. Gavrilova NS and Gavrilov LA. Patterns of mortality during pandemic: An example of Spanish flu pandemic of 1918. *Popul Econ.* 2020;4(2):56-64. <https://doi.org/10.3897/popecon.4.e53492>
3. Rampal L and Liew BS. Malaysia's third COVID-19 wave a paradigm shift required. *Med J Malaysia.* 2021;76(1):1-4.
4. Karako K, Song P, Chen Y, Tang W and Kokudo N. Overview of the characteristics of and responses to the three waves of COVID-19 in Japan during 2020-2021. *Biosci Trends.* 2021;15(1):1-8. <https://doi.org/10.5582/bst.2021.01019>
5. El-Shabasy RM, Nayel MA, Taher MM, Abdelmonem R,

- Shoueir KR and Kenawy ER. Three waves changes, new variant strains, and vaccination effect against COVID-19 pandemic. *Int J Biol Macromol.* 2022;204:161-168.
<https://doi.org/10.1016/j.ijbiomac.2022.01.118>
6. Covid -19 Outbreak Control and Prevention State Cell Health and Family Welfare Department, Government of Kerala. Available from: <https://dhs.kerala.gov.in/wp-content/uploads/2022/01/Bulletin-HFWD-English-January-1.pdf> [Last accessed on 5 May 2022]
 7. Singhal T. The emergence of omicron: Challenging times are here again! *Indian J Pediatr.* 2022;89(5):490-496.
<https://doi.org/10.1016/j.ijbiomac.2022.01.118>
 8. Londhey V, Redkar N, Gulhane S, Yadav S, Memon F, Relwani P, et al. Analysis of COVID deaths: A single center experience in Mumbai medical college. *J Assoc Physicians India.* 2021;69(9):11-12.
 9. Zhou F, Yu T, Du R, Fan G, Liu Y, Liu Z, et al. Clinical course and risk factors for mortality of adult inpatients with COVID-19 in Wuhan, China: A retrospective cohort study. *Lancet.* 2020;395(10229):1054-1062.
[https://doi.org/10.1016/s0140-6736\(20\)30566-3](https://doi.org/10.1016/s0140-6736(20)30566-3)
 10. Ioannidis JP, Axfors C and Contopoulos-Ioannidis DG. Second versus first wave of COVID-19 deaths: Shifts in age distribution and in nursing home fatalities. *Environ Res.* 2021;195:110856.
<https://doi.org/10.1016/j.envres.2021.110856>
 11. Pednekar SJ, Sabesan S, Pandey D, Mirg S, Pawar N, Nandwani J, et al. Study of clinical spectrum of severe COVID-19 infection in elderly patients and its outcome a major Mumbai tertiary care hospital observations. *J Assoc Physicians India.* 2022;70(3):11-12.
 12. Indian SARS-CoV-2 Genomic Consortia (INSACOG) Key Aspects May 6, 2021. Available from: <http://dbtindia.gov.in/sites/default/files/INSACOG%20Key%20Aspects%20May%206%202021.pdf> [Last accessed on 2 May 2022]
 13. Kumar G, Mukherjee A, Sharma RK, Menon GR, Sahu D, Wig N, et al. Clinical profile of hospitalized COVID-19 patients in first and second wave of the pandemic: Insights from an Indian registry based observational study. *Indian J Med Res.* 2021;153(5-6):619-628.
https://doi.org/10.4103/ijmr.ijmr_1628_21
 14. Wenham C, Smith J, Morgan R. Gender and COVID-19 Working Group. COVID-19: the gendered impacts of the outbreak. *Lancet.* 2020;395(10227):846-848.
[https://doi.org/10.1016/s0140-6736\(20\)30526-2](https://doi.org/10.1016/s0140-6736(20)30526-2)
 15. Tian T, Zhang J, Hu L, Jiang Y, Duan C, Li Z, et al. Risk factors associated with mortality from COVID-19 in 3125 counties of the United States. *Infect Dis Poverty* 2021;10(1):3.
<https://doi.org/10.1186/s40249-020-00786-0>
 16. Bonanad C, García-Blas S, Tarazona-Santabalbina F, Sanchis J, Bertomeu-González V, Fácila L, et al. The effect of age on mortality in patients WITH COVID-19: A meta-analysis with 611,583 subjects. *J Am Med Dir Assoc.* 2020;21(7):915-918.
<https://doi.org/10.1016/j.jamda.2020.05.045>

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MM- Concept and design of the study, data acquisition and analysis, drafting of manuscript, and final approval of manuscript; **RK**- Data acquisition and analysis and interpretation of results; **AK**- Data collection and review of literature; **SK**- Planning of study design, critically reviewing the article, and preparation of manuscript; and **BD**- Statistical analysis and interpretation of results

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