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*Research Article*

# Clinical Characteristics and Risk Factors Associated with COVID-19 Mortality: A Retrospective Study

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**ABSTRACT**

**Background**: COVID-19 originating in the end of Dec 2019, linked to the SARS-CoV-2 has presented major health challenges for people around the globe**,** with over 773 million cases and 6.91 million mortality recorded asof December 2023. In India, a total of 44.9 million confirmed positive COVID-19 cases, resulting in the 533,392 deaths. The COVID-19, which caused widespread mortality globally, necessitates a focused and thorough analysisof inpatient fatalities.

**Aim**: This study aimed to investigate the risk factors and clinical characteristics associated with mortality in COVID-19 patients.

**Material and Methods**: This observational analytical study was conducted at the Integral Institute of Medical Sciences and Research, Integral University, Lucknow, between December 2020 and June 2021. Out of 1,196 confirmed positive cases, 107 adult mortality cases were thoroughly examined. The data analysis included the use of frequencies, mean values with standard deviations, as well as bivariate and multivariate statistical techniques.

**Results**: The study revealed an overall mortality rate of 1.57% among admitted COVID-19 patients, with a case fatality rate of 8.9%. This study shows outmost number of COVID-19-related deaths occurred in April 2021, representing 61% of total fatalities. Males accounted for 67.37% of the deaths, while females comprised 33%. Theage group of 41-60 years shows the highest mortality rate, contributing to 44.85% of the total deaths. Among the patients, 69 (64%) and 38 (35%) were from rural areas and urban areas simultaneously. Fever (91.5%) and breathlessness (84.1%) were the most commonly reported symptoms, with hypertension being the most prevalentcomorbidity, affecting 34.58% of deceased patients. Increased inflammatory markers, such as increased CRP levels and WBC counts, were strongly linked to severe disease progression. Additionally, male patients showed higher levels of urea, creatinine, D-dimer, and blood glucose, indicating more severe systemic inflammation.

**Conclusions**: A mortality rate of 1.57% was observed in the study population. Despite the shorter duration of thesecond wave, it resulted in a higher number of deaths, potentially due to more virulent strains or overwhelmed healthcare systems. These findings underscore the vitality of early identification and approaches for Addressing the needs of high risk Groups, emphasizing the importance of the biochemical markers in prognosticating the severity in COVID-19 Patients.

**Keywords:** COVID-19, Mortality, Comorbidities, C-reactive Protein, Hyperglycemia

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**BACKGROUND**

In late December 2019, healthcare institutions in Wuhan, China began to analyze situations involving pneumonia with an unknown source[1-3]. This illness was eventually identified as being caused by novel coronavirus, later named Severe Acute Respiratory Syndrome Coronavirus 2 (SARS-CoV-2). The WHO subsequently labeled the disease as Coronavirus Disease 2019 (COVID-19) [4]. The emergence of SARS-CoV-2 triggered an unprecedented health crisis [5-7].

As of December 2023, the WHO reported 773million confirmed COVID-19 cases and 6.9 million mortalities worldwide. India witnessedthe second-highest number of cases globally, with 41.47 million, behind the United States, which recorded 73.53 million cases. Regarding fatalities, India ranked third, with 0.49 milliondeaths, trailing the United States (US) 0.87million and Brazil 0.62 million mortality [8-9].The COVID-19 pandemic caused multi-organ failures, primarily affecting the lungs, heart, kidneys, and liver, which prolonged hospital stays and contributed to high mortality rates. Despite global advancements in COVID-19 research, there has been limited explorationinto the connections between clinical factors, demographic variables, and mortality rates, particularly in India. To bridge this gap, the present study seeks investigation the clinical characteristics and risk factors associated withCOVID-19 deaths at Integral Institute of Medical Sciences and Research Hospital in Lucknow.

**MATERIAL AND METHODS**: This hospital-based, cross-sectional study was conducted to identifyCOVID-19 mortality patterns during the first and second waves from December 2020 to June2021 at the Department of Microbiology, Integral Institute of Medical Sciences and Research, Integral University, Lucknow. The investigation encompassed all hospitalizedindividuals who were RT-PCR positive for COVID-19 during the first wave (October 2020 to February 2021) and the second wave (March 2021 to June 2021). Among the 1,196 patients admitted with confirmed COVID-19 through RT-PCR, data were analyzed from 107adults who died due to the disease.

Comprehensive demographic information, symptoms, comorbidities, and hospitalization details were collected from ICMR specimen referral forms for COVID-19, mortality case sheets, and medical audit reports. The analysis revealed significant differences in mortality patterns between the first and second waves, underscoring variations in comorbidities, age distribution, and disease severity among patients.

The case fatality rate and mortality was calculated using formula:

Case Fatality Rate = Number of patient who died of COVID-19 / Total number of positive cases of COVID-19 x 100

Mortality rate = Number of patient who died with COVID-19/ Total Population at risk during that period x 100

Inclusion Criteria: The study included all mortality cases of patients who tested positive with SARS-CoV-2, were clinically diagnosed for COVID-19, and had comprehensive medical records were available for data extraction.

Exclusion Criteria**:** The study excluded COVID-19 patients died on arrival without undergoing RT-PCR testing and those involved in medico-legal cases at IIMSR, Integral University, Lucknow.

**RESULTS**

Out of total 1,196 confirmed SARS-CoV-2 cases, detected through RT-PCR, were evaluated in this study. Among these cases, 107 adult mortality cases were scrutinized, resulting in a case fatality rate of 8.9% and mortality rate of 1.57%. The highest number of COVID-19-related deaths occurred in April2021, accounting for 61% of the total fatalities.The age group of 41-60 years had the leading mortality rate, representing 44.85% of totaldeaths. Among the patients analyzed, 69 (64%)were from rural areas, while 38 (35%) were from urban areas. The predominant symptomsobserved among COVID-19 patients included fever (91.51%) and breathlessness (84%). Additionally, the study emphasizes the relationship between comorbid conditions and adverse COVID-19 outcomes. Common Comorbidities were Diabetes mellitusand Hypertension. Patients with pre-existing conditions such as Diabetes Mellitus and Hypertension exhibited a higher risk of severe complications and mortality, suggesting that comorbidities significantly impact patient prognosis.

Notably, significant gender- based differences were identified in hematological parameters, the elevated levels of inflammatory markers like C-reactive protein (CRP) and D-dimer in male patients further indicate a more intense inflammatory response, which could contribute to the increased severity observed among this group, theseinsights underscore the very importance of integrating gender-specific criteria in clinical assessments to enhance the accuracy of diagnostic evaluations and tailor management strategies effectively in future pandemic scenario of COVID-19 infection.

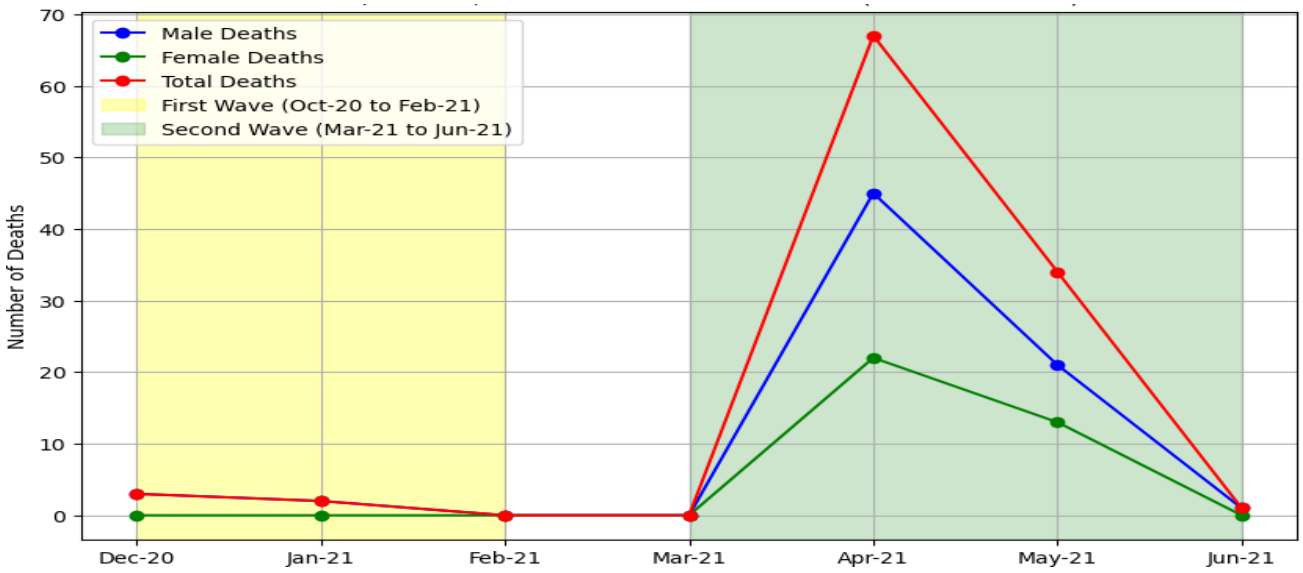


**Figure 1: Monthly COVID-19 Mortality Rates from December 2020 to June 2021**

Figure 1. depicts COVID-19-related deaths by gender from December 2020 to June 2021, highlighting two distinct infection waves. In the first wave, male deaths were sporadic, primarily occurring in December 2020 and February 2021, while female deaths remained negligible. A notable increase in deaths commenced in March 2021, with peakmortality recorded in April 2021, totaling 66deaths. Following April, a gradual decline in the number of deaths was observed May 2021 and June 2021.

**Table 1. Distribution of patients by age and gender**

| Age Interval | Male Patients (n) | Male Patients (%) | Female Patients (n) | Female Patients (%) | Overall (n) | Overall (%) |
|---|---|---|---|---|---|---|
| 0-20 | 0 | 0% | 1 | 0.93% | 1 | 0.93% |
| 21-40 | 5 | 4.67% | 2 | 1.86% | 7 | 6.54% |
| 41-60 | 31 | 28.90% | 17 | 15.88% | 48 | 44.85% |
| 61-80 | 29 | 27.10% | 13 | 12.10% | 42 | 39.25% |
| 81-100 | 7 | 6.54% | 2 | 1.86% | 9 | 8.41% |
| **Total** | **72** | **67.37%** | **35** | **32.63%** | **107** | **100%** |

Table 1. presents the age distribution of COVID-19 fatalities among the study population, which included 107 deaths, comprising one neonate and 106 adults. The data indicate that the majority of deaths (44.85%) occurred in individuals aged 41-60 years, followed by the 61-80 age group (39.25%). Overall, males accounted for 67.37% of the fatalities, while females represented 32.63%. This age-sex distribution offers valuable insights into the demographic characteristics of adult mortalities within the study population.

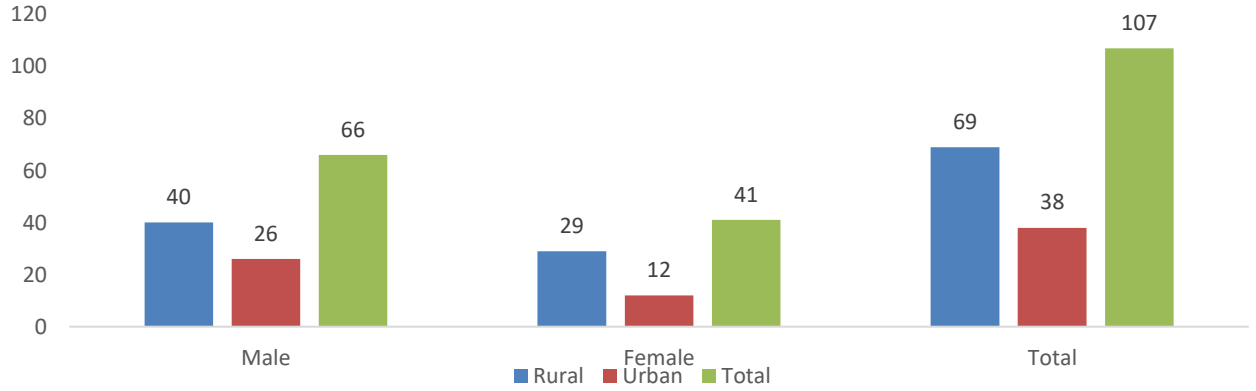


**Fig 2: Gender distribution in Rural and Urban population**

Fig 2 shows that in the rural category, we observed 40 males and 29 females, resulting in a total of 69 individuals. Conversely, the urban category comprised 26 males and 12 females, yielding a total of 38 individuals. Overall, the sample included 107 participants, with 66 males (61.68%) and 41 females (38.32%). The rural population constituted 64.5% of the total sample, with males representing a larger proportion in both settings 57.97% in rural and 68.42% in urban areas.

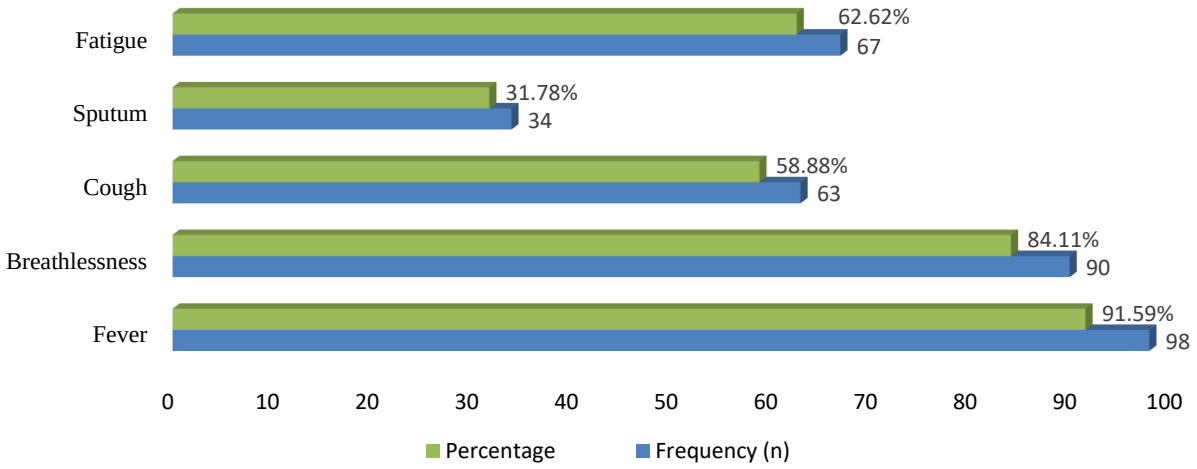


**Figure 3. Distribution of Symptoms in COVID-19 Patients**

Fig 3. The bar chart illustrates the prevalence of various symptoms among patients, displaying both the frequency (n) and the corresponding percentage of occurrence. The most frequently reported symptom is fever**,** observed in 91.59% of cases (n = 98). This is closely followed by breathlessness**,** affecting 84.11% of patients (n = 90). Fatigue is another common symptom, occurring in 62.62% of individuals (n = 67), while cough is reported by 58.88% (n = 63). The least common symptom is sputum production**,** which is noted in 31.78% of patients (n = 34).

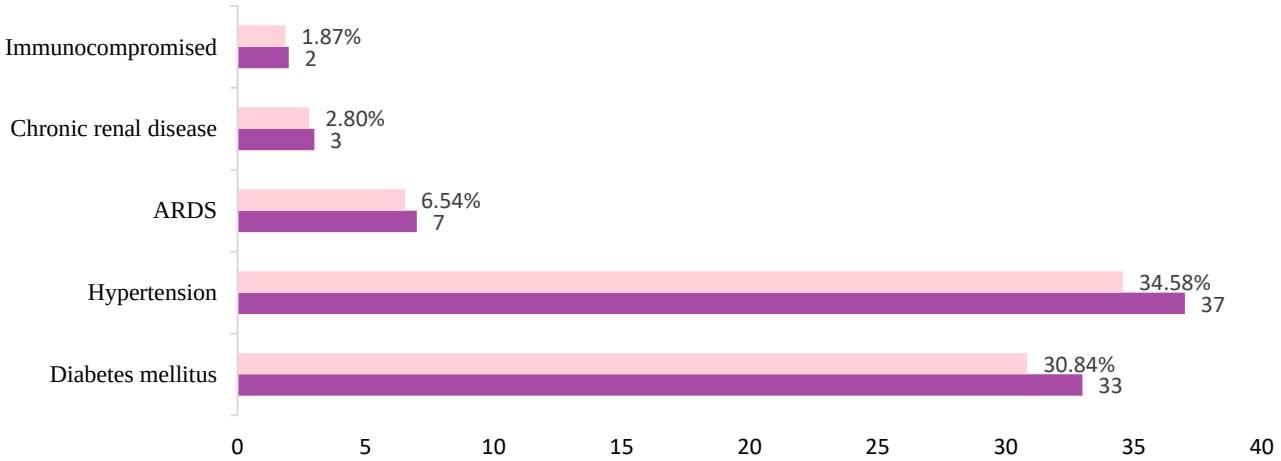


**Figure 4. The Distribution of Comorbidities in COVID-19 Patients**

Fig. 4 represents the distribution of health comorbidities among COVID-19 patients, revealingthat a significant number of cases involved underlying health conditions. The most prevalent comorbidities were hypertension (34.57%) followed by diabetes mellitus affecting (30.8%) of patients. In contrast, acute respiratory distress syndrome was reported in 6.5% of cases, a critical condition linked to severe lung damage and respiratory failure in COVID-19. Chronicrenal disease was observed in 2.81% of patients, highlighting the additional risks faced by individuals with impaired kidney function. Immunocompromised status, including condition such as HIV, cancer, or those on immunosuppressive therapy, was reported in 1.87% of cases,indicating that such patients remain a vulnerable group for severe COVID-19 complications.

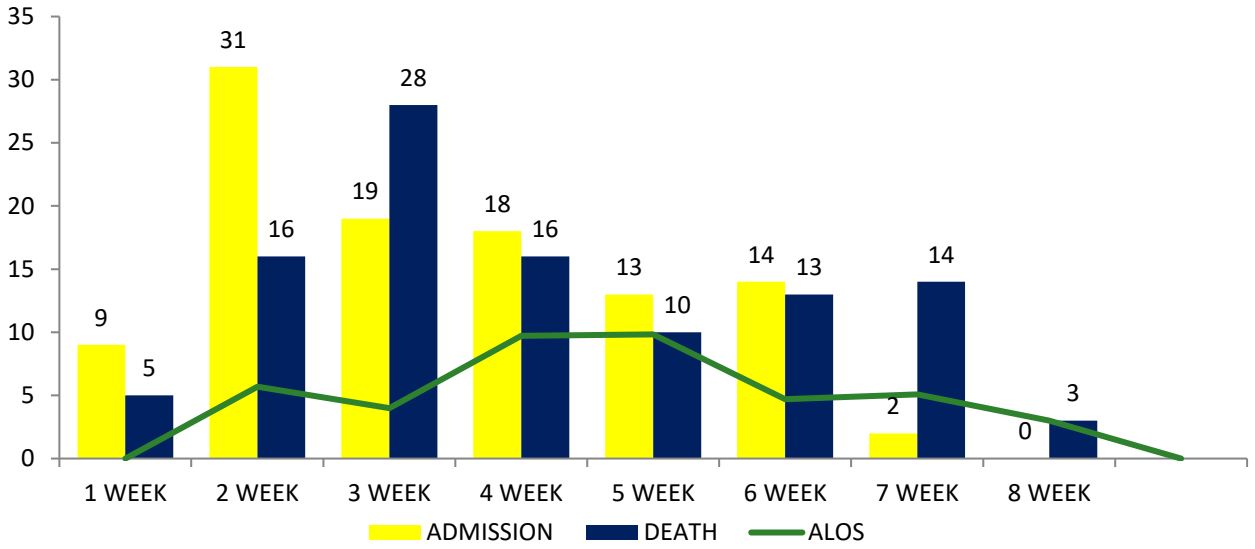


**Fig.5: Admissions, Deaths, and Mean duration during Hospitalization**

**Fig 5.** Shows the analysis of trends in admissions, mortality, and average length of stay (ALOS)over an 8-week period revealed critical insights into healthcare dynamics. Admissions peakedin Week 2 at 31 patients, followed by a mortality peak of 28 deaths in Week 3 ($p < 0.05$), indicating a significant lag attributed to disease progression and delays in intensive care. ALOSreached a maximum of 10 days in Week 4 & week 5, highlighting the prolonged hospitalizationrequired for critically ill patients. This was associated with a subsequent decline in ALOS to 3 days by Week 8, coinciding with a reduction in mortality to 3 deaths, suggesting improved patient outcomes and healthcare management ($r = 0.85$, $p < 0.01$). These findings illustrate the healthcare system's capacity to adapt to fluctuating patient loads and underscore the importance of timely interventions in optimizing resource utilization and enhancing survival rates.

**Table 2. Hematological and Biochemical Parameters by gender**

| Parameters | Gender | n | Mean Value | Std. Deviation | p-value | Min Value | Max Value |
|---|---|---|---|---|---|---|---|
| **Hemoglobin (12-18 gm/dl)** | M | 35 | 11.73 | 0.9 | | 9.2 | 18 |
| | F | 17 | 11.18 | 2.4 | 0.23 | 4.7 | 13.8 |
| **Leucocytes(4000-11,000cu/mm)** | M | 35 | 14832.4 | 8520.8 | | 4500 | 58000 |
| | F | 17 | 10512.5 | 5932.7 | 0.0664 | 4600 | 25800 |
| **Platelets (1.5-4.5 lac/cumm)** | M | 35 | 222000 | 78000 | | 80000 | 440000 |
| | F | 17 | 198000 | 84300 | 0.31 | 43300 | 500000 |
| **Urea (15-40 mg/dl)** | M | 29 | 47.982 | 25.14 | | 22 | 116 |
| | F | 17 | 49.65 | 12.33 | 0.79 | 19 | 244 |
| **Creatinine (0.5-1.3 mg/dl)** | M | 31 | 1.536 | 0.91 | | 0.87 | 6.01 |
| | F | 16 | 1.007 | 0.28 | 0.028 | 0.5 | 1.26 |
| **D-dimer (500 ng/ml)** | M | 22 | 1472 | 1557 | | 129 | 4500 |
| | F | 10 | 1730 | 1680 | 0.67 | 85 | 4000 |
| **CRP (3 mg/L)** | M | 19 | 145 | 86.71 | | 22 | 302 |
| | F | 12 | 56.67 | 68.03 | 0.0056 | 3.0 | 262 |
| **Blood glucose (70-140 mg/dl)** | M | 14 | 161.85 | 28.28 | | 86 | 277 |
| | F | 7 | 126 | 15.45 | 0.0058 | 79 | 640 |

Table No. 2 analyzes hematological and biochemical parameters that revealed significant gender differences in several markers among patients infected with COVID-19. Males disclosed significantly higher mean of creatinine (1.536 mg/dl, p=0.028), CRP (145 mg/l, p=0.0056), and blood glucose (161.85 mg/dl, p=0.0058), indicating greater renal impairment, systemic inflammation, and poorer glycemic control compared to females. This suggests that male COVID-19 patients may require more intensive monitoring and management of renal andinflammatory markers, as well as tighter control of blood glucose levels to mitigate disease progression and complications

This table shows no significant differences in hemoglobin (p=0.23), leucocytes (p=0.0664), platelets (p=0.31), urea (p=0.79), or D-dimer levels (p=0.67), suggesting that these parameters do not vary significantly by gender in this cohort. However, elevated mean leucocyte counts in males (14,832.4 cells/mm³) compared to females (10,512.5 cells/mm³) approached statistical significance, hinting at a potential trend that could warrant further investigation in a larger cohort. Moreover, blood glucose levels were also elevated in males (mean 161.85 mg/dl) compared to females (mean 126 mg/dl), highlighting gender differences in metabolic health.

**DISCUSSION:**

This retrospective observational investigation analyzed data from the 107 patients admitted toIntegral Hospital with a positive COVID-19 diagnosis.to discern the clinical and laboratoryfactors linked to mortality. The study identified two distinct peaks in Mortality rate between April and May 2021, coinciding with the surge of the highly transmissible and virulent Delta variant in second wave. The findings indicate an overall case fatality rate of 8.9%, significantly higher than the early global estimates of 3% to 4%. However, there were considerable regional disparities, with Maharashtra reporting an exceptionally high CFR of 29.4% compared to lower rates in Delhiand Rajasthan at 4.5% and 2.23%, respectively [12-15]. These substantial differences in regional CFR are likely a reflection of the varied healthcare infrastructure, population density.

The persistent trend of elevated mortality ratesamong males with COVID-19 is consistent with global research, underscoring gender- specific disparities and revealing a greater susceptibility of males to severe outcomes andhigher fatality rates from the disease. [16-21]. This study indicates, 44.85% of COVID-19related deaths occurred among individuals aged 41-60, which aligns with previous reports suggesting that this age group, often more exposed through work-related activities, faces a higher caseload compared to the general population in India [22].

This study shows that fever and breathlessnesswere the most common sign & symptoms among COVID-19 cases, reported by 91.5% and 84.1% of patients, respectively. A study from Lucknow similarly found that approximately 86% of individuals were symptomatic upon hospital admission with fever, cough, and breathlessness being the predominant symptoms. Studies frequently suggest that chronic comorbidities are associated with a higher severity of COVID-19 and greater mortality risks.

Hypertension and Diabetes emerged as the most typical comorbidities, consistent with findings reported in studies conducted in otherregions [23-27].

This finding aligns with the observations madein our study, consistent with the findings by Chilimuri et al [28], Previous research has demonstrated that treatments for diabetes and hypertension, such as ACE angiotensin converting enzyme inhibitors as well as angiotensin I type II receptor blockers, can elevate expression of the ACE2 receptors. This elevation potentially increases the risk of fatal complications of COVID-19 [29].

In the analysis of laboratory variables, individuals who succumbed to the illness exhibited notably elevated levels of leukocytes, neutrophils, and reduced lymphocyte countshave consistently been established as well- documented risk factors associated with severe COVID-19 disease [30, 31] Notably, patients with severe COVID-19 disease exhibited only a moderate increase in WBC number, whereas patient who did not survive were identified to be more clinically elevated WBC. In terms of hematological parameters, our study demonstrated a significant correlation betweenelevated total leukocyte count (TLC) and disease severity, with a statistically significant result ($P < 0.001$) [32-34]. Multiple earlierinvestigations demonstrated a decrease in lymphocyte counts in the context of COVID- 19 infections [35-36].

Additionally, this study also highlights that a significant number of patients developed elevated blood glucose levels during their illness. Significantly, elevated blood glucose levels in patients with COVID-19 infectionmay reflect the body's pathophysiological response to the infection. Several studies have indicated that elevated blood glucose is linked to more severe disease progression [37-41].The levels of (CRP) have appeared as a crucial biomarker for assessing the severity of COVID-19 infections. Elevated CRP levels are indicative of an acute inflammatory response, which is often correlated with more severemanifestations of the disease. In this study, individuals who did not survive exhibited significantly more CRP levels compared than those observed in patients withless severe outcomes. This finding underscoresthe significance of CRP as a prognostic tool inclinical settings. [42].

**Conclusion:** With an observed case fatality rate of 1.57%, our findings highlight the importance of identifying demographic and clinical factors contributing to severe outcomes. Despite being shorter in duration, comparatively with first wave, the second waveof COVID-19 was linked with a disproportionately higher fatality rate, underscoring the need for more

robust preparedness and response strategies in future outbreaks. The higher mortality rate amongmales and individuals with concurrent health issues like hypertension and diabetes mellitus signals the vulnerability of certain populations. In particular, the frequent occurrence of hyperglycemia in deceased patientsemphasizes the importance of comprehensive management.

Additionally, elevated inflammatory markers, including WBC counts and CRP levels, emerge as important predictors of adverse outcomes. These findings call for further investigationand targeted interventions to reduce mortality and improve public health responses in future pandemics. The study was conducted at a single tertiary care Integral Hospital, but its findings align with the majority of systematic reviews and meta-analyses.

**Limitations:** The narrow timeframe of the study may not adequately capture changes in mortality trends over time. Furthermore, the single-center, referral-based design limits the representativeness of the findings. Futureresearch involving multiple centers and extended periods is warranted to validate theseresults.

**Conflict of Interest:** The authors collectively assert that there are no conflicts of interest concerning the publication of this researcharticle.

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