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Original Article

Epidemiology Section

Survival and Risk Modelling of Mucormycosis Outcomes in Post COVID-19 Era: A Retrospective Observational Study

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ABSTRACT

Introduction: Mucormycosis is a rare but potentially lethal fungal infection with a high morbidity and fatality rate that is brought on by filamentous fungi. With high death rates, mucormycosis has become a serious opportunistic illness, especially in the post Coronavirus disease 2019 (COVID-19) period. With more instances reported globally, the COVID-19 pandemic has reignited interest in this pathogen. Understanding the time to adverse outcomes and their predictors can inform clinical prioritisation and resource allocation to reduce mortality.

Aim: To evaluate survival time and identify independent predictors of mortality among hospitalised mucormycosis patients using time-to-event analysis.

Materials and Methods: This retrospective observational study was conducted at the Department of Community Medicine, Dr. V.M. Government Medical College, Solapur, Maharashtra, India, a tertiary care government hospital, from April 2025 to June 2025. A total of 270 confirmed mucormycosis cases admitted between January 2021 to December 2022 were included. Survival analysis using the Kaplan-Meier method was performed to estimate survival probabilities and compared using the log-rank test. Hazard ratios (HRs) and 95% Confidence Intervals (CIs) were computed for each covariate. Statistical analysis was done using IBM Statistical Package for Social Sciences (SPSS) statistics version 25.0, with p-value <0.05 considered statistically significant.

Results: Of 270 patients, 66 (24.4%) died. Older age (>60 years), COVID-19 positivity, and absence of surgical intervention were significantly associated with reduced survival. Patients aged 20-40 years (HR=0.24; 95% CI: 0.08–0.68; p-value=0.008) and 41-60 years (HR=0.57, p-value=0.03) had better survival compared to those >60 years. COVID-19 positivity increased mortality risk nearly two-fold (HR=1.92, p-value=0.015). Lack of surgical intervention was associated with a markedly higher hazard of death (HR=4.57, p-value <0.001).

Conclusion: Advanced age, COVID-19 positivity, and absence of surgical management independently predicted mortality in mucormycosis patients. Early diagnosis and timely surgical intervention are crucial to improving survival in the post pandemic period.

Keywords: Complications, Coronavirus disease 2019, Coronavirus pandemic, Fungal infection, Mortality, Risk factors, Survival analysis

INTRODUCTION

Mucormycosis is a rare but aggressive angioinvasive fungal infection caused by filamentous fungi belonging to the order Mucorales of the class Zygomycetes. It predominantly affects immunocompromised individuals and is associated with high morbidity and mortality despite advances in antifungal therapy and surgical management [1,2].

Globally, mucormycosis has been considered an uncommon infection; however, its burden is disproportionately high in India. Prakash H and Chakrabarti A reported that India accounts for nearly 70% of the global burden of mucormycosis, with an estimated prevalence of approximately 140 cases per million population-significantly higher than that reported from developed countries [2]. Roden MM et al., reported overall mortality rates ranging from 20% to 50%, with mortality increasing to 70-90% among critically ill, immunocompromised patients and those with disseminated disease [1].

The second wave of the COVID-19 pandemic had a profound impact on the Indian healthcare system. During this period, daily COVID-19 cases increased sharply from approximately 11,794 cases in early February 2021 to over 315,000 cases by April 2021 [3]. This surge was accompanied by an unprecedented rise in cases of COVID-19-associated Mucormycosis (CAM), bringing renewed attention to this otherwise rare fungal infection.

Increasing reports of mucormycosis among patients with COVID-19 have been documented worldwide, particularly from India [3,4]. COVID-19 creates a favourable milieu for fungal proliferation through immune dysregulation, uncontrolled hyperglycaemia, corticosteroid therapy, hypoxia, acidic metabolic states, and elevated iron levels [3,4]. Singh AK et al., in their systematic review highlighted India as the epicentre of CAM cases during the pandemic, emphasising the role of diabetes mellitus and steroid exposure as major predisposing factors [4].

Clinically, mucormycosis presents in various forms, including rhino-orbital-cerebral, pulmonary, cutaneous, gastrointestinal, and disseminated infections, with rhino-orbital-cerebral involvement being the most frequently reported form in COVID-19 associated cases [5,6]. Despite aggressive medical and surgical treatment, outcomes remain poor in a significant proportion of patients.

Although numerous studies have described the epidemiology and clinical characteristics of mucormycosis [1,2,7,8], limited literature has focused on time-to-event outcomes using robust survival analysis methods [9,10]. Understanding survival duration and identifying predictors of mortality using Kaplan-Meier and Cox proportional hazards models may aid clinicians in early risk stratification, prioritisation of surgical intervention, and optimal resource allocation.

In view of the high morbidity and mortality associated with mucormycosis and the marked resurgence of cases during the COVID-19 pandemic, the present study was conducted among mucormycosis patients admitted to a tertiary care government hospital in Western Maharashtra and aimed to evaluate survival patterns and identify predictors of mortality using time-to-event analysis.

MATERIALS AND METHODS

The present study was designed as a retrospective observational study aimed at analysing survival time and identifying clinical predictors of mortality among patients diagnosed with mucormycosis. The study was conducted at the Department of Community Medicine, Dr. V.M. Government Medical College, Solapur, Maharashtra, India, from April 2025 to June 2025. This hospital functions as a major referral centre for the surrounding rural and urban districts. During the COVID-19 pandemic, and particularly in the aftermath of India's second wave, the hospital played a critical role in managing post COVID-19 complications, including a substantial burden of mucormycosis cases.

The study included mucormycosis cases admitted over two years from January 2021 to December 2022, encompassing the peak of the second wave of the COVID-19 pandemic and the subsequent post wave period in India. Data were collected retrospectively from hospital medical records. Data compilation, verification, and statistical analysis were performed from April 2025 to June 2025. This timeline allowed adequate follow-up for in-hospital outcomes and ensured completeness of time-to-event data required for survival analysis.

Inclusion criteria: Patients admitted between January 2021 and December 2022 with a confirmed diagnosis of mucormycosis, either based on clinical suspicion corroborated by imaging or microbiological confirmation, via Potassium Hydroxide (KOH) mount and/or fungal culture, were included in the study. The criteria ensured that only patients with verifiable and complete time-to-event data were included, thereby maintaining the integrity of the survival analysis.

Exclusion criteria: Only cases with complete medical records were considered eligible, including availability of demographic details, diagnostic test results, treatment information, and documented survival outcomes. Cases with incomplete records- particularly those lacking information on time of admission or discharge, COVID-19 status, surgical intervention, or treatment outcome were excluded from the analysis.

Study Procedure

Data were collected retrospectively from the hospital's Medical Records Department using a structured data abstraction form. Each patient's file was reviewed by trained investigators under supervision to ensure data consistency and minimise transcription errors.

The following variables were extracted: Demographic Information: age, gender (male, female), residence (urban, rural).

The clinical and diagnostic parameters determined COVID-19 status- via Reverse Transcriptase Polymerase Chain Reaction (RT-PCR) or rapid antigen test, Diabetes Mellitus (DM) -diagnosed based on medical history or glycaemic indices, Steroid use recorded, if corticosteroids were administered within four weeks prior to mucormycosis diagnosis, KOH mount result (positive or negative), fungal culture result (positive or negative).

Treatment details: Mode of admission (emergency or routine referral), antifungal therapy (administered or not; details were captured where available), surgical intervention (yes/no; including type of procedure if documented), duration of hospital stay (in days).

Outcome variables:

- Survival status: Deceased or cured (discharged alive)
- Survival time: Number of days from hospital admission to death or discharge

Cured patients were treated as censored observations in the survival model.

The primary endpoint was in-hospital mortality, and survival time was defined accordingly. Patients who survived until discharge were not assumed to remain event-free beyond hospitalisation, hence the need for censoring in survival analysis. This approach reflects standard conventions in medical survival studies and allows for appropriate statistical treatment of patients with incomplete follow-up.

STATISTICAL ANALYSIS

All analyses were conducted using IBM SPSS Statistics for Windows, version 25.0 (IBM Corp., Armonk, NY, USA). Descriptive Analysis such as frequencies and percentages were used for categorical variables, Means and standard deviations were calculated for continuous variables. Kaplan-Meier method was applied to estimate survival probabilities and generate survival curves for different subgroups, the log-rank test was used to compare survival distributions across categories (e.g., by age group, COVID-19 status, surgical intervention). Cox proportional hazards regression was performed to identify independent predictors of mortality while adjusting for potential confounders. Variables significant at p-value <0.05 in univariate analyses were entered into the multivariate model. Hazard ratios (HRs) and 95% Confidence Intervals (CIs) were computed for each covariate. The proportional hazards assumption was assessed using Log-minus-log survival plots, Schoenfeld residuals.

RESULTS

Basic characteristics: Among the 270 patients included in the analysis, 204 (75.6%) were cured, while 66 (24.4%) succumbed to the illness. Outcomes varied across demographic and clinical variables.

Age was significantly associated with outcomes. The highest cure rate was observed in patients aged 20-40 years (91.3%), followed by those aged 41-60 years (78.3%). Patients over 60 years had the lowest cure rate (62.8%) and the highest mortality (37.2%).

Gender also showed a disparity in outcomes, though not statistically significant (p-value=0.18). Males had a higher cure rate (78.2%) compared to females (70.8%), while mortality was higher in females (29.2% vs. 21.8%).

No significant difference in outcome was observed based on residential location (p-value=0.96). Cure rates were similar in rural (75.5%) and urban (75.8%) patients.

Mode of admission was associated with clinical outcome. Referred patients had a higher cure rate (86.2%) compared to those admitted directly (72.2%), and lower mortality (13.8% vs. 27.8%).

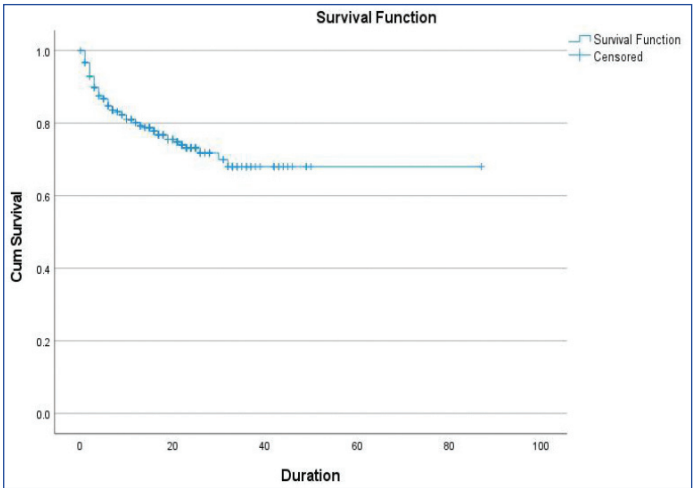
Symptom duration prior to presentation showed a strong association with outcome. Patients presenting within 1-7 days of symptom onset had the highest mortality whereas those presenting later had more favourable outcomes (64.3% for 0-1 day; 61.8% for 2-7 days), whereas those presenting later had more favourable outcomes. Cure rates increased progressively with longer symptom duration: 65.6% at two weeks, 90.0% at three weeks, and 94.9% at ≥4 weeks [Table/Fig-1].

Kaplan-Meier survival analysis: Survival probabilities were estimated using Kaplan-Meier curves for the entire cohort as well as stratified by key demographic and clinical variables. The overall survival curve demonstrated a steady decline in survival probability over time, with a pronounced drop observed in the initial 30-60 days of hospitalisation [Table/Fig-2]. This suggests a concentration of mortality events early in the course of hospitalisation, consistent with the clinical severity of mucormycosis.

Characteristics	Cured (n=204)	Death (n=66)	Total	χ^2 value	p-value
Age (in years)					
20-40	42 (91.3)	4 (8.7)	46	14.3	<0.001**
41-60	108 (78.3)	30 (21.7)	138		
>60	54 (62.8)	32 (37.2)	86		
Gender					
Male	136 (78.2)	38 (21.8)	174	1.79	0.18
Female	68 (70.8)	28 (29.2)	96		
Residence					
Urban	50 (75.8)	16 (24.2)	66	0.002	0.96
Rural	154 (75.5)	50 (24.5)	204		
Mode of admission					
Direct admission	148 (72.2)	57 (27.8)	205	5.21	0.02*
Referred cases	56 (86.2)	9 (13.8)	65		
Duration (days)					
0-1 day	5 (35.7)	9 (64.3)	14	83.41	<0.001**
2-7 days	21 (38.2)	34 (61.8)	55		
1-2 weeks	21 (65.6)	11 (34.4)	32		
3 weeks	63 (90.0)	7 (10.0)	70		
≥4 weeks	94 (94.9)	5 (5.1)	99		

[Table/Fig-1]: Basic characteristics of the study population (N=270).

The mean survival time among the overall cohort was observed to be 62.8±2.8 days. The observed cumulative survival probability of mucormycosis patients over time. Each tick mark represents a censored case. The curve indicates an early decline in survival, with stabilisation after approximately 40 days and a cumulative survival estimate of ~68-70% at 90 days [Table/Fig-2].



[Table/Fig-2]: Kaplan-Meier survival curve.

A Kaplan-Meier survival analysis was conducted to evaluate the impact of clinical and demographic variables on patient survival, with survival differences assessed using the log-rank test.

Age was a significant predictor of survival (p-value <0.001**). The 41-60 year age group had the most favourable outcomes (mean: 64.6 days; 95% CI: 56.9-72.3), while patients older than 60 years had the poorest survival (31.4 days; 95% CI: 26.3-36.6). Younger patients (20-40 years) had intermediate survival durations (44.8 days; 95% CI: 40.9-48.7). No significant survival differences were observed based on gender (p-value=0.237), place of residence (p-value=0.782), or steroid therapy status (p-value=0.214). Although some differences in mean survival were noted across these groups (e.g., males: 65.0 days vs. females: 35.1 days), these did not reach statistical significance. Urban patients had a longer mean survival (62.1 days; 95% CI: 50.7-73.6) than rural patients (37.9 days; 95% CI: 34.9-40.8).

Furthermore, mode of admission was associated with survival (p-value=0.036*): directly admitted patients had a higher mean survival (60.6 days; 95% CI: 54.5-66.8) compared to those referred from other facilities (41.5 days; 95% CI: 36.1-46.9). COVID-19 status significantly influenced survival outcomes. COVID-19 positive individuals had a markedly lower mean survival of 33.4 days (95% CI: 29.4-37.4) compared to 70.4 days (95% CI: 63.3-77.4) among COVID-19-negative patients (p-value <0.001*).

Patients with DM had significantly lower mean survival (35.1 days; 95% CI: 32.0–38.3) than non diabetic patients (70.1 days; 95% CI: 60.0–80.1; p-value=0.016*).

Steroid therapy was not significantly associated with survival (p-value=0.214). Patients not receiving steroids had a mean survival of 67.0 days (95% CI: 58.7-75.4), compared to 39.0 days (95% CI: 35.7-42.3) among those who did. Patients with missing steroid data had the lowest mean survival (28.5 days; 95% CI: 22.9-34.2), although this subgroup was small.

Microbiological findings were significantly associated with survival. Patients with a negative culture report had a higher mean survival (68.8 days; 95% CI: 61.7-76.0) compared to those with positive culture findings (34.4 days; 95% CI: 30.7-38.1; p-value=0.034*). A similar pattern was observed in KOH-negative patients, who had a mean survival of 65.7 days (95% CI: 59.2-72.2), versus 32.8 days (95% CI: 27.9–37.8) in KOH-positive patients (p-value=0.017*).

Surgical intervention was strongly associated with improved survival outcomes. Patients who underwent surgery had a significantly longer mean survival of 78.5 days (95% CI: 72.9-84.0) compared to 30.1 days (95% CI: 26.2-34.1) among those managed non surgically (log-rank p <0.001**). Similarly, patients receiving only medical treatment did not show a statistically significant difference in survival compared to those receiving combined or other forms of care (mean survival: 35.4 vs. 63.1 days; p-value=0.365) [Table/Fig-3].

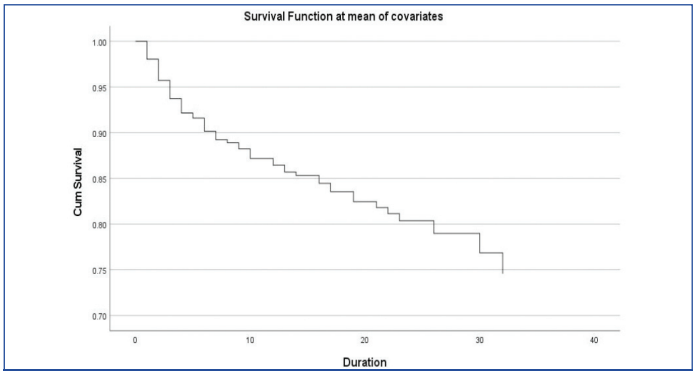
Cox proportional hazards model: The predicted survival probability over time based on the Cox proportional hazards model, adjusted for the mean values of covariates. The curve reflects the model-based estimate of survival decline, assuming proportional hazards across included variables [Table/Fig-4]. The survival probability declines gradually, consistent with a steady hazard rate over time under the proportional hazards assumption.

Cox proportional hazards regression analysis: A multivariate Cox proportional hazards model was applied to identify independent predictors of mortality among mucormycosis patients. On multivariate, Cox proportional hazards regression analysis, age group, surgical treatment, and COVID-19 status emerged as statistically significant independent predictors of mortality among patients with mucormycosis. Compared to patients aged above 60 years, those aged 20-40 years demonstrated a significantly lower hazard of death (HR=0.24; 95% CI: 0.08-0.68; p-value=0.008), while patients aged 41-60 years also had improved survival outcomes (HR=0.57; 95% CI: 0.35-0.92; p-value=0.03). These findings indicate a progressively increasing risk of mortality with advancing age.

Surgical management was found to have a strong protective effect on survival. Patients who did not undergo surgical intervention had a significantly higher hazard of mortality compared to those who received surgical treatment (HR=4.57; 95% CI: 2.29-9.10; p<0.001), underscoring the critical role of timely surgical debridement in improving outcomes. COVID-19 positivity was also independently associated with an increased risk of death. Patients with concurrent or recent COVID-19 infection had nearly a twofold higher hazard of mortality compared to COVID-19-negative patients (HR=1.92; 95% CI: 1.14-3.25; p-value=0.015), highlighting the adverse impact of COVID-19 on mucormycosis prognosis.

Predictor variables	Group	N	Events (deaths)	Censored (%)	Mean survival (days)	95% CI for mean	Log-rank p-value
Age group (in years)	20-40	46	4	91.3%	44.8	40.9-48.7	<0.001 **
	41-60	138	30	78.3%	64.6	56.9-72.3	
	>60	86	32	62.8%	31.4	26.3-36.6	
Gender	Female	96	28	70.8%	35.1	30.8-39.5	0.237
	Male	174	38	78.2%	65.0	58.4-71.6	
Residence	Rural	204	50	75.5%	37.9	34.9-40.8	0.782
	Urban	66	16	75.8%	62.1	50.7-73.6	
Mode of admission	Direct	205	57	72.2%	60.6	54.5-66.8	0.036 *
	Referred	65	9	86.2%	41.5	36.1-46.9	
COVID-19 status	Positive	127	43	66.1%	33.4	29.4-37.4	<0.001 **
	Negative	143	23	83.9%	70.4	63.3-77.4	
Diabetes (DM)	No	83	12	85.5%	70.1	60.0-80.1	0.016 *
	Yes	187	54	71.1%	35.1	32.0-38.3	
Steroid treatment	No (N)	76	17	77.6%	67.0	58.7-75.4	0.214
	Yes (Y)	154	34	77.9%	39.0	35.7-42.3	
	Missing (NA)	40	15	62.5%	28.5	22.9-34.2	
KOH report	Negative	194	40	154 (79.4%)	65.7	59.2-72.2	0.017 *
	Positive	76	26	50 (65.8%)	32.8	27.9-37.8	
Culture report	Negative	123	23	100 (81.3%)	68.8	61.7-76.0	0.034 *
	Positive	147	43	104 (70.7%)	34.4	30.7-38.1	
Only medical treatment	No	232	55	177 (76.3%)	63.1	57.1-69.1	0.365
	Yes	38	11	27 (71.1%)	35.4	28.2-42.5	
Surgical treatment	No	117	10	107 (91.5%)	78.5	72.9-84.0	<0.001 **
	Yes	153	56	97 (63.4)	30.1	26.2-34.1	

[Table/Fig-3]: Kaplan–Meier survival analysis macross predictor variables.
* p <0.05, <0.01



[Table/Fig-4]: Cox proportional hazards regression model based survival function, adjusted for age, COVID-19 status, and surgical intervention.

Non significant variables in the Cox model included mode of admission, DM status, KOH mount results, and fungal culture results. While these factors exhibited trends towards association in univariate Kaplan-Meier analysis, they did not retain significance after adjusting for confounders in multivariate modelling [Table/Fig-5].

Variables	Hazard Ratio (HR)	95% Confidence Interval (CI)	p-value
Age 20-40 (years)	0.24	0.08–0.68	0.008 *
Age 41-60 (years)	0.57	0.35–0.92	0.03 *
Mode of admission	0.98	0.26 – 3.68	0.972
KOH report (N vs P)	0.74	0.45 – 1.24	0.252
Culture report (N vs P)	0.70	0.42 – 1.18	0.178
Surgical treatment (No vs Yes)	4.57	2.29–9.10	<0.001 *
COVID-19 positive	1.92	1.14–3.25	0.015 *
Diabetes mellitus (No vs Yes)	0.66	0.20 – 2.14	0.484

[Table/Fig-5]: Multivariate cox proportional hazards regression analysis of mortality predictors.
*p<0.05, <0.01, N: Negative; P: Positive

DISCUSSION

The present study evaluated predictors of mortality among mucormycosis patients using time-to-event analysis with Kaplan-Meier survival curves and multivariate Cox proportional hazards regression. Age group, surgical intervention, and COVID-19 status were identified as independent predictors of mortality, while other clinical parameters such as diabetes mellitus, microbiological findings, and steroid use did not retain statistical significance after adjustment. These findings are particularly relevant in the context of the post COVID-19 surge of mucormycosis in India.

Age was a significant determinant of survival, with progressively poorer outcomes observed with advancing age. In the present study, patients aged 20-40 years (HR=0.24; p-value=0.008**) and 41-60 years (HR=0.57; p-value=0.03*) demonstrated significantly better survival compared to patients aged above 60 years, who exhibited the highest mortality rate (37.2%) and the shortest mean survival duration (31.4 days).

Roden MM et al., in their review of 929 cases, reported an overall mortality of approximately 44%, with advanced age and underlying co-morbidities being important contributors to poor outcomes [1]. In contrast, Prakash H and Chakrabarti A highlighted that while India bears a disproportionately high burden of mucormycosis, mortality is particularly elevated among elderly patients and those with multiple co-morbidities [2]. The present findings align with these observations and further quantify the impact of age using survival models.

Sen M et al., in a large multicentric Indian study on COVID-19–associated rhino-orbital-cerebral mucormycosis, reported significantly higher mortality among patients aged above 60 years compared to younger age groups (p-value <0.05), supporting the age-dependent survival differences observed in the present study [7]. Similarly, Selarka L et al., observed poorer outcomes in elderly patients with multiple comorbidities, reinforcing the role of age as an important prognostic factor [8].

Surgical intervention emerged as the strongest predictor of survival in this cohort. Patients who underwent surgical debridement had a significantly longer mean survival (78.5 days) compared to those managed non surgically (30.1 days; p-value <0.0001). On multivariate analysis, absence of surgical treatment was associated with a 4.57-fold higher hazard of mortality. These findings are consistent with the global guideline by Cornely OA et al., which emphasises early and aggressive surgical debridement as a cornerstone of mucormycosis management [5]. Ibrahim AS et al., also demonstrated that surgical removal of necrotic tissue reduces fungal burden and improves antifungal penetration, thereby improving survival outcomes [6].

The COVID-19 positivity independently increased the risk of mortality in the present study (HR=1.92; p-value=0.015). COVID-19 positive patients had markedly reduced mean survival (33.4 days) compared to COVID-19 negative patients (70.4 days). John TM et al., described CAM as a "perfect storm," driven by immune dysregulation, corticosteroid exposure, and uncontrolled hyperglycaemia [3]. Similarly, Singh AK et al., in a systematic review, reported high mortality rates among CAM patients, particularly in those with diabetes mellitus and severe COVID-19 [4]. The findings of the present study reinforce these observations and demonstrate the adverse prognostic impact of COVID-19 even after adjusting for confounders.

Pal R et al., in an updated systematic review, reported pooled mortality rates ranging from 25% to 38% among CAM patients, with higher fatality observed in those with delayed diagnosis and severe COVID-19 [9]. Moorthy A et al., highlighted the synergistic effect of COVID-19, uncontrolled diabetes, and corticosteroid therapy on disease severity and adverse outcomes, a finding that aligns with the increased mortality observed among COVID-19 positive patients in the present study [10].

Although KOH mount and fungal culture positivity were associated with poorer survival on Kaplan-Meier analysis (p-value=0.017 and p-value=0.034, respectively), these factors did not retain significance in the multivariate Cox model. This suggests that while microbiological positivity may reflect disease severity, survival is more strongly influenced by age, COVID-19 status, and timely surgical management. Similar observations have been reported in previous studies where clinical outcomes depended more on early intervention than on microbiological burden alone [11].

Diabetes mellitus, despite being highly prevalent in the present cohort (71.1%), was not an independent predictor of mortality (HR=0.66; p-value=0.484). Chakrabarti A et al., and Patel A et al., identified diabetes as a major predisposing factor for mucormycosis, particularly in India; however, its influence on mortality appears to diminish once acute disease severity and management variables are considered. This suggests that diabetes plays a greater role in disease acquisition than in determining survival outcomes [12,13].

Steroid use was not significantly associated with mortality (p-value=0.214), although patients with missing steroid data demonstrated poorer survival. While corticosteroids are a recognised risk factor for CAM, as highlighted by Singh AK et al., incomplete documentation in retrospective studies may obscure their true impact on outcomes [4].

The survival curve derived from the Cox proportional hazards model demonstrated a gradual decline consistent with the proportional hazards assumption, supporting the robustness of the statistical model and the validity of the identified predictors.

Limitation(s)

A key strength of the present study is the application of both univariate and multivariate time-to-event analyses, providing nuanced insight into the temporal dynamics of patient outcomes. Survival analysis allowed for adjustment of censoring and enabled comparison of hazard rates rather than static proportions. Moreover, the use of real-world hospital data from a tertiary care centre during a high-incidence period enhances the clinical relevance of the findings. However, several limitations must be considered. The retrospective study design limits causal inference and is susceptible to documentation and selection biases. Missing data, particularly regarding steroid use and glycaemic control indices, may have reduced statistical power for some variables. Additionally, the single-centre setting restricts generalisability to other regions with differing healthcare infrastructures or epidemiological profiles.

CONCLUSION(S)

The present study demonstrates that older age, COVID-19 positivity, and the absence of surgical intervention are independent predictors of mortality among patients diagnosed with mucormycosis during the second wave of COVID-19 era. The use of time-to-event analysis revealed that patients aged above 60 years, COVID-19 positive individuals, and those not undergoing surgical debridement experienced significantly reduced survival. In contrast, younger patients and those who received prompt surgical management exhibited markedly improved outcomes. These findings underscore the importance of early risk stratification, aggressive surgical intervention, and close clinical monitoring, particularly in resource-limited settings where delayed presentation and inadequate access to surgery may increase mortality. Timely diagnosis and integrated clinical management should be prioritised to reduce mucormycosis-related morbidity and mortality in the post-pandemic landscape. Given the markedly higher mortality among COVID-19 positive and surgically untreated mucormycosis patients, early identification and timely referral for surgical management should be a public health priority. Community health systems, particularly in rural and primary care settings, must implement protocols to detect early signs of mucormycosis and activate prompt referral pathways. In addition, surveillance systems should be strengthened for post COVID-19 complications, with particular focus on elderly individuals and those with immunosuppressive exposures.

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