

## Knowledge, attitude, and practice toward mucormycosis among patients presenting to six tertiary eye care hospitals in South India – A multicentric online questionnaire-based survey

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**Purpose:** To study the awareness on mucormycosis among outpatients who visited six tertiary eye care hospitals at Madurai, Pondicherry, Coimbatore, Tirunelveli, Chennai, and Tirupati. **Methods:** This was a telephone-based survey conducted using questionnaires consisting of 38 questions in five sections from July 5 to 25, 2021. Patients visiting the eye hospitals for an examination were contacted over their phones and responses were directly entered onto the Google forms platform. **Results:** A total of 4573 participants were included in the study. Among all participants, a cumulative 83% of participants had some knowledge of mucormycosis. More than 80% of them reported that their prime source of information was through mass communication like television or radio. Around 34.8% of the respondents were aware that it can occur after treatment for coronavirus disease 2019 (COVID-19) infection, only half of them (54.3%) knew that systemic steroids were the main risk factor. The knowledge scores were higher for participants who were diabetics ( $n = 1235$ ) or had been affected by COVID-19 earlier ( $n = 456$ ) or whose friends had mucormycosis earlier ( $n = 312$ ). Knowledge, attitude, and practice (KAP) scores of nonprofessional health-care workers ( $n = 103$ ) were much better compared to patients. **Conclusion:** Such KAP studies give us an idea of the impact of the measures taken for educating the public. In this study, a cumulative 83% of participants had some knowledge of mucormycosis and 86% knew that this was an emergency. More than 50% of the participants were not aware that diabetes is a risk factor for mucormycosis.

**Key words:** Attitude and Practice, black fungus, COVID-19, KAP, mucormycosis, outpatients

Coronavirus disease 2019 (COVID-19), caused by severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), is a disease with potential devastating complications.<sup>[1-3]</sup> The case fatality rate has been reported to be 2.3% to 7.2% depending upon the population characteristics.<sup>[4]</sup> One of the life-threatening complications of COVID-19 is rhino-orbital-cerebral mucormycosis (ROCM).<sup>[5,6]</sup> The various risk factors for the development of ROCM in COVID-19 patients include uncontrolled diabetes with or without ketoacidosis, malignancies, organ transplant recipients, long-term use of antibiotics, immunosuppressant or corticosteroid use, high ferritin levels, and mechanical ventilation of the host.<sup>[7]</sup> In India, prevalence of mucormycosis is estimated as 140 per million population, which is about 80 times higher than the

prevalence in developed countries, and it has been announced as a notifiable disease by the Government of India.<sup>[8]</sup> Review of existing literature shows that India contributed to 81% of the cases of COVID-19-associated ROCM.<sup>[9]</sup> Therefore, widespread information was disseminated via newspapers, radio, television, social media about mucormycosis.<sup>[10,11]</sup> But did it really improve awareness among the public is a question that needs to be evaluated. To date, there has been no published data on knowledge, attitude, and practice (KAP) patterns toward mucormycosis among patients presenting to a tertiary hospital. Hence, we conducted this study to assess the KAP of people toward ROCM, among general patients presenting to eye hospitals just after the peak of second wave of the COVID-19 pandemic.

### Methods

This questionnaire-based study was conducted in six branches of our hospital located in the states of Tamil Nadu

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(Chennai, Coimbatore, Madurai, and Tirunelveli), Union Territory of Pondicherry, and Andhra Pradesh (Tirupati). The study protocol, questionnaire, validation, and consent form were approved by the hospital's ethical committee and followed the Declaration of Helsinki guidelines.

KAP questionnaire was designed based on Indian Council of Medical Research (ICMR) guidelines for screening, diagnosis, and management of mucormycosis. This was used as it was an evidence-based advisory for India.<sup>[12]</sup> Two individual bilingual translators translated the questions into native languages (Tamil and Telugu), which was then approved by the ethical committee. The questionnaire was validated by two different co-investigators during pilot testing, which had 82 participants. The questionnaire consisted of 38 questions in five sections, which included seven questions on patients' demographics and two questions on general information, 18 on their knowledge, six on attitude, and five on practices related to ROCM [Appendix 1]. For every correct response, a score of 2 was given and incorrect responses gained a score of 0; for responses like "don't know" or "may be," a score of 1 was given. All walk-in patients above 18 years of age, both new and under review, who presented to the eye hospital between July 5 and 20, 2021, that is, just after the second wave of the pandemic, were invited to participate in this survey. Apart from them, nonprofessional health-care workers involved in community eye care, like the camp sponsors and volunteers, were also included in the study to assess their awareness on mucormycosis. Patients who were not willing to participate, those presenting with emergency ocular conditions like pain or trauma, people with hearing problems, or those who were systemically unfit were excluded from the study.

After getting written informed consent, the questionnaire was administered by the study coordinators, who had been formally trained and encouraged to speak in an easily understandable, patient-friendly language. For example, COVID-19 was replaced by Corona and mucormycosis by black fungus. The coordinators entered the responses directly onto the Google forms. The data was extracted into Excel sheets (Microsoft Corporation, Redmond, WA, USA) and then analyzed.

### Statistical analysis

Fully completed questionnaires were extracted into Google Excel sheets and saved. Duplicate entries were removed, and the data was then extrapolated for statistical analysis.

Mean (standard deviation [SD]) and frequency (percentage) were used to describe the summary statistics. KAP scores were compared using the Kruskal-Wallis test for demographic variables like gender. Univariate regression analysis was used to find the factors associated with KAP scores. *P* values <0.05 were considered as statistically significant. All the statistical analyses were performed using STATA version 14.0.

## Results

### Demographic characteristics

A total of 4573 participants were included in the study. Of them, 2960 were from Tamil Nadu (759 [16.6%] from Chennai, 719 [15.7%] from Coimbatore, 732 [16.0%] from Madurai, and 750 [16.4%] from Tirunelveli), 873 (19.1%) from Pondicherry, and 740 (16.2%) from Tirupati, Andhra Pradesh. There was nearly equal gender distribution, with male: female ratio being

50.5:49.5. The majority of our participants were from urban or semiurban areas (72.8%). Among the participants, 13.2% had no formal education, 53.2% had completed school education, and remaining were graduates or postgraduates. Nearly one-third of them (32.6%) were diabetics and 14.6% had previously been affected by COVID-19. Also, 8.4% reported ROCM in close family members or friends.

### Knowledge assessment

Among all participants, 772 (17%) were not aware that a condition called mucormycosis exists. Hence, only 3801 participants were asked further questions. More than 80% of them reported that their prime source of information was through television or radio. More than 50% thought that this was a new disease which began after the onset of the COVID-19 pandemic. Around 34.8% of the respondents were aware that it can occur after treatment for COVID-19 infection, among whom only half (54.3%) knew that systemic steroids were the main risk factor. With regards to the other risk factors, 44% correctly pointed out about diabetes. Only 30.8% were aware that it can be acquired even with a negative COVID-19 test and 35.5% thought that it can spread from one person to another. A vast majority (86.9%) believed that this needed emergency medical attention. Though 80.7% were aware that it can affect the eye, only 40% were only aware that it can affect the nose, sinuses, and the brain. Regarding the presenting symptoms, 51.3% knew that eye swelling and visual loss may be due to ROCM, 33% knew that headache, toothache, and facial pain can be symptoms, and only 29% were aware that nasal discharge and bleeding can also be a symptom.

Nearly half of the respondents (50%) were, however, not aware that this complication can be fatal.

The knowledge score was significantly better in males ( $P = 0.003$ ) and those with better education ( $P < 0.001$ ); however, no such difference was noted with regards to the place of residence ( $P = 0.196$ ) [Table 1].

The knowledge score was also variable among different centers. Coimbatore had the highest median score of 20, whereas Madurai had a score of 6. Chennai, Pondicherry, Tirunelveli, and Tirupati had median knowledge scores of 15, 16, and 17, respectively.

### Attitude assessment

The overall attitude among participants was positive toward prevention of ROCM. More than three-fourths of them (78%) felt that good diabetic control would reduce its incidence and 84.4% felt that proper mask hygiene can prevent ROCM. Also, 63.9% felt that avoiding agricultural work for a few weeks after COVID-19 infection may reduce the incidence of ROCM. More than 75% felt that this condition can be prevented, but only 50% felt that vaccination against COVID-19 will prevent ROCM. Univariate analysis showed better attitude scores in urban and semiurban population ( $P < 0.001$ ) and in educated population ( $P = 0.003$ ). Diabetic participants had a higher attitude score ( $P < 0.001$ ) [Table 1].

### Practice assessment

The responses to practice questions were also generally good. Nearly 80% reported advising their friends and relatives about good diabetic control and 86.6% reported following proper mask hygiene and advising the same to their near ones. However,

**Table 1: Correlation of demographic characteristics with knowledge, attitude, and practices in relation to rhino-orbito-cerebral mucormycosis**

Scores	Gender						P
	Male			Female			
	n	Mean (SD)	Min.-max.	n	Mean (SD)	Min.-max.	
Knowledge	1946	14.8 (6.4)	0-28	1855	14.1 (6.5)	0-28	0.003 <sup>M</sup>
Attitude	1946	8.4 (1.9)	0-12	1855	8.4 (1.9)	0-12	0.528 <sup>M</sup>
Practice	1946	3.6 (1.5)	0-5	1855	3.6 (1.5)	0-5	0.042 <sup>M</sup>

  

Scores	Place						P
	Rural		Semiurban		Urban		
	n	Mean (SD)	Min.-max.	n	Mean (SD)	Min.-max.	
Knowledge	1033	14.8 (6.1)	0-28	774	14.2 (7.0)	0-28	0.196 <sup>K</sup>
Attitude	1033	8.0 (1.9)	0-12	774	8.5 (1.9)	0-12	0.001 <sup>K</sup>
Practice	1033	3.2 (1.7)	0-5	774	3.9 (1.3)	0-5	0.001 <sup>K</sup>

  

Scores	Education						P
	No formal education		School level		Graduated		
	n	Mean (SD)	Min.-max.	n	Mean (SD)	Min.-max.	
Knowledge	292	12.9 (6.6)	0-28	2084	13.0 (6.6)	0-28	0.0001 <sup>K</sup>
Attitude	292	8.1 (1.9)	2-12	2084	8.4 (1.8)	0-12	0.0008 <sup>K</sup>
Practice	292	3.1 (1.8)	0-5	2084	3.6 (1.6)	0-5	0.0001 <sup>K</sup>

K=Kruskal-Wallis test, M=Mann-Whitney U test. P value in bold indicates statistical significance

**Table 2: Correlation of diabetic status with knowledge, attitude, and practices in relation to rhino-orbito-cerebral mucormycosis**

Scores	Diabetes				P
	Yes		No		
	n	Median (IQR)	n	Median (IQR)	
Knowledge	1235	15 (9-19)	2566	16 (11-19)	0.002 <sup>M</sup>
Attitude	1235	9 (7-10)	2566	9 (7-10)	0.687 <sup>M</sup>
Practice	1235	5 (3-5)	2566	4 (3-5)	<0.001 <sup>M</sup>

IQR=interquartile range, M=Mann-Whitney U test

**Table 4: Correlation of knowledge, attitude, and practices in relation to ROCM with presence of friends or relatives affected by ROCM**

Scores	Affected by ROCM				P
	Yes		No		
	n	Median (IQR)	n	Median (IQR)	
Knowledge	312	18 (13-22)	3489	15 (10-19)	<0.001 <sup>M</sup>
Attitude	312	10 (7-10)	3489	9 (7-10)	0.036 <sup>M</sup>
Practice	312	4 (3-5)	3489	4 (3-5)	0.0003 <sup>M</sup>

IQR=interquartile range, M=Mann-Whitney U test, ROCM=rhino-orbito-cerebral mucormycosis

**Table 3: Correlation of previous infection by COVID-19 with knowledge, attitude, and practices in relation to rhino-orbito-cerebral mucormycosis**

Scores	Affected by COVID-19 earlier				P
	Yes		No		
	n	Median (IQR)	n	Median (IQR)	
Knowledge	456	16 (10-20)	3345	15 (10-19)	0.003 <sup>M</sup>
Attitude	456	10 (8-10)	3345	9 (7-10)	<0.001 <sup>M</sup>
Practice	456	4 (4-5)	3345	4 (3-5)	<0.001 <sup>M</sup>

COVID-19=coronavirus disease 2019, IQR=interquartile range, M=Mann-Whitney U test

**Table 5: Comparison of knowledge, attitude, and practice scores of nonprofessional health-care workers with those of the general public in relation to ROCM**

Scores	Nonprofessional health-care workers		Others		P
	n	Median (IQR)	n	Median (IQR)	
	Knowledge	103	20 (17-23)	3698	
Attitude	103	8 (7-9)	3698	9 (7-10)	0.0001 <sup>M</sup>
Practice	103	4 (4-5)	3698	4 (3-5)	0.0009 <sup>M</sup>

IQR=interquartile range, M=Mann-Whitney U test, ROCM=rhino-orbito-cerebral mucormycosis

the practice of avoiding agricultural work for a few weeks after COVID-19 infection was relatively less (around 66.5%). Mann-Whitney U test showed better practice scores in males

than females ( $P < 0.04$ ). Univariate analysis showed better practice scores in urban and semiurban population ( $P < 0.001$ ) and among educated people ( $P < 0.001$ ) [Table 1].

Comparison of the KAP scores among diabetics and non-diabetics revealed that diabetics had better knowledge ( $P=0.002$ ) and better practices ( $P<0.001$ ) in relation to ROCM [Table 2].

Comparison of the KAP scores with regards to previous infection with COVID-19 showed that those who were previously infected had better attitude and practices ( $P<0.001$ ) with regards to ROCM [Table 3].

Comparison of the KAP scores with regards to presence of friends or relatives affected by ROCM showed that those who had known someone experiencing ROCM had better knowledge ( $P < 0.001$ ), attitude ( $P = 0.036$ ), and practices ( $P = 0.0003$ ) with regards to ROCM [Table 4].

On comparison of KAP scores of nonprofessional health-care workers with those of the general public, it was found that nonprofessional health-care workers had better scores ( $P < 0.001$  for all) [Table 5].

## Discussion

Mucormycosis has created an epidemic during the pandemic situation in the second wave of COVID-19 infection in India. The incidence varies from 0.005 to 1.7 per million population, and the global case fatality is as high as 46%.<sup>[5,6]</sup> Considering the severity and mortality of this disease, it is crucial to engage the population to detect it at an early stage. Understanding KAP among patients is valuable in this regard.

This could be due to the mass media coverage and also due to the initiative by the Ministry of Health and Family Welfare.<sup>[12]</sup> Around 17% of the participants were still not aware that such a condition exists, despite good mass media propaganda and a large number of infections. As would be expected, graduates had better knowledge (median score of 17) compared to the uneducated (median score of 13). This could have been due to better understanding of information by the educated, which proves that education makes a difference in one's thinking. This is similar to the study by Padmanaban *et al.*,<sup>[13]</sup> which reported that 65.5% of students presented with high knowledge of the disease. For a population with varying literacy level, visual representation and awareness through mass audio campaign may be more useful, rather than written sources like newspaper.

Urban and semiurban participants showed a significantly better attitude and practice scores ( $P<0.001$ ), probably because the rural population, despite some knowledge, did not think and act proactively, which reflected in their lower attitude and practice scores.

More than 50% of the participants were not aware that diabetes is a risk factor for mucormycosis. A study by Sen *M et al.*<sup>[9]</sup> demonstrated that the major risk factor for ROCM was use of systemic steroids (87%) and the most common systemic comorbidity was diabetes (78%). Only 34.8% of our respondents knew that it can be caused due to the treatment given for COVID, and less than 20% (746/3801) knew that steroid treatment was a risk factor. Though steroids are life savers in a severe COVID-19 setting, they may act as a double-edged sword and the physician needs to reinforce the same to the patient. A study by Dave *et al.*<sup>[14]</sup> showed that steroids are not only a risk factor for ROCM, but are also associated with

poorer prognosis. Any over-the-counter use of steroids should be discouraged. More stress has to be given on the importance of diabetic control in the recovery period.

We note that those who were previously infected with COVID-19 and those who knew someone with ROCM had better KAP. Additionally, diabetics showed a significantly better ( $P < 0.05$ ) knowledge and practice compared to non-diabetics. This finding is similar to the study by Lingam *et al.*,<sup>[15]</sup> which showed people with diabetes had a higher mean knowledge and attitude score about diabetes, hypertension, and diabetic retinopathy than non-diabetics. This reiterates the statement that a person with a disease or has known someone who has suffered an ailment is naturally more concerned and aware about the disease and its possible consequences.

Only 50% were aware that vaccination for COVID-19 would prevent mucor infection also. This is alarming, considering there is clear evidence that COVID-19 vaccination is protective against ROCM.<sup>[16]</sup>

A study on health-care workers showed that more than 80% of them in India had adequate knowledge, positive attitude, and practices during COVID-19.<sup>[17]</sup> Our study showed that nonprofessional health-care workers involved in the organization of outreach programs had significantly better KAP than the general population. They probably witnessed these acute presentations with predominance of peri-ocular symptoms and were more interested and concerned, leading to improved awareness.

The strength of this study lies in its large sample size. The involved institutions are large tertiary eye care centers catering to a large population, and therefore, even though the patients presented for general eye care, they can be considered to be an unbiased sample of the general population. Though several KAP studies have been done on COVID-19, no KAP study has yet been published on mucormycosis associated with COVID-19.

The limitations of the study are that this study was conducted in a tertiary eye hospital setting and this could have confounded responses for a few eye-related questions. The sample population may not reflect the general population, and the studied population visiting the hospital may have been more health literate.

## Conclusion

In conclusion, though our study showed 83% of participants have knowledge about mucormycosis, the area of concern was that less than 50% knew that diabetes was an important systemic risk factor and less than 20% (746/3801) were aware that systemic steroids used to treat COVID-19 may predispose to developing mucormycosis. Therefore, there is an urgent need for increased awareness by the health-care givers regarding the same, and special efforts have to be made to increase the awareness among rural population and those who are uneducated. The myth that mucormycosis can spread from person to person and that it also needs a quarantine prevails in the community.

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#### Conflicts of interest

There are no conflicts of interest.

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## Appendix 1

# Mucor KAP Study

### 1. Study Site

*Mark only one oval.*

Pondicherry

Chennai

Coimbatore

Tirunelveli

Tirupati

### 2. Participant ID

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### 3. Name

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### 4. Age

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### 5. Sex

*Mark only one oval.*

Male

Female

6. Place of living

*Mark only one oval.*

- Rural
- Semi Urban
- Urban

7. Education Status

*Mark only one oval.*

- Middle School
- High School
- Diploma / Graduate
- Post Graduate
- No formal education

8. Do you have Diabetes?

*Mark only one oval.*

- Yes
- No

**Knowledge**

9. K1. Do you know that a condition called black fungus exists?

*Mark only one oval.*

- Yes     *Skip to question 10*
- No

If Yes,

10. K2. How did you come to know about it?

*Mark only one oval.*

- Newspaper
- Social Media (TV, Radio, Mobile)
- Friends/Relatives
- Doctors/Paramedics
- Other: \_\_\_\_\_

11. K3. Do you think black fungus existed before COVID?

*Mark only one oval.*

- Yes
- No
- Maybe
- Don't know

12. K4. Do you think it can occur after COVID infection?

*Mark only one oval.*

- Yes
- No
- Maybe
- Don't Know



13. K5. Do you think it can be caused by treatment given for COVID?

*Mark only one oval.*

- Yes    *Skip to question 14*
- No    *Skip to question 15*
- Maybe    *Skip to question 15*
- Don't Know    *Skip to question 15*

If Yes

14. K6. What treatment given for COVID in your opinion causes it?

*Check all that apply.*

- Vitamins
- Steroids
- Antivirals
- Prolonged Oxygen Therapy
- Don't Know

Other:  \_\_\_\_\_

If No

15. K7. What do you think are added risk factors for black fungus infection?

*Check all that apply.*

- Diabetes
- Hypertension
- Asthma
- Sinusitis
- Prolonged Hospital Stay
- Don't Know

16. K8. Do you think a person can get black fungus infection in spite of COVID negative test?

*Mark only one oval.*

- Yes
- No
- Maybe
- Don't Know

17. K9. Do you think it can spread from one person to another just like COVID?

*Mark only one oval.*

- Yes
- No
- Maybe
- Don't Know

18. K10. Do you think home quarantine can cure this black fungus infection?

*Mark only one oval.*

- Yes
- No
- Maybe
- Don't Know

19. K11. Do you think that this disease needs immediate treatment?

*Mark only one oval.*

- Yes
- No
- Maybe
- Don't Know

20. K12. Do you think black fungus can affect the eye?

*Mark only one oval.*

- Yes
- No
- Maybe
- Don't know

21. K13. Do you think black fungus can affect the nose/sinuses?

*Mark only one oval.*

- Yes
- No
- Maybe
- Don't know

22. K14. Do you think black fungus can affect the brain?

*Mark only one oval.*

- Yes
- No
- Maybe
- Don't know

23. K15. Do you think eye swelling and loss of vision can be a symptom of black fungus?

*Mark only one oval.*

- Yes
- No
- Maybe
- Don't know

24. K16. Do you think headache, tooth ache and facial pain can be a symptom of black fungus?

*Mark only one oval.*

- Yes
- No
- Maybe
- Don't know

25. K17. Do you think nasal discharge / bleeding can be a symptom of black fungus?

*Mark only one oval.*

- Yes
- No
- Maybe
- Don't know

26. K18. Do you think a person can die due to black fungus infection?

*Mark only one oval.*

- Yes
- No
- Maybe
- Don't know

## Attitude

27. A1. Handwashing and avoiding agricultural work after corona infection will prevent black fungus

*Mark only one oval.*

- Agree  
 Disagree  
 Not Aware

28. A2. Good diabetic control after COVID infection can prevent black fungus disease

*Mark only one oval.*

- Agree  
 Disagree  
 Not Aware

29. A3. Good mask hygiene in COVID affected patients helps to prevent this disease

*Mark only one oval.*

- Agree  
 Disagree  
 Not Aware

30. A4. Only patients with severe COVID 19 disease are affected by black fungus infection

*Mark only one oval.*

- Agree  
 Disagree  
 Not Aware

31. A5. Timely treatment can help reduce mortality due to black fungus infection

*Mark only one oval.*

- Agree  
 Disagree  
 Not Aware

#### Practice

32. P1. I have started to advice good control of Diabetes for my friends and relatives affected by COVID / controlling my blood sugars well

*Mark only one oval.*

- Yes  
 No

33. P2. I have started maintaining mask hygiene and advising the same for my near ones in the recent days

*Mark only one oval.*

- Yes  
 No

34. P3. I have started spreading awareness to my known persons about this disease in the recent days

*Mark only one oval.*

- Yes  
 No

#### General

35. G1. Were you affected by COVID?

*Mark only one oval.*

- Yes and confirmed
- Had symptoms but not confirmed
- No

36. G2. Were any of your family / friends affected by black fungus infection?

*Mark only one oval.*

- Yes
- No
- Don't Know

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