

## SHORT ARTICLE

**Infoveillance of Mucormycosis in India: A Google™ Trends Based Study****Gaurav Jain<sup>1</sup>, Boudhayan Das Munshi<sup>2</sup>, Venkata Lakshmi Narasimha<sup>3</sup>, Saurabh Varshney<sup>4</sup>**

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**Abstract**

India reported highest incidence of Mucormycosis in the past and during the second wave of COVID-19. Google Trends is a potential tool for infoveillance of infectious disease like Mucormycosis. Relative Search Volume (RSV) for term Mucormycosis (+ Black fungus), diabetes, steroid, oxygen, D-dimer (+ferritin) had been extracted from Google Trends for three months (March to May 2021) and state-wise prevalence for Mucormycosis released by Ministry of Health and Family Welfare was used for the analysis. India reported highest RSV for Mucormycosis among the top five countries with COVID-19 cases. RSV peak for oxygen preceded the Mucormycosis spike. Correlation between state-wise prevalence of Mucormycosis and their corresponding RSV was not significant. While a positive correlation was observed between Mucormycosis, diabetes and steroid, it was not statistically significant. Infoveillance using Google trends can serve as a proxy marker for the public health needs and priorities much before actual field surveys.

**Keywords**

Mucormycosis; Google Trends; Diabetes; Steroids

**Introduction**

Mucormycosis (MM) was once considered as a rare infection, but its incidence during the second wave of COVID-19 pandemic has increased exponentially in India. Patients with uncontrolled Diabetes Mellitus (DM), taking corticosteroids for management of COVID-19 and having long stay in intensive care unit are at a higher risk of developing MM. (1)

According to the data released by Government of India (GOI), as on May 22, 2021, the number of reported cases of MM stood at 8848. (2) Government and private health care systems tried to educate people about the diagnosis and management of MM through different media platforms. Furthermore, several Indian states have declared it as a notifiable disease. (3) However, it is unclear about the public perception and awareness about MM. Infoveillance is a type of surveillance that specifically utilizes information found online to gather information

about human behavior. (4) One of the ways to conduct infoveillance of the new infection is to study the internet online search trends by the population. Google trends™ is an open-source platform that acts as a proxy indicator for the people perception about new information by providing large access to unfiltered sample of actual search request made to Google.™

**Aims & Objectives**

1. To estimate the geographical and temporal relative search volumes of Mucormycosis in the last three months using google trends analysis.
2. To determine the correlation between Mucormycosis search volume with other search terms and state wise prevalence.

**Material & Methods**

Search results on Google™ are proportionate to the time and location of a query by the following process: Each data

point is divided by the total searches of the geography and time range it represents to compare relative popularity. The resulting numbers are then scaled on a range of 0 to 100 based on a topic's proportion to all searches on all topics. Different regions that show the same search interest for a term do not always have the same total search volumes. (5) The value zero does not necessarily indicate no searches, but rather indicates exceptionally low search volumes that are not included in the results. Non-Realtime data of sample of searches (keywords) from March 1, 2021 to May 31, 2021 was downloaded from Google™ trends in normalized Relative Search Volume (RSV) format. (6) The keywords used for search were "Mucormycosis + Black Fungus", "Steroid", "Diabetes", "Oxygen", "D-Dimer + ferritin". Values showing <1 but not 0 were considered as 1 and we did not use COVID-19 related search due to high RSV. State-wise data on distribution of cases on May 22, 2021, was obtained from Ministry of Health and Family Welfare. (2) Data was analyzed using Microsoft Excel (Microsoft corporation, Washington DC, United States of America) and R software (R core team, CRAN network, New Zealand). Ethical approval and consent for the study is not required as the study includes analysis of data available on online open-source platform.

## Results

Among the top five countries affected by COVID-19 (number of cases), RSV for the term "Mucormycosis + Black Fungus" between March 1, 2021, to May 31, 2021, is highest in India (Figure 1A). During the second wave of the COVID-19 pandemic in India, increase in number of COVID-19 cases was accompanied by an increased demand for oxygen. This was reflected as rise in RSV for "Oxygen" during initial phase of second wave followed by the peak of MM (Figure 1B). Significant correlation was lacking between the state-wise Mucormycosis data and RSV ( $R=0.26$ ;  $p=0.14$ ) (Figure 2A). While a positive correlation with more association of MM with diabetes and steroids compared to oxygen and d-dimer (+ferritin) was observed it was not statistically significant ( $P>0.05$ ) (Figure 2B).

## Discussion

Historically, before COVID-19, India reported the maximum number of MM cases in the world. (7) Further, with the advent of pandemic, the incidence of MM cases surged in India, specifically during the second wave. (8) While the number of COVID-19 cases reported in India is comparable to top five countries, the number of cases of MM is disproportionately high. Similar patterns were highlighted in this study using google trends analysis. Hyperglycemia (pre-existing DM, new onset, steroid induced), hypoxia (low oxygen tension), elevated iron levels (elevated ferritin), acidic environment (metabolic acidosis, diabetic ketoacidosis), immunosuppression induced decreased phagocytic activity of WBC's (COVID-

19, underlying co-morbidities, use of steroids and other immunosuppressants) have been postulated as reasons for germination of mucorales spores in COVID-19 patients(9) Although it is speculative, high prevalence of diabetes and increased usage of steroids in India could be the possible cause for such high incidence of MM.

Interestingly, clinical experience suggests the peak of MM during the second wave of the COVID-19 pandemic in India was preceded by the peak of increased oxygen demand. This has been reflected as the rise in RSV for "Oxygen" during initial phase of pandemic followed by MM (Figure 1B). This can possibly be attributed to the increased awareness of the public through the mass media campaigns by government and private stakeholders of healthcare. Although black fungus term is a misnomer for MM, its increased usage by the mass media led to its increased RSV, thus underscoring a requirement for more responsible reporting by information dispensing platforms. (10)

Lack of statistical correlation between the number of cases of MM in each state and its corresponding RSV can probably be explained by the i) under reporting of cases in certain states ii) the increased mass media coverage and accessibility of information to the lay public created an environment of "panic" which led to its increased RSV even in the absence of cases in that state.

Further, a correlation between the RSV of steroids and DM with MM (statistically not significant) gives a signal about public perception related to its association. Therefore, google trends act as a proxy marker for public perceptions and using it as a potential tool for infoveillance during this pandemic is important. Additionally, the potential of this tool in predictive modelling for upcoming waves needs to be explored.

## Conclusion

During second wave, Google trend analysis highlights the geographical and temporal trends of Mucormycosis related search in India. While a correlation between different search terms with Mucormycosis is observed, the association is not statistically significant including the state-wise prevalence.

## Recommendation

Google trends RSV can serve as a proxy marker for the health needs and priorities of the public much before actual field surveys and thus act as a guiding factor for determining health policies for taking early pre-emptive action. There should be an increased moral responsibility of the information providers to provide updated and authentic information in the public domain to avoid rumor mongering and confusion amongst the lay public on "Mucormycosis"

## Limitation of the study

Google Trends only gives relative search volume and do not give absolute numbers (6).

**Relevance of the study**

The study underscores the importance of Google trends analysis as a potential marker for infoveillance of disease like Mucormycosis.

**Authors Contribution**

GJ, BDM, VLN conceptualized and designed the study. SV has provided intellectual content. GJ and VLN has done the data acquisition and VLN has done the analysis. All the authors contributed for manuscript preparation.

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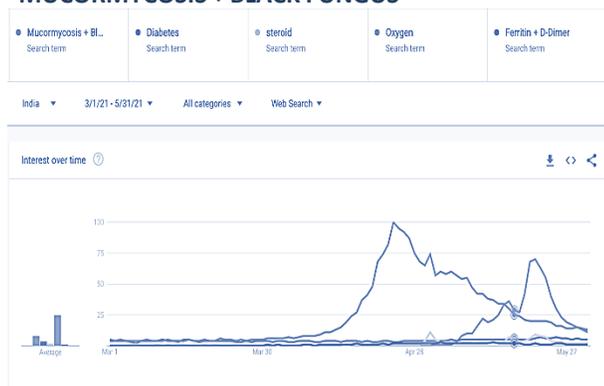
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**Figures**

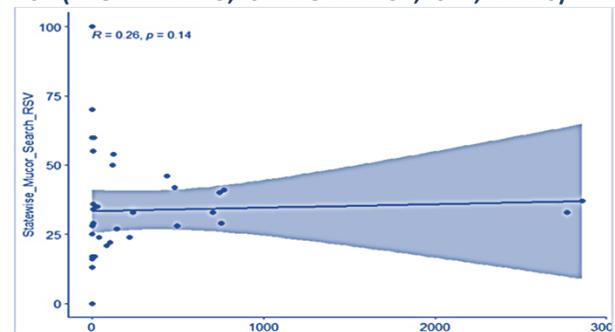
**FIGURE 1A RSV FOR “MUCORMYCOSIS + BLACK FUNGUS” IN TOP 5 COUNTRIES AFFECTED BY COVID19 (RED: - INDIA) FROM MARCH 1, 2021, TO MAY 31, 2021**



**FIGURE 1B INITIAL INTEREST DURING THE SECOND WAVE OF COVID-19 IN INDIA WAS OVER “OXYGEN” (GREEN) FOLLOWED BY INCREASED INTEREST OVER “MUCORMYCOSIS + BLACK FUNGUS”**



**FIGURE 2A THERE WAS NO SIGNIFICANT CORRELATION (R=0.26; P=0.14) BETWEEN THE NUMBER OF MUCORMYCOSIS CASES STATE WISE (ON MAY 25<sup>TH</sup> 2021, X-AXIS) AND THE STATE-WISE MUCORMYCOSIS SEARCH RSV (FROM MAY 25,2021 TO MAY 31,2021, Y-AXIS)**



**FIGURE 2B CORRELATION OF RSV OF “MUCORMYCOSIS + BLACK FUNGUS” WAS GREATER WITH “DIABETES” AND “STERIOD”; LESSER WITH “OXYGEN” AND “D-DIMER”; HOWEVER, THE P-VALUES ARE >0.05 ACROSS ALL THE CORRELATIONS.**

