



COVID 19 and Nutrition in Mucormycosis (Black Fungus)

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Mucormycosis or black fungus is usually a rare but life-threatening infection resulting from commonly distributed fungi belonging to the *Mucorales* orders. The disease was previously known as zygomycosis, since *Rhizopus* species, such as *Rhizopus arrhizus*, *Rhizopus microsporus*, and *Rhizopus oryza* were more isolated from infected patients than *Mucor* (Chegini *et al.*, 2020, Spellberg, 2017).

These saprophytic fungi are commonly reproduced and found in soil, air, agricultural compost, decade fruits and vegetables, mouldy bread, and even in the nose mucus of healthy people (Spellberg, 2017).

Since these fungi are acidophilic, saccharolytic, and thermophile fungi, their growth dramatically increased in the acidic and high glucose environments; therefore, they are threaten patients with diabetic ketoacidosis (Chegini *et al.*, 2020).

There are several underlying factors associated with this disease (Figure 1), including diabetes (especially ketoacidosis diabetic patients),

malnutrition, increased iron, severe immune system failure, long term immunosuppressive treatments, neutropenia, burns, hematological disorders, metabolic ketoacidosis, and even renal insufficiency (Dantas *et al.*, 2021, Patel *et al.*, 2020, Shariati *et al.*, 2020).

Mucormycosis was previously known as an extraordinary, and rare fungal infection reported in uncontrolled diabetes mellitus and immunocompromised status with a high mortality rate to 90% (Kontoyiannis *et al.*, 2005). It has become urgent since 2020, following the outbreak of coronavirus pandemic (Mekonnen *et al.*, 2021) individually in India (Patel *et al.*, 2021); known as COVID-19 associated mucormycosis (CAM). Following India, there have been reports of the CAM from other 18 countries (Garg *et al.*, 2021), including more recently from Iran (Tabarsi *et al.*, 2021). This simultaneous occurrence of this fatal fungal infection with COVID-19 patients caused great concern particularly in Iranian social media (Taghinejad *et al.*, 2021).

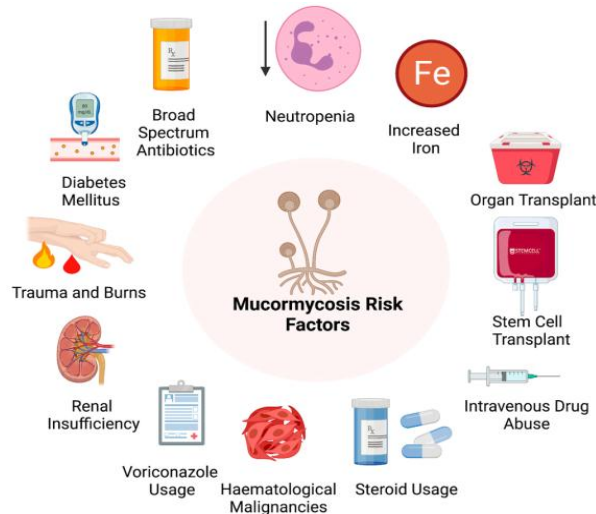


Figure 1. Risk factors associated with the development of mucormycosis (Mahalaxmi et al., 2021)

Several epidemiologic studies in literature reported different predisposing factors for mucormycosis worldwide. For example, hematological malignancies in Europe (Skiada *et al.*, 2020), diabetes mellitus in Iran (Dolatabadi *et al.*, 2018), India (Chamilos *et al.*, 2008), Mexico (Corzo-León *et al.*, 2018), middle east, and north of Africa (Stemler *et al.*, 2020) are reported as the most incline aspects for mucormycosis.

Nowadays the world has widely been facing the outbreak of the COVID-19 pandemic. About two-thirds of the world's adult population is overweight, and approximately 6 percent are diabetic (Hjartåker *et al.*, 2008). Obesity and diabetes are observed in two-thirds of mucormycosis cases along with the other predisposing factors (Gleissner *et al.*, 2004). Accordingly, rather than COVID 19, weight control, controlling of blood glucose and iron levels, and the elimination of malnutrition, are very critical for preventing mucormycosis in COVID-19 subjects. In addition to persistent hyperglycemia resulting from high blood glucose levels, which caused acidic conditions in the diabetic patient favored by mucormycosis agents, it also leads to suppression of the host immune cells. It provides desirable environments for various opportunistic pathogens especially mucus and rhizopus species (Rammaert *et al.*, 2012).

Therefore, in addition to clarifying mucormycosis pathophysiologic mechanisms in COVID 19 patients, and improving new control and treatment protocols, diet and weight modification are also crucially needed for their outcome improvements.

Shirazi *et al.*, in an animal model of obesity using *Drosophila melanogaster* female flies infected with *R. oryza* to induce mucormycosis, reported a higher survival rate in normal-weight flies with low blood sugar (treated with metformin) than the obese as well as untreated flies (Shirazi *et al.*, 2014). The rhino-cerebral form of mucormycosis, known as the most prevalent clinical form in COVID 19 patients, is also concomitant with diabetes mellitus. Thus controlling blood glucose levels, using a low-sugar diet, weight control, and elimination of malnutrition are very important to consider in Iranian COVID 19 patients.

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