

# Prevalence of Positive Fungal Cultures in Patients with Chronic Sinusitis undergoing Functional Endoscopic Sinus Surgery in Yasuj, Iran

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## ABSTRACT

**Aims** Sinusitis is the inflammation of the nasal cavity, and Paranasal sinuses occur by pathogen agents such as bacteria, viruses, fungi, or other allergens. This study was aimed to determine the prevalence of positive fungal cultures in patients with chronic sinusitis undergoing functional endoscopic sinus surgery.

**Materials & Methods** This experimental study was carried out on 60 patients with chronic sinusitis in 2019. After anesthesia in the operating room, the ENT specialist evacuated the sinuses of patients with chronic sinusitis undergoing sinus endoscopic surgery. After sampling of evacuated sinus tissue of eligible patients and transfer to mycology laboratory, fungal elements were identified using direct smear and culture of the sample on sub-dextrose agar medium. The patient's profiles were recorded. Data were analyzed using SPSS 21 software by the descriptive statistic.

**Findings** 36 of selected patients with chronic sinusitis were male (60%), and 24 were female (40%) with a mean age of 38.4±11.5 years. Two *Candida parapsilosis* (3.3%), one *Aspergillus flavus* (1.7%), and one *Aspergillus niger* (1.7%) were detected. Therefore, the prevalence of positive fungal cultures in patients with chronic sinusitis undergoing endoscopic sinus surgery was 6.7% in Yasuj, southwest of Iran, in 2019.

**Conclusion** The prevalence of fungal sinusitis is low in patients with chronic sinusitis in Yasuj due to the location of Yasuj in a mountainous region with a cold and dry climate.

**Keywords** Sinusitis; Fungi; Prevalence

## CITATION LINKS

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## Introduction

Sinusitis is an acute or chronic inflammation of the mucous membranes in the paranasal sinuses, occurring in 20% of people throughout their life [1]. Sinusitis is mainly caused by several predisposing factors such as viral infections of the upper respiratory tract, allergic rhinitis, improper use of topical nasal decongestants, and immune system deficiency [2]. The main symptoms of this disease include nasal congestion, facial pain, and decreased sense of smell. In chronic sinusitis affecting 5% of the population, the symptoms last for more than 12 weeks. The disease caused impaired mucosal drainage and accumulation in the sinuses caused by bacterial agents (bacteroids and *Haemophilus influenzae*), viral agents (rhinovirus and adenovirus), and fungal agents (*Aspergillus*, *Alternaria*, *Mucor*, *Curvularia*, and *Cryptococcus neoformans*) [3, 4]. Fungal infections are one of the four major microbiological subtypes, and they can appear as yeasts, which are unicellular organisms, and molds, which are branching filamentous organisms and hence are more easily identified [5, 6]. There are thousands of species of fungi, few of which are known as clinical microorganisms. Spores of these fungi are abundant in the atmosphere, which forms part of the normal sinusoidal flora after inhalation under natural conditions. Although these fungi are then destroyed by normally functioning immunological cascades, following the prolonged use of antibiotics, poor ventilation, dark and moist environments, and immunocompromised, these immunological pathways are disrupted, making fungal infections more likely [7]. Fungal rhino-sinusitis includes a varied range of disease processes in clinical presentation, histological forms, and biological significance and is classified as invasive or noninvasive based on the fungus penetration into the tissue. Invasive Fungal rhino-sinusitis can dramatically tissue invasion through the mucosa, bone, neurovascular structures, and surrounding organs, distinguishing it from noninvasive forms [8-16]. The most common age range for fungal sinusitis is 10-60, which is directly related to the degree of involvement of people in activities in humid environments contaminated with fungal spores. In some studies, the incidence of men and women was reported to be the same [12], and according to other studies, men are more involved than women [1]. The disease is more common in immunocompromised patients and more recently in healthy individuals [17-19]. Previous studies show the different prevalence of positive fungal culture in people with sinusitis at different times and communities, depending on the type of disease, health status, geographical location, temperature, humidity, etc. In a study in India, Karthikeyan & Coumare reported a 22% prevalence of positive fungal culture in people whose disease has been diagnosed with chronic fungal sinusitis due to

clinical and radiological symptoms [20]. This rate was 8.8% in the study of Badiie *et al.* in Iran, and isolated fungi are reported to be *Aspergillus fumigatus*, *Penicillium*, *Aspergillus flavus*, and *Alternaria* based on the frequency [21]. In the study of Fasunla *et al.* in Nigeria, the fungi *Aspergillus fumigatus* and *Candida albicans* were isolated [22].

According to a study by Singh *et al.*, allergic fungal rhinosinusitis is the most common type of fungal rhinosinusitis, which *Aspergillus flavus* has been reported as its most common cause [23]. Collins *et al.*, in a study in Australia, reported an 8.6% prevalence of allergic fungal rhinosinusitis [24]. Although Awan *et al.*, quoting Collins *et al.*, reported 5 to 10% incidence of allergic fungal rhinosinusitis in patients with chronic rhinosinusitis. However, according to the results of their study in Pakistan, the incidence of allergic fungal rhinosinusitis in patients with chronic sinusitis has been reported to be 20.8% [25]. Sharma, quoting Marple, reported the different incidences of allergic fungal rhinosinusitis in the different geographical areas. Most of the reports of infection are related to temperate regions with relatively high humidity [26]. The prevalence of allergic fungal rhinosinusitis among patients with sinusitis with nasal polyps has been reported to be 11% and 22.4% in the studies of Irshad-ul-Haq *et al.* and Rehman *et al.* in Pakistan, respectively [27, 28].

Given that fungal infections are one of the four main microbiological subgroups, and. In contrast, sustainable health development and optimal planning to promote community health require knowledge of epidemiological indicators; therefore, this study aimed to determine the frequency of positive fungal culture in patients with chronic sinusitis undergoing endoscopic sinus surgery.

## Materials and Methods

This experimental study was conducted in Yasuj, southwestern Iran, in 2019. Eligible patients with chronic sinusitis participated in this study who undergoes functional endoscopic sinus surgery as part of the treatment process. These people should not have congenital disorders or genetic syndromes and should not have taken antibiotics or antifungal drugs for two weeks before surgery.

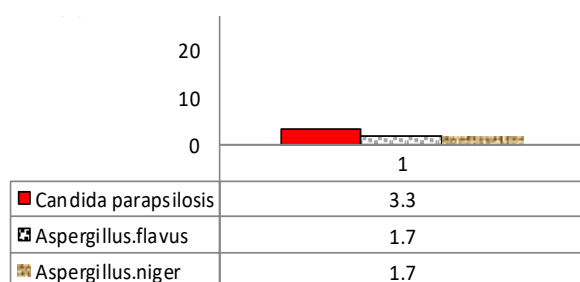
Patients' demographic and background characteristics were recorded in the checklist, including age, gender, underlying disorders and nasal discharge status, information about surgery site, and laboratory findings. The ethics approvals of the Research Ethics Committee of Yasouj University of Medical Sciences and the Vice-Chancellor for Research and Technology of Yasouj University of Medical Sciences were received. The ENT specialist evacuated the sinuses of patients with chronic sinusitis in the operating room of Yasouj University of Medical Sciences under anesthesia. In this study, all research ethics considerations such as obtaining

informed written consent from the patient, confidentiality of information, destruction, and disposal of all tested contents were observed according to the standards of disposal of infectious and chemical waste and the necessary precautions to prevent bio-pollution. In this study, all research ethics considerations including obtaining informed written consent from the patient, confidentiality of information, destruction of all tested contents according to infectious and chemical waste disposal standards, and the necessary precautions to prevent bio-pollution. After sampling the drained tissue of patients' sinus, the samples were placed in a BHI culture medium and sent to the mycology laboratory of Yasouj University of Medical Sciences within half an hour.

After 24 hours of incubation, the samples were classified into two parts using a sterile scalpel. A direct slide was prepared with 10% KOH from one part of the samples. After 24 hours, yeast or filamentous fungal elements were identified under a microscope with or without a middle blade. The other part of the sample was also cultured; so that the synthetic culture medium was sterilized at pH six at autoclave at 121°C for 15 minutes after adding 65 g of Sabouraud dextrose agar culture medium powder one liter of sterile distilled water. After adding chloramphenicol to the medium (to prevent bacterial growth), a sample of sinus tissue was cultured. According to the macroscopic and microscopic morphological characteristics, the results were evaluated and positive culture samples were identified during two weeks [29, 30]. Data were analyzed using SPSS 21 software by the descriptive statistic.

## Findings

This study was conducted on 60 patients with chronic sinusitis, including 36 men (60%) and 24 women (40%). The average age and infection duration of these patients were  $38.4 \pm 11.5$  and  $5.1 \pm 4.9$ , respectively. Out of 60 samples submitted to the mycology laboratory, two samples (3.3%) of *Candida parapsilosis*, 1 sample (1.7%) of *Aspergillus flavus*, and 1 sample (1.7%) of *Aspergillus niger* were evaluated (Figure 1).



**Diagram 1)** Prevalence of relative frequency of positive fungal cultures in evacuated sinuses tissues of patients with chronic sinusitis

Accordingly, the relative frequency of positive fungal culture in patients with chronic sinusitis undergoing sinus endoscopic surgery in Yasuj was 6.7%. The characteristics of the subjects, whose fungal species were identified in a sample of evacuated sinuses tissue, have been reported in Table 1. Fungal species were identified in a tissue sample drained from their sinuses.

**Table 1)** Raw data of positive fungal cultures in evacuated sinuses tissues of patients with chronic sinusitis

Isolated Fungus	Drainage Sinus	Nasal Discharge	Underlying Disorder	Age (Year)	Sex
<i>Candida parapsilosis</i>	Right-Maxillary	Watery	Diabetes	47	Male
<i>Candida parapsilosis</i>	Right-Maxillary & Ethmoid	Nothing	Diabetes	50	Male
<i>Aspergillus flavus</i>	Right-Maxillary	Mucopurulent	Nothing	21	Male
<i>Aspergillus niger</i>	Right-Maxillary & Ethmoid & Sphenoid	Mucoid	Diabetes	52	Female

## Discussion

This study aimed to determine the frequency of positive fungal culture in patients with chronic sinusitis undergoing sinus endoscopic surgery in Yasuj, southwestern Iran, in 2019. In this study, the average age of the subjects with positive fungal culture consisting of 3 males and one female was  $42.5 \pm 14.5$ . Although the present study results on the role of gender in fungal sinusitis are not in accordance with the study of Granville *et al.* [12], the results of the study of Shetty *et al.* are in accordance with the findings of the present study [1]. The reason for more positive fungal cultures in men than women, especially in recent studies, can be due to the risky occupation of men. In the study by Awan *et al.*, the average age of patients with fungal sinusitis was  $29.49 \pm 9.16$  in 45 patients, including 26 men and 19 women [25]. In the study of Rehman *et al.*, the average age of patients with fungal sinusitis, including 17 men and 11 women, was 33 [28]. In the study of Badiei *et al.*, the average age of patients, including 59 men and 43 women, was reported to be  $33.89 \pm 10.28$  years [21]. In a study by Nowrozi *et al.*, fungal sinusitis was reported in 6 men and two women aged 30-39 years [31]. Since the functioning of the immune system at the mentioned ages is better than the older ages. Therefore, the younger age of chronic sinusitis patients with positive fungal culture in such studies compared to the results of the present study may be due to the lack of health conditions during the study. In the present study, out of 4 patients with positive fungal culture, three also had diabetes. Diabetes has been reported as the most common underlying disease in studies by Nikakhlagh & Saki [32] and Hosseini & Borghei [33], which are in accordance with the findings of this study. The results of the study by Parikh *et al.* are inconsistent with the findings of the present study. In their study, the underlying causes



were blood malignancy (28 cases), diabetes (10 cases), organ transplantation (3 cases), and AIDS (1 case), respectively [34]. The difference between the findings of Parikh *et al.* and the present study can be due to the difference in data collection time, the level of hygiene and attention to the prevention of non-communicable diseases, and the difference in the nutritional culture of the research community. Out of 4 patients with positive fungal culture, 3 had a nasal discharge. In the study of Irshad-ul-Haq *et al.*, all patients reported nasal discharge [27]. These different findings may be due to the different research communities and climatic conditions. Also, maxillary sinus was involved in all patients who had positive fungal culture. The present study results are consistent with the findings of Fasunla *et al.* and Suresh *et al.* [22, 35]. This study identified four fungal cases, including *Candida parapsilosis*, *Aspergillus flavus*, and *Aspergillus niger*, in 60 samples of sinuses tissue drained from patients with chronic sinusitis. In the study by Nowrozi *et al.*, the isolated fungi were *Alternaria*, *Aspergillus flavus*, and *Psilomyces*, respectively [31]. In the study by Badii *et al.*, nine cultured cases of 102 patients without a history of immunodeficiency were positive, including 3 cases of *Aspergillus fumigatus*, 3 cases of *Penicillium*, 2 cases of *Aspergillus flavus*, and 1 case of *Alternaria* [21]. The results of the two mentioned studies in Iran were similar to the results of the present study. In the study of Fasunla *et al.*, the isolated fungi included *Aspergillus flavus*, *Aspergillus fumigatus*, and *Candida albicans* [22]. Rupa *et al.* and Saravanan *et al.* have identified *Aspergillus* as the most common cause of chronic invasive fungal sinusitis and, in general, as the most common cause of fungal sinusitis [36, 37]. Singh *et al.* also reported the *Aspergillus flavus* as the most common fungus [23]. The present study's relative frequency of positive fungal culture in patients with chronic sinusitis was lower than in other studies. Invasive fungal rhinosinusitis is an opportunistic and invasive infection that often begins in the nose and sinuses and spreads to the eye and skull, and can lead to fatal consequences through the brain and meningeal infections [38]. Therefore, clinical and paraclinical examination and early diagnosis of this disease are essential. Also, the promotion of health services can effectively reduce the frequency of positive fungal culture in patients with chronic sinusitis undergoing sinus endoscopic surgery in Yasuj.

## Conclusion

The prevalence of fungal sinusitis is low in patients with chronic sinusitis in Yasuj due to the location of Yasuj in a mountainous region with a cold and dry climate.

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**Ethical Permissions:** This study was approved by the Research Ethics Committee of Yasouj University of Medical Sciences with the code of IR.YUMS.REC.1397.034.

**Conflicts of Interests:** This study results from a research project approved by the Research Council of Yasouj University of Medical Sciences.

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## References

- Shetty S, Chandrashekar S, Aggarwal N. A study on the prevalence and clinical features of fungal sinusitis in chronic rhinosinusitis. *Indian J Otolaryngol Head Neck Surg.* 2020;72(1):117-22.
- Wiszniewska M, Walusiak-Skorupa J, Pannenko I, Draniak M, Palczynski C. Occupational exposure and sensitization to fungi among museum workers. *Occup Med.* 2009;59(4):237-42.
- Wilson M, Wilson PJK. Chronic sinusitis. In: Wilson M, Wilson PJK. *Close encounters of the microbial kind.* Cham: Springer; 2021.
- Gendy S, Walsh MA, McConn-Walsh R, Costello RW. Recent consensus on the classification of rhinosinusitis—a way forward for research and practice. *Surgeon.* 2007;5(2):67-71.
- Chang CC, Incaudo GA, Gershwin ME. *Diseases of the sinuses: A comprehensive textbook of diagnosis and treatment.* Amsterdam: Springer; 2014.
- Ellis D, Davis S, Alexiou H, Handke R, Bartley R. *Descriptions of medical fungi.* Adelaide: University of Adelaide; 2007.
- Watkinson JC, Clarke RW. *Scott-Brown's otorhinolaryngology and head and neck surgery.* London: Tylor & Francis Group; 2018.
- Soler ZM, Schlosser RJ. The role of fungi in diseases of the nose and sinuses. *Am J Rhinol Allergy.* 2012;26(5):351-8.
- Aribandi M, McCoy VA, Bazan C. Imaging features of invasive and noninvasive fungal sinusitis: A review. *Radiographics.* 2007;27(5):1283-96.
- Chakrabarti A, Das A, Panda NK. Controversies surrounding the categorization of fungal sinusitis. *Med Mycol.* 2009;47 Suppl 1:299-308.
- Chakrabarti A, Denning DW, Ferguson BJ, Ponikau J, Buzina W, Kita H, et al. Fungal rhinosinusitis: A

categorization and definitional schema addressing current controversies. *Laryngoscope*. 2009;119(9):1809-18.

12- Granville L, Chirala M, Cernoch P, Ostrowski M, Truong LD. Fungal sinusitis: Histologic spectrum and correlation with culture. *Hum Pathol*. 2004;35(4):474-81.

13- Taxy JB. Paranasal fungal sinusitis: contributions of histopathology to diagnosis: A report of 60 cases and literature review. *Am J Surg Pathol*. 2006;30(6):713-20.

14- Das A, Bal A, Chakrabarti A, Panda N, Joshi K. Spectrum of fungal rhinosinusitis: Histopathologist's perspective. *Histopathology*. 2009;54(7):854-9.

15- Montone KT, Livolsi VA, Feldman MD, Palmer J, Chiu AG, Lanza DC, et al. Fungal rhinosinusitis: A retrospective microbiologic and pathologic review of 400 patients at a single university medical center. *Int J Otolaryngol*. 2012;2012:6848835.

16- Deutsch PG, Whittaker J, Prasad S. Invasive and non-invasive fungal rhinosinusitis-a review and update of the evidence. *Medicina*. 2019;55(7):319.

17- Lawson W, Blitzler A. Fungal infections of the nose and paranasal sinuses: Part II. *Otolaryngol Clin North Am*. 1993;26(6):1037-68.

18- Stammberger H. Endoscopic surgery for mycotic and chronic recurring sinusitis. *Ann Otol Rhinol Laryngol Suppl*. 1985;119:1-11.

19- Hadi U, Bitar M, Hachem R, Saade R, Husni R, Raad I. Fungal sinusitis in the immunocompetent patient: Risk factors and surgical management. *Surg Infect*. 2003;4(2):199-204.

20- Karthikeyan P, Coumare VN. Incidence and presentation of fungal sinusitis in patient diagnosed with chronic rhinosinusitis. *Indian J Otolaryngol Head Neck Surg*. 2010;62(4):381-5.

21- Badiei P, Gandomi B, Sabz GA, Jafarian H. A study on the frequency of fungal rhinosinusitis and to determine the sensitivity of the isolates to antifungal drugs in Shiraz, Iran 2012-2013. *J Arak Univ Med Sci*. 2015;18(3):1-8. [Persian]

22- Fasunla AJ, Fayemiwo SA, Bakare RA, Ijaluola GTA. Aerobic bacteria and fungal isolates in maxillary sinusitis of adults in a resource poor environment. *Afr J Clin Exp Microbiol*. 2018;19(2):113.

23- Singh AK, Gupta P, Verma N, Khare V, Ahamad A, Verma V, et al. Fungal rhinosinusitis: Microbiological and histopathological perspective. *J Clin Diagn Res*. 2017;11(7):10-2.

24- Collins MM, Nair SB, Wormald PJ. Prevalence of noninvasive fungal sinusitis in South Australia. *Am J Rhinol*. 2003;17(3):127-32.

25- Awan NU, Cheema KM, Naumeri F, Qamar S. Allergic

fungal rhino-sinusitis frequency in chronic rhino-sinusitis patients and accuracy of fungal culture in its diagnosis. *Pak J Med Sci*. 2020;36(3):555-8.

26- Sharma S. Understanding allergic fungal rhino-sinusitis. *Glob J Otolaryngol*. 2018;13(3):1-6.

27- Irshad-ul-Haq M, Farooq M, Qadri SH. Prevalence of allergic fungal sinusitis among patients with nasal polyps. *JSZMC*. 2014;5(4):690-2.

28- Rehman A, Rafiq F, Uppal AA. Evaluation of allergic fungal sinusitis occurrence in patients with nasal polyps. *Pak J Med Health Sci*. 2015;9(3):875-8.

29- Singh S, Beena PM. Comparative study of different microscopic techniques and culture media for the isolation of dermatophytes. *Indian J Med Microbiol*. 2003;21(1):21-4.

30- Sabz G, Gharaghani M, Mirhendi H, Ahmadi B, Gatee MA, Sisakht MT, et al. Clinical and microbial epidemiology of otomycosis in the city of Yasuj, southwest Iran, revealing aspergillus tubingensis as the dominant causative agent. *J Med Microbiol*. 2019;68(4):585-90.

31- Nowrozi H, Alavi S, Kazemi A, Razmpa E, Emami M, Oshaghi M. Fungus paranasal sinusitis in non-immunocompromised patients in Tehran, Iran (2006-07). *J Gorgan Univ Med Sci*. 2012;14(1):129-35. [Persian]

32- Nikakhlagh S, Saki N. Functional endoscopic sinus surgery for fungal sinusitis (three years experience). *Iranian J Otorhinolaryngol*. 2004;16(3):36-41. [Persian]

33- Hosseini SMS, Borghei P. Rhinocerebral mucormycosis: Pathways of spread. *Eur Arch Otorhinolaryngol*. 2005;262(11):932-8.

34- Parikh SL, Venkatraman G, DelGaudio JM. Invasive fungal sinusitis: a 15-year review from a single institution. *Am J Rhinol*. 2004;18(2):75-81.

35- Suresh S, Arumugam D, Zacharias G, Palaninathan S, Vishwanathan R, Venkatraman V. Prevalence and clinical profile of fungal rhinosinusitis. *Allergy Rhinol*. 2016;7(2):115-20.

36- Rupa V, Jacob M, Mathews M, Job A, Kurien M, Chandi S. Clinicopathological and mycological spectrum of allergic fungal sinusitis in south India. *Mycoses*. 2002;45(9-10):364-7.

37- Saravanan K, Panda NK, Chakrabarti A, Das A, Bapuraj RJ. Allergic fungal rhinosinusitis: an attempt to resolve the diagnostic dilemma. *Arch Otolaryngol Head Neck Surg*. 2006;132(2):173-8.

38- Chen CY, Sheng WH, Cheng A, Chen YC, Tsay W, Tang JL, et al. Invasive fungal sinusitis in patients with hematological malignancy: 15 years experience in a single university hospital in Taiwan. *BMC Infect Dis*. 2011;11:250.