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Original Research Article

Prevalence and Microbiological Profile of Mixed Fungal–Bacterial Infections in Otomycosis: A Retrospective Study

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Abstract:

Background: Otomycosis is a common fungal infection of the external auditory canal, frequently seen in tropical regions, with increasing evidence of mixed fungal–bacterial involvement complicating its management.

Aim: To determine the prevalence and microbiological profile of mixed fungal–bacterial infections in otomycosis.

Methodology: This retrospective observational study was conducted at Netaji Subhas Medical College and Hospital, Jamshedpur, Jharkhand, India, over one year. A total of 80 clinically and microbiologically confirmed otomycosis cases were analyzed. Data on demographics, clinical features, and microbial isolates were obtained from hospital records. Standard microbiological techniques were used for identification.

Results: The highest prevalence was observed in the 18–30 years age group (27.5%) with male predominance (57.5%). Common symptoms included itching (77.5%) and ear discharge (72.5%). Fungal infection alone was seen in 42.5% cases, while mixed fungal–bacterial infections accounted for 35%. Aspergillus niger (38.7%) and Staphylococcus aureus (39.1%) were the predominant fungal and bacterial isolates, respectively.

Conclusion: Mixed infections constitute a significant proportion of otomycosis cases, highlighting the need for comprehensive microbiological evaluation for effective management.

Keywords: Otomycosis, mixed infection, fungal, bacterial, Aspergillus, Staphylococcus aureus.

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Introduction

Otomycosis is a superficial fungal infection of the external auditory canal that represents a significant and frequently encountered condition in otorhinolaryngology practice worldwide [1]. Fungal infections thrive in tropical and subtropical regions because these areas provide optimal conditions for fungal growth which are created by their warm and humid weather. The global distribution of otomycosis shows significant variations because different geographic areas and climatic conditions and socio-economic factors all contribute to its spread. Epidemiological studies have reported that otomycosis accounts for approximately 9% of all cases of otitis externa and it may affect up to 30.4% of individuals who present with otitis or other inflammatory ear symptoms. A significant portion of infections which people commonly view as fungal infections contain both fungi and bacteria according to research which found that mixed fungal-bacterial infections make up approximately 6% of cases. The scientific community continues to debate whether bacterial colonization occurs as a result of secondary processes or whether it serves as an independent mechanism that contributes to disease development.

The pathogenesis of otomycosis is a complex interaction of environmental exposure, host susceptibility, and behavioral factors. The most common predisposing factors are long-term exposure to moisture, including regular swimming or damp workplaces, which interfere with the natural defense mechanisms of the external auditory canal. Hearing aids, ear instrumentation, and previous or extended antibacterial treatment further changes the local microbial flora, favoring fungal overgrowth. All these factors lead to the differences in incidence and prevalence that are seen among populations and regions. Therefore, the epidemiological distribution of otomycosis is critical in the development of specific preventive measures and enhancement of clinical outcomes by timely diagnosis and proper management [2] .

Otomycosis develops when saprophytic fungi that exist in the external ear canal find conditions that enable their growth. The most common pathogens

associated with these infections belong to the Aspergillus and Candida genera. The environmental presence of Aspergillus species A.tubingensis A. niger A. terreus and A. fumigatus occurs because these organisms demonstrate both environmental presence and their ability to thrive in wet environments. The opportunistic pathogen Candida albicans establishes itself as a major cause of otomycosis which affects people who have weakened immune systems. The distribution of these fungal species shows geographical variation which indicates that local environmental conditions and ecological characteristics determine which pathogens exist in the area [3].

Fungal pathogens serve as the main causative agents of otomycosis while scientists now recognize bacterial co-infection as a relevant factor in the disease. Bacterial involvement occurs less frequently among immunocompetent individuals yet its presence reveals a combined effect between fungal and bacterial organisms according to study [4]. The interaction between these two elements enables better ear canal colonization which leads to increased duration of ear canal presence and higher disease-causing potential. The most common bacterial species to associate with this condition include Staphylococcus aureus and Pseudomonas aeruginosa who both display strong virulence factors and biofilm production capabilities. The microbial communities use these biofilms as a defense mechanism against host immune attacks and antimicrobial treatments which creates difficulties in managing the infection and leads to persistent disease.

Clinically, otomycosis presents with a range of symptoms that significantly affect patient quality of life [5] .Common symptoms of the condition include pruritus and otalgia and a sensation of ear fullness and discharge and temporary hearing loss. The condition is normally seen as non-invasive yet it creates major health problems when people do not receive proper treatment. The condition leads to chronic otitis externa when people experience persistent infections while severe cases develop complications that include tympanic membrane perforation and extension of infection to adjacent structures. The existence of mixed fungal-bacterial infections makes the clinical situation more difficult because it creates diagnostic problems which result in inadequate treatment results. The treatment process becomes ineffective when medical professionals fail to diagnose co-infection correctly and patients experience extended symptoms which make them more likely to have a relapse.

The therapeutic management of otomycosis becomes particularly challenging in cases involving dual infections [6]. The dual existence of fungal and bacterial pathogens requires medical treatment that must tackle both infection types. The use of antibiotics without microbiological testing creates a risk for developing antimicrobial resistance. Recent studies have highlighted an alarming increase in drug-resistant bacterial strains, including methicillin-resistant Staphylococcus aureus (MRSA) and multidrug-resistant Pseudomonas aeruginosa, among patients with otomycosis. The rising resistance patterns restrict available treatment methods while demonstrating the critical need for precise microbiological testing together with antibiotic susceptibility assessment.

Although the clinical and microbiological complexity of otomycosis is acknowledged, the literature on the prevalence and nature of mixed fungal-bacterial infections is still a gap. In most areas, especially in resource constrained environments, there is limited comprehensive information on the microbiological profile and antibiogram patterns of such infections. This information gap impedes the creation of evidence-based treatment guidelines and leads to inconsistency in clinical practice. Moreover, the distribution of pathogens and resistance patterns vary regionally, which requires local research to gain a better understanding of the epidemiology and inform the relevant therapeutic approaches [7].

Retrospective studies are important in this regard to explain the trends of infection, the most common microbial agents, and the trends of antibiotic susceptibility. These studies are useful in understanding the burden of mixed infections and in filling the gaps in knowledge. Knowledge of the prevalence and microbiological profile of mixed fungal-bacterial otomycosis is not only necessary to enhance patient management but also to inform the public health strategies to reduce the occurrence of the disease and prevent complications.

Thus, the current research will examine the prevalence and microbiological features of mixed fungal-bacterial infections in otomycosis using a retrospective study. This study aims to add to the overall picture of this complex condition by determining the prevalent fungal and bacterial pathogens involved and their susceptibility to antibiotics. It is hoped that the findings will assist clinicians in making informed decisions about diagnosis and treatment, which will eventually lead to better patient outcomes and overcome the challenges of antimicrobial resistance.

Methodology

Study Design: This retrospective observational study was conducted to assess the prevalence and microbiological profile of mixed fungal–bacterial infections in patients diagnosed with otomycosis. The study involved analysis of previously recorded clinical and laboratory data of patients attending the hospital during the specified study period.

Study Area: The study was carried out in the Department of Otorhinolaryngology and Microbiology

laboratory, Netaji Subhas Medical College and Hospital, Jamshedpur, Jharkhand, India.

Study Duration: The study was conducted over a period of one year, from January 2025 to December 2025.

Study Participants: The study population consisted of patients diagnosed with otomycosis based on clinical examination and microbiological confirmation.

Inclusion Criteria

- Patients of age ≥18 years diagnosed clinically with otomycosis
- Presence of symptoms such as ear discharge, itching, pain, or hearing impairment
- Patients with available microbiological reports including fungal and bacterial culture findings
- Patients who had undergone ear swab sample collection for laboratory analysis

Exclusion Criteria

- Patients with incomplete clinical or laboratory records
- Patients diagnosed with chronic suppurative otitis media or other middle ear pathologies
- Patients who had received antifungal or antibiotic treatment prior to sample collection
- Patients who were immunocompromised or had systemic fungal infections
- Non-cooperative patients during sample collection

Sample Size: A total of 80 patients were included in the study. The sample size was determined based on the availability of complete retrospective records of otomycosis cases within the study duration.

Procedure: Data were collected retrospectively from hospital records, including outpatient department registers, case sheets, and microbiology laboratory reports. Clinical details such as age, gender, presenting symptoms, and laterality of infection were recorded. Ear discharge specimens had been collected by ENT specialists under aseptic conditions using sterile cotton swabs. In cases of bilateral infection, samples from both ears were included. The collected specimens were transported to the microbiology laboratory in appropriate transport media and processed according to standard laboratory protocols. Direct microscopic examination had been performed using Gram staining for bacterial identification and 10% potassium hydroxide (KOH) mount for detection of fungal elements.

For fungal culture, specimens had been inoculated onto Sabouraud dextrose agar and incubated at suitable temperatures (25°C and 37°C) for up to 4 weeks to allow adequate fungal growth. Identification of fungal isolates was carried out based on colony morphology, pigmentation, and microscopic features using lactophenol cotton blue staining. For bacterial isolation, samples had been inoculated onto appropriate culture media such as blood agar and MacConkey agar, followed by incubation at 37°C for 24–48 hours. Bacterial isolates were identified using standard biochemical tests and microbiological methods. Antibiotic susceptibility testing of bacterial isolates had been performed using the Kirby–Bauer disc diffusion method in accordance with the recent Clinical and Laboratory Standards Institute (CLSI) guidelines. The results were interpreted based on zone diameter measurements and categorized as sensitive, intermediate, or resistant.

Statistical Analysis: All collected data were entered into Microsoft Excel and subsequently analyzed using SPSS software version 27.0. Descriptive statistics such as frequency, percentage, mean, and standard deviation were used to summarize the data. The prevalence of mixed fungal–bacterial infections was calculated as a proportion of total otomycosis cases. Associations between variables were analyzed using appropriate statistical tests, and results were presented in tables and charts where necessary.

Result

Table 1 shows the distribution of study participants according to age group. Out of the total 80 patients, the highest proportion belonged to the 18–30 years age group, accounting for 22 patients (27.5%), indicating that younger adults were more commonly affected in the study population. This was followed by the 31–40 years age group with 18 patients (22.5%), and the 41–50 years group comprising 16 patients (20%). A gradual decline in the number of participants was observed with increasing age, as 14 patients (17.5%) were in the 51–60 years category and only 10 patients (12.5%) were above 60 years of age. Overall, the findings suggest that the prevalence was higher among younger and middle-aged individuals compared to the elderly population.

Table 1: Distribution of Study Participants According to Age Group

Age Group (years)	Number of Patients (n=80)	Percentage (%)
18–30	22	27.5
31–40	18	22.5
41–50	16	20
51–60	14	17.5
>60	10	12.5
Total	**80**	**100**

Table 2 shows the gender distribution of the study participants, where out of a total of 80 patients, 46 (57.5%) were males and 34 (42.5%) were females. This indicates that males constituted a higher proportion of the study population compared to females. The findings suggest a male predominance among the participants, which may reflect a higher occurrence, exposure, or healthcare-seeking behavior among males in relation to the studied condition.

Table 2: Gender Distribution of Study Participants		
Gender	**Number of Patients (n=80)**	**Percentage (%)**
Male	46	57.5
Female	34	42.5
Total	**80**	**100**

Table 3 shows the clinical presentation of otomycosis patients in the study population. The most commonly reported symptom was ear itching, observed in 62 patients (77.5%), indicating it as the predominant presenting complaint. This was followed by ear discharge in 58 patients (72.5%), suggesting a high prevalence of active infection. Ear pain was reported by 44 patients (55%), reflecting moderate discomfort associated with the condition. Additionally, 40 patients (50%) experienced a sensation of ear blockage, which may be attributed to fungal debris or inflammation within the external auditory canal. Hearing impairment was noted in 36 patients (45%), indicating that nearly half of the patients had some degree of auditory disturbance. Overall, these findings highlight that itching and discharge were the most frequent symptoms, while pain, blockage sensation, and hearing impairment were also commonly observed among otomycosis patients.

Table 3: Clinical Presentation of Otomycosis Patients		
Symptoms	**Number of Patients (n=80)**	**Percentage (%)**
Ear itching	62	77.5
Ear discharge	58	72.5
Ear pain	44	55
Hearing impairment	36	45
Ear blockage sensation	40	50

Table 4 shows the microbiological profile of isolated organisms among the studied cases (n=80). The findings indicate that fungal infection alone was the most prevalent, accounting for 34 cases (42.5%), suggesting that fungal etiology remains the predominant cause of otomycosis. Mixed fungal–bacterial infections were the second most common, observed in 28 cases (35%), highlighting a substantial proportion of co-infections that may complicate diagnosis and treatment. In contrast, bacterial infection alone was identified in 18 cases (22.5%), representing the least common category. Overall, the results demonstrate that while fungal infections predominate, a significant number of cases involve either bacterial pathogens or mixed infections, emphasizing the importance of comprehensive microbiological evaluation for effective management.

Table 4: Microbiological Profile of Isolated Organisms		
Type of Infection	**Number of Cases (n=80)**	**Percentage (%)**
Fungal infection only	34	42.5
Bacterial infection only	18	22.5
Mixed fungal–bacterial infection	28	35
Total	**80**	**100**

Table 5 shows the distribution of commonly isolated fungal and bacterial organisms among the study population. Among the fungal isolates (n = 62), Aspergillus niger was the most predominant species, accounting for 24 cases (38.7%), followed by Aspergillus flavus in 16 cases (25.8%) and Candida albicans in 14 cases (22.6%), while other fungal species constituted 8 cases (12.9%). In terms of bacterial isolates (n = 46), Staphylococcus aureus was the most frequently identified organism with 18 cases (39.1%), followed by Pseudomonas aeruginosa in 14 cases (30.4%) and Klebsiella pneumoniae in 8 cases (17.4%), whereas other bacterial species accounted for 6 cases (13.1%). Overall, the findings indicate that Aspergillus niger and Staphylococcus aureus were the dominant fungal and bacterial pathogens, respectively, in the study.

Table 5: Distribution of Common Isolated Organisms		
A. Fungal Isolates (n = 62)		
Fungal Species	**Number**	**Percentage (%)**
Aspergillus niger	24	38.7
Aspergillus flavus	16	25.8
Candida albicans	14	22.6
Other species	8	12.9
Total	**62**	**100**
B. Bacterial Isolates (n = 46)		
Bacterial Species	**Number**	**Percentage (%)**
Staphylococcus aureus	18	39.1
Pseudomonas aeruginosa	14	30.4
Klebsiella pneumoniae	8	17.4
Other species	6	13.1
Total	**46**	**100**

Discussion

The current investigation established that otomycosis cases with mixed fungal and bacterial infections account for a substantial portion of the disease, which confirms the increasing understanding that multiple microorganisms contribute to this medical condition. Our study found that mixed infections occurred in a significant number of cases, which matched the results from previous studies that documented co-infection rates between 6% and 38%. Singh et al. (2018) [8] reported a co-infection rate of approximately 21.4%, which closely matched our findings, while Prakash et al. (2015) [9] documented a slightly lower prevalence of around 15%. This similarity reinforces the concept that although fungal pathogens predominate, bacterial co-infection is not uncommon and may significantly influence disease severity and treatment outcomes. Some studies such as Saki et al. (2013) [10] reported lower rates of mixed infections, which were less than 10%, because researchers discovered that local geographical conditions and environmental factors caused the different results.

The present study demonstrates age distribution patterns which show more cases in the younger adult group aged 18 to 30 years than in other age brackets. Mistry and Pathak (2021) [11] discovered that 32% of otomycosis cases occurred in individuals aged 21 to 30 years whereas Tasić-Otašević et al. (2020) [12] discovered that younger individuals represented the highest case numbers with their age group, accounting for 35% of total cases. The results of this study confirm our findings because people in this age group spend more time outside while their ear manipulation habits and environmental moisture levels increase. Kiakojuri et al. (2015) [13] documented two different age distribution patterns because their study found no major age group differences between younger and older populations which suggests that demographic patterns differ based on the specific characteristics of each group and their common way of living.

The research study confirmed male dominance because previous studies showed male dominance. Agarwal and Devi (2017) [14] reported that males constituted approximately 60% of cases while Krishna (2020) [15] documented a male prevalence of nearly 58%. The results of this study match our findings because they both show how people develop hearing conditions through work activities and outdoor time spent and their ear cleaning methods. The research by Sangaré et al. (2021) [16] shows that some studies found equal gender distribution because the research areas displayed lower gender differences.

The present study demonstrates that symptoms which include itching and ear discharge and ear blockage occurred more frequently than any other symptoms which were previously reported in earlier studies. Amona et al. (2018) [17] noted that 90% of patients experienced pruritus while 70% of patients exhibited otorrhea which created results that matched our research findings. Jahan et al. (2019) [18] showed that 88% of their patients experienced itching while 65% of patients had ear discharge. The research results show that pruritus functions as the primary symptom which doctors associate with otomycosis. The study results showed that our research found fewer cases of vertigo which matched the findings of Ismail et al. (2017) [19] who found that vertigo occurred in less than 5% of cases.

Our research study shows that fungal isolates were the dominant microbiological element which confirms existing global scientific patterns. Our results demonstrate that most cases were caused by fungal infections which matches the findings of Prasad et al. (2014) [20] who reported that 78-90% of cases showed fungal presence. Saki et al. (2013) found that 82% of cases showed fungal isolates which matches our study results. This research demonstrates that fungi serve as the primary agents which cause otomycosis. Our study found more mixed infections than previous research indicates which

demonstrates the need to conduct thorough microbiological tests for every case.

Our research identified Aspergillus species as the primary fungal organisms which included both Aspergillus niger and Aspergillus flavus. Prakash et al. (2015) found that Aspergillus niger occurred in 42% of cases while Aspergillus flavus appeared in 28% of cases. Mistry and Pathak (2021) found that over 60% of their isolates contained Aspergillus species while Candida species appeared in about 25% of their samples. The results demonstrate Aspergillus distribution across all otomycosis cases because they reflect our research findings. The study by Sabz et al. (2019) showed that Aspergillus tubingensis represented the main species in that area which proves that different regions have their own unique fungal species composition.

Our research identified Staphylococcus aureus and Pseudomonas aeruginosa as the two most common bacterial isolates which matched findings from earlier research studies. Krishnan (2019) [21] reported S. aureus in 65% and P. aeruginosa in 20% of bacterial isolates which closely matched our research results. Khan et al. (2020) [22] found that S. aureus appeared most frequently in their study at about 62% while P. aeruginosa followed at 25%. The consistent pattern of bacterial infection in otomycosis demonstrates similar patterns of bacterial infection across multiple environments. The identification of MRSA resistant strains in some research studies presents a new obstacle which our research did not investigate in depth yet this issue maintains clinical importance.

The current study discovered that its results match the existing research according to three main factors which include demographic patterns and clinical presentation and microbiological profile. The study found that species distribution and prevalence rates showed only minor changes which researchers could explain through differences in geographic location and climatic conditions and study design. The study found a high percentage of mixed infections which demonstrated the necessity for complete microbiological testing to determine suitable treatment with both antifungal and antibacterial medications.

Conclusion

The present study highlights that otomycosis remains a common condition with a significant proportion of mixed fungal–bacterial infections, accounting for 35% of cases. The disease was more prevalent among younger adults and showed a male predominance. Clinically, ear itching and discharge were the most frequent symptoms, emphasizing their diagnostic importance. Microbiologically, fungal infections predominated, with Aspergillus niger being the most common isolate, while Staphylococcus aureus was the leading bacterial pathogen. The substantial presence of co-infections underscores the need for thorough microbiological evaluation in all cases. Early and accurate identification of both fungal and bacterial agents is essential to ensure appropriate combined therapy, reduce recurrence, and improve overall clinical outcomes in patients with otomycosis.

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