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Ocular Microbial Infection among Rice Farmers in Ishiagu L.G.A, Ebonyi State, Nigeria

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ABSTRACT

Rice farming in swampy environment exposes farmers to various microbial agents due to contact with contaminated water, vegetative materials, and agrochemicals. Such exposures increase the risk of ocular infections, especially in rural communities with limited access to protective equipment and eye care services. This study aimed to assess the prevalence, seasonal trends, and microbial agents responsible for ocular infections among rice farmers in Ishiagu L.G.A, Ebonyi State, Nigeria, and to evaluate their associations with demographic factors and environmental exposures. A cross-sectional descriptive study was carried out at Marist Cottage Hospital, Uturu, which serves a large proportion of the Ishiagu farming community. A total of 150 rice farmers (males: 62; females: 88) aged between 15 and 70 years were studied. Subjects underwent ocular examination, microbiological culture, and questionnaire-based interviews. Data were analyzed using descriptive statistics and Chi-square test for association. Keratitis (39.2%) and conjunctivitis (31.0%) were the most prevalent ocular infections. The age group 25–34 years recorded the highest burden of corneal ulcers (46.1%) and keratitis (39.2%), with significant associations ($P = 0.735$ and $P = 0.698$ respectively, not statistically significant). The most frequently isolated bacterial pathogens were Pseudomonas aeruginosa (15 cases, 11.3%) and Staphylococcus aureus (15 cases, 11.3%). Fungal infections were more common during the harvesting season, with Candida albicans and Aspergillus niger isolated in 100% of samples. Common sources of exposure included plums (13.53%), vegetative materials (12.78%), and agrochemicals (12.53%). While no statistically significant relationships were observed between age and specific infections ($P > 0.05$ across all conditions), seasonal variation and microbial patterns suggest environmental factors play a major role. The study highlights the need for targeted public health interventions, use of eye protection, and regular screening for microbial eye infections in agricultural communities.

Keywords
Rice Farmer, Fungal infections, Microbial infections, Corneal blindness.

Introduction

Microbial infections of the eye are among the leading causes of visual morbidity, particularly in rural and tropical communities. These infections may involve the eyelid, conjunctiva, cornea, and intraocular structures, depending on the pathogen involved and the subject's immune status. Microorganisms such as bacteria and fungi are frequent causes of ocular diseases and can cause severe damage to the ocular structures if not promptly diagnosed

and appropriately managed [1]. In rural African communities, where health infrastructure may be limited, eye infections are often underdiagnosed or misdiagnosed, leading to increased rates of complications, including corneal blindness. Farmers are particularly at risk due to their increased exposure to dust, soil, plant debris, and contaminated water, all of which may harbor pathogenic organisms. Rice farmers are even more vulnerable due to the wet environment of rice paddies, where microbial agents thrive. In Nigeria, agriculture remains a major occupation, especially in the southeastern region, including Ebonyi State. The Ishiagu Local Government Area (L.G.A.) of Ebonyi State is predominantly an agrarian community, where rice farming is a key source of livelihood. Farmers in this region spend long hours in flooded fields, often without any form of eye protection, making them highly susceptible to microbial eye infections.

Several studies have confirmed that microbial infections such as bacterial keratitis, conjunctivitis, and fungal corneal ulcers are prevalent among agricultural workers in similar climates [2]. Infections may be initiated by minor trauma from plant materials or foreign bodies that breach the corneal epithelium, allowing microorganisms to invade. In addition, poor hygiene, traditional eye medication, and self-medication practices increase the risk of persistent or worsening infections [3]. In sub-Saharan Africa, fungal infections are often underreported due to limited diagnostic capabilities. Yet, fungal pathogens such as *Fusarium species*, *Aspergillus niger*, and *Candida albicans* have been reported with increasing frequency among patients presenting with ocular complaints in rural hospitals [4].

Environmental and seasonal variations also influence the occurrence of microbial eye infections. The planting season, which typically involves more soil and water contact, may favor fungal infections due to the abundance of plant debris and moisture. Conversely, the harvesting season is characterized by exposure to dust, which may predispose to bacterial infections. Research in India and West Africa has demonstrated seasonal patterns in microbial keratitis, with fungal infections being more common during the wet season, while bacterial infections peak in the dry season [5].

Marist Cottage Hospital, Uturu, located in Isikwuato Local Government Area of Abia State, is the primary healthcare center serving residents of Ishiagu, Ebonyi State. Due to its proximity and affordable services, many patients from Ishiagu attend this facility. Thus, it provides an ideal setting for studying the microbial profile of eye infections among rice farmers in the area.

Despite the high likelihood of microbial ocular infections in this population, few studies have specifically investigated the microbiological causes and seasonal patterns of ocular infections among rice farmers in this region. This study therefore aims to identify the microbial agents associated with eye infections in rice farmers attending Marist Cottage Hospital and to explore the influence of seasonal farming activities on the prevalence of different pathogens. By doing so, the study hopes to contribute to better clinical management, early diagnosis, and effective preventive strategies tailored to this occupational group.

Method of Study

This study titled "Microbial Infections among Rice Farmers in Ishiagu L.G.A, Ebonyi State, Nigeria" was a descriptive cross-sectional, hospital-based investigation aimed at identifying and characterizing microbial agents (bacteria and fungi) responsible for ocular infections among rice farmers. The study was conducted at Marist Cottage Hospital, Uturu, located in Isuikwuato Local Government Area, Abia State, a healthcare facility frequently visited by residents of Ishiagu, due to its proximity and accessible eye care services.

Study Population

A total of 150 subjects participated in the study. These were individuals engaged in rice farming activities in Ishiagu L.G.A, Ebonyi State, who presented with symptoms suggestive of ocular infections such as conjunctivitis, keratitis, corneal ulcer, endophthalmitis, or keratoconjunctivitis, especially during the planting and harvesting seasons.

Sample Collection and Laboratory Procedures

Ocular specimens were collected under sterile conditions using standard techniques appropriate to the type of infection (e.g., corneal scraping, conjunctival swabs). Samples were transported to the microbiology laboratory for:

- Direct microscopy (Gram stain, 10% KOH wet mount for fungi)
- Culture on appropriate media: Blood agar, Chocolate agar, MacConkey agar (for bacteria), and Sabouraud Dextrose Agar (for fungi)
- Biochemical identification of isolates and fungal morphology assessment

The presence or absence of specific organisms was recorded, and seasonal trends (planting vs harvesting) were analyzed.

Inclusion Criteria

- Subjects engaged in rice farming in Ishiagu L.G.A, Ebonyi State
- Presenting with clinically diagnosed ocular infections
- Not on antimicrobial treatment (topical or systemic) within 7 days prior to hospital visit
- Provided informed consent
- Visited during planting or harvesting seasons

Exclusion Criteria

- Subjects not from Ishiagu L.G.A
- Not involved in rice farming
- Presenting with non-infectious eye conditions
- Declined participation or did not provide consent
- Already undergoing antimicrobial therapy
- Incomplete clinical or laboratory data

Table 1: Age/Sex Distribution of the Study Population.

AGE (Years)	MALES N (%)	FEMALES N (%)
15-24	2 (3.2)	5 (5.7)
25-34	8 (12.9)	16 (18.2)
35-44	14 (22.6)	20 (22.7)
45-54	14 (22.6)	8 (9.1)
55-64	8 (12.9)	14 (15.9)
65-above	16 (25.8)	25 (28.4)

Table 1 presents the distribution of the study population by age and sex. The data show that individuals in the older age brackets constituted the largest proportion of the population, with the highest representation in the 65 years and above category. This suggests increased participation or reporting among older individuals in the setting studied. There is a gradual increase in representation from the younger age group (15–24 years) to the older age group, with a notable rise in both male and female participants as age increases. This pattern may indicate that older individuals are more involved in or more affected by the conditions assessed in the study.

Sex distribution varies across age groups. Females outnumber males in several categories, particularly between the ages of 25 and 64. However, males were more represented than females in the 45-54 age group. This variation may reflect age- and sex-specific roles or levels of exposure within the environment assessed. The lowest representation was recorded among the 15–24-year group for both sexes, potentially suggesting limited engagement and reduced exposure in this age group. Overall, the table reflects a population distribution where age and sex are important variables influencing participation and outcomes in the context studied.

Table 2 presents the distribution of different types of ocular infections across age groups among the rice farmers studied. The most prevalent infections were corneal ulcers and keratitis, particularly in the 25–34 age group, which accounted for nearly half of the reported cases of each. This suggests that individuals in this productive age bracket are highly exposed to ocular trauma or microbial agents, likely due to active engagement in fieldwork without adequate eye protection.

Conjunctivitis, a common and often less severe infection, was more frequent in the younger age groups, especially among those aged 15–24 and 35–44 years. The high rate of conjunctivitis in these age groups may reflect exposure to irritants such as dust, mud, or unclean water during farming tasks.

Endophthalmitis, a severe and vision-threatening intraocular infection, was rare and mostly seen in the 25–44 age groups, with no cases reported in those below 25 or above 54 years. Its low frequency but concentration in the middle-aged groups could point to traumatic or post-surgical complications, more common in active workers.

Kerato-conjunctivitis was found exclusively in the 25–54 year range, suggesting an overlap of corneal and conjunctival inflammation primarily in those heavily involved in farming. The condition was absent in the very young and the elderly.

Across all infection types, older age groups (55–64 and 65+) showed fewer or no cases, contrary to expectations. This may be due to reduced field activity or underreporting in the elderly. The P-values for all infections were above 0.05, indicating that the associations between age and the types of ocular infections were not statistically significant, though clinically meaningful trends are evident.

Table 3: Frequency of Causative Agents with Season.

Causative Agents	No. of casualties (%)
Paddy water	13 (9.77)
Seedling	12 (9.02)
Chemical/Pesticides	17 (12.53)
Rice grain	15 (11.28)
Vegetative materials	17 (12.78)
Stones	10 (7.52)
Tree trunks	15 (11.28
Sticks	16 (12.03)
Plums	18 (13.53)

Table 3 presents the frequency distribution of various environmental agents responsible for ocular injury or contamination across different seasonal exposures. The data indicate that multiple natural and man-made elements contribute to the reported cases.

Among the listed agents, plums accounted for the highest proportion of cases, suggesting that this material poses a significant risk of contact or trauma during certain farming or harvesting activities. Vegetative materials and chemicals/pesticides also showed high frequencies, indicating a strong association between both organic plant debris and chemical exposure with the recorded conditions. These may cause irritation, inflammation, or infections, especially when protective measures are not used.

Table 2: Frequency Distribution of Ocular Infections with Age.

	Ocular infections				
AGE (Year)	Cornea Ulcer n (%)	Keratitis n (%)	Conjunctivitis n (%)	Endophthalmitis n (%)	Kerato-conjunctivitis n (%)
15-24	2 (5.1)	2 (3.9)	9 (31.0)	0 (0)	0 (0)
25-34	18 (46.1)	20 (39.2)	4 (13.8)	5 (50)	2 (50)
35-44	6 (15.4)	12 (23.5)	9 (31.0)	4 (40)	0 (0)
45-54	5 (12.8)	3 (5.9)	5 (17.2)	1 (10)	2 (50)
55-64	4 (10.3)	10 (19.6)	2 (6.9)	0 (0)	0 (0)
65-above	4 (10.3)	4 (7.9)	0 (0)	0 (0)	0 (0)
P value	0.735	0.698	0.194	0.367	0.410

Sticks, rice grains, and tree trunks were also prominent causative agents, each with relatively similar proportions. Their frequency suggests that mechanical injuries from tools or plant structures are common and contribute notably to the total number of cases.

Less frequent but still significant were paddy water, seedlings, and stones. While these agents accounted for fewer cases, they may still act as carriers of microbes or particulate matter that could cause infections or irritation, especially in environments with high moisture or unfiltered exposure.

The table shows that both natural materials (like vegetative debris and plums) and man-made or cultivated elements (like pesticides and seedlings) contribute to the occurrence of ocular contact or trauma. The diversity and frequency of these agents emphasize the need for safety awareness and protective interventions during activities involving physical and environmental exposure.

The table highlights the distribution of bacterial species isolated from various ocular infections, including corneal ulcer, keratitis, conjunctivitis, endophthalmitis, and keratoconjunctivitis. The aim is to identify the most prevalent pathogens and their association with specific clinical presentations. *Staphylococcus aureus* and *Pseudomonas aeruginosa* were the most frequently isolated organisms, each accounting for 16 cases (13.9%). *Staph. aureus* was most common in conjunctivitis, while *P. aeruginosa* had a wider distribution and was one of the few organisms isolated from endophthalmitis. Staphylococcus epidermidis (12.2%) and Streptococcus species (10.4%) were also significantly represented, especially in keratitis, corneal ulcers, and conjunctivitis, suggesting their role in anterior segment infections. Klebsiella species (9.6%) and Micrococcus species (8.7%) also contributed notably, particularly in corneal infections. Other isolates such as Bacillus species, Corynebacterium, and Escherichia coli (each around 7.8–8.7%) appeared mainly in superficial infections and were absent in deeper infections like endophthalmitis. Serratia species was the least common, contributing 8 cases (7.0%). Keratitis and corneal ulcers had the greatest diversity of pathogens, while endophthalmitis had limited bacterial involvement, with only three isolates detected. The findings indicate a predominance of Gram-positive cocci and Gram-negative bacilli, underlining the need for broad-spectrum empirical therapy in ocular infections. Pseudomonas aeruginosa and Staphylococcus aureus are the dominant pathogens across ocular infections in this population. This distribution pattern is crucial for guiding empirical treatment before culture results are available.

Table 5 examines the seasonal distribution of fungal isolates in ocular infections, comparing the planting and harvesting seasons. The data reveal both a variation in fungal species and differences in clinical presentation between the two seasons. During the planting season, only three fungal species were isolated: *Candida albicans*, *Fusarium species*, and *Aspergillus niger*. Each of these was involved in 60% of the fungal infections for the season. They were predominantly associated with keratitis, corneal ulcer, and conjunctivitis, with no involvement in endophthalmitis or keratoconjunctivitis. This indicates that fungal infections during the planting period tend to affect more superficial ocular structures, likely due to milder environmental exposure to fungal pathogens. In contrast, the harvesting season showed a marked increase in

Table 4: Frequency Distribution of the Bacterial Isolates in the Ocular Infections.

	Ocular infections					
Bacterial isolates	**CorneaUlcer**	**Keratitis**	**Conjunctivitis**	**Endophthalmitis**	**Keratoconjunctivitis**	**Total (%)**
Bacillus species	4	4	1	0	1	10 (8.7)
Corynebacterium	3	5	1	0	0	9 (7.8%)
Escherichia coli	2	4	2	0	1	9 (7.8%)
Klebsiella species	4	4	2	0	1	11 (9.6)
Micrococcus species	4	5	1	0	0	10 (8.7%
Pseudomonas aeruginosa	6	6	2	1	1	16 (13.9)
Staphylococcus epidermidis	5	5	2	0	2	14 (12.2)
Serratia species	2	3	3	0	0	8 (7.0%)
Streptococcus species	4	4	3	1	0	12 (10.4)
Staphylococcus aureus	4	3	7	1	1	16 (13.9)

Table 5: Seasonal Trend of Fungal Eye Infections.

Season	Isolates	Keratitis	Corneal Ulcer	Conjunctivitis	Endophthalmitis	Keratoconjunctivitis	Occurrence (%)
Planting	*Candida albicans*	+	+	+	-	-	60
	Fusarium species	+	+	+	–	–	60
	Aspergillus niger	–	+	+	–	+	60
Harvesting	*Candida albicans*	+	+	+	+	+	100
	Fusarium species	+	+	+	+	+	80
	Aspergillus niger	+	+	+	+	+	100
	Paecilomyces species	+	+	–	–	-	40
	Microsporium species	+	+	+	–	–	60

Key: "+" = Present; "–" = Absent

both the diversity and severity of fungal eye infections. Five fungal species were identified, including the previously mentioned three and two additional ones: Paecilomyces species and Microsporium species. *Candida albicans* and *Aspergillus niger* were isolated in 100% of the fungal infections during this season, with presence across all ocular infection types, including endophthalmitis and keratoconjunctivitis. *Fusarium species* was present in 80% of cases, also extending across the full clinical spectrum. Meanwhile, Paecilomyces and Microsporium were limited to keratitis and corneal ulcer, suggesting a role in more localized infections.

Notably, endophthalmitis and keratoconjunctivitis—deeper or more extensive ocular infections—were reported only in the harvesting season, suggesting an increased fungal burden or exposure during this period. This may be attributed to the aerobiological load of fungal spores, contact with contaminated harvest materials, and trauma from plant debris, which are more prevalent during harvest activities.

The table illustrates a clear seasonal trend, with the harvesting period associated with a higher prevalence, broader spectrum, and greater severity of fungal eye infections. These findings underscore the need for heightened awareness, protective strategies, and early intervention during agricultural seasons, particularly among high-risk groups such as farmers and field workers.

Discussion

The age and sex distribution of the rice farmers affected by ocular microbial infections in Ishiagu L.G.A indicates that older adults, particularly those aged 65 and above, formed the largest proportion of affected individuals. This finding aligns with previous studies suggesting that older adults in agrarian communities often maintain active roles in farming, thereby increasing their exposure to environmental risk factors, including dust, water-borne pathogens, and poor ocular hygiene [6]. The higher prevalence of infections in females within most age groups, particularly from 25 to 64 years, may reflect their extended time in paddy fields, involvement in water-intensive farming tasks, and potential lack of protective eyewear. Similar trends were observed in a study [7], where rural female farmers had significantly higher rates of conjunctivitis and microbial keratitis than their male counterparts due to prolonged exposure to contaminated water and plant material. The relatively low representation among the 15–24 age group suggests limited involvement in rice farming or less cumulative exposure, consistent with findings from another study [8], who reported fewer ocular conditions in younger age groups within rural farming populations. The mid-life age groups (35–54 years) also had a substantial number of cases, reinforcing the idea that active involvement in field work during one's prime years contributes to increased vulnerability to ocular infections.

Table 2 provides a detailed overview of the various types of ocular infections recorded among rice farmers in Ishiagu Local Government Area, Ebonyi State, across different age groups. The infections identified were corneal ulcer, keratitis, conjunctivitis, endophthalmitis, and kerato-conjunctivitis. The table reveals age-specific distribution patterns for each infection type, providing insight into occupational exposure, behavioral risks, and possible environmental influences on the eye health of the farming population.

Corneal Ulcer

The highest frequency of corneal ulcers was observed in the 25–34-year age group, accounting for nearly half of the cases. This age bracket represents the peak of physical productivity in farming communities and is most actively involved in high-exposure tasks such as land preparation, weeding, and transplanting. The risk of corneal trauma from foreign bodies such as grass blades, dust particles, mud, and farming implements is significantly increased in this age group. This trend is supported by the findings of Ajayi, Adeoti, and Olusanya [9], who reported that corneal ulcers were particularly common among middle-aged farmers due to high levels of outdoor exposure without the use of protective gear. Other age groups showed significantly lower frequencies of corneal ulcers, with the elderly (65 years and above) recording few or no cases. This could be attributed to reduced participation in strenuous farm work among older adults, limiting their exposure to causative agents. Additionally, older individuals may be less likely to report or seek treatment for eye injuries, resulting in underreporting of cases. Similar patterns were documented by Ukponmwan [10], who noted a decline in corneal trauma-related conditions with advancing age in rural populations.

Keratitis

Keratitis, which often results from bacterial or fungal infections following trauma or prolonged exposure to contaminated water, was also most prevalent in the 25–34-year age group. This finding highlights the vulnerability of actively working farmers to microbial contamination of the cornea, particularly during the rainy season or in swampy rice fields. The 35–44-year group followed closely, indicating continued high exposure among early middle-aged individuals. The relatively lower frequency of keratitis in the 15–24 age group could be explained by limited involvement of younger individuals in full-time farming, while the 65+ age group showed minimal involvement, again likely due to age-related reduction in occupational activity. Olatunji, Adeniji, and Fasina [11] also observed that fungal keratitis and bacterial keratitis were significantly associated with middle-aged farmers involved in wetland rice cultivation, where waterborne pathogens are more prevalent.

Conjunctivitis

Unlike the more invasive infections, conjunctivitis showed a different pattern. It was most common in the 15–24 and 35–44 age groups, with relatively high proportions in both. Conjunctivitis, particularly of infectious or allergic origin, is frequently caused by dust, wind, chemical exposure, and unsanitary hand-to-eye contact, all of which are common in outdoor farming environments. The prevalence in younger adults might also reflect poorer hygiene practices or more frequent rubbing of the eyes due to irritation. Interestingly, conjunctivitis appeared less common in the 25–34-year group compared to corneal infections. This suggests that

while this group may experience more direct trauma or microbial injury to the cornea due to intense physical work, conjunctival inflammation may be more prominent in younger or slightly older farmers with different exposure patterns or immune responses. According to Eze, Maduka-Okafor, and Onwasigwe [12], conjunctivitis remains one of the most common eye disorders in Nigerian farming communities and is often self-treated with herbal or over-the-counter remedies, which may influence reporting patterns.

Endophthalmitis

Endophthalmitis, a serious intraocular infection, was the least common condition reported, found only in the 25–44-year range. The limited occurrence of endophthalmitis reflects its rarity but does not diminish its clinical importance, as it is often associated with severe vision loss. Its presence in this specific age range again supports the observation that the most occupationally active farmers face higher risks of ocular injury or contamination that could lead to secondary intraocular infections. Trauma from sharp objects or plant material can introduce infectious organisms deep into the eye, especially when initial injuries are not properly managed. Ukponmwan [10] emphasized that improper treatment or use of contaminated traditional medications after eye trauma can lead to endophthalmitis, particularly in rural settings where access to ophthalmic care is limited.

Kerato-conjunctivitis

Kerato-conjunctivitis, an inflammatory condition involving both the cornea and conjunctiva, was reported exclusively in the 25–54 age range, with no cases among those younger than 25 or older than 54. This dual-tissue involvement may result from prolonged exposure to irritants such as ultraviolet rays, smoke, pesticides, or microbial agents, all of which are prevalent in rice farming. The fact that cases were only reported among middle-aged adults suggests that chronic exposure and accumulated micro-trauma over years of farm work may predispose this group to more complex ocular inflammations. As documented by Ajayi [9], kerato-conjunctivitis is particularly common in environments where farming involves continuous contact with contaminated water, dusty fields, or use of agrochemicals without proper protective measures. The absence of this condition in younger or older individuals may reflect differences in cumulative exposure or immune responsiveness.

Statistical Significance

The P-values for all types of ocular infections in relation to age were greater than 0.05, indicating that there were no statistically significant associations between age and any specific ocular infection in this study. However, the clinical trends observed are relevant and meaningful, as they reflect occupational exposure patterns, health-seeking behavior, and possibly even cultural practices regarding eye care in the rural population. In epidemiological studies, especially in small populations or those with limited health access, statistically non-significant findings may still point to important public health issues that require intervention [13].

The data in Table 3 highlight the various physical and environmental agents responsible for ocular exposure, trauma, or microbial contamination during field activities. The most frequently reported causative agent was plums, accounting for the highest proportion of cases. This suggests a significant risk of ocular contact or injury associated with fruiting vegetation, particularly during harvesting or clearing periods when workers are in close contact with dense foliage. This trend aligns with the findings of Ajayi, Adeoti, and Olusanya, who reported that plant-based materials, including branches and fruit stalks, were common sources of ocular trauma in agrarian populations due to direct contact or snapping of vegetation [14].

Vegetative materials, including leaves and plant debris, also ranked high among causative agents. These materials may introduce foreign bodies or harbor microbial contaminants, especially during wet seasons when moisture increases microbial survival on organic surfaces. Olatunji, Adeniji, and Fasina similarly found that organic plant matter was a major contributor to corneal abrasions and infections among rural laborers working in swampy or overgrown fields [15]. Another major contributor was chemical and pesticide exposure, which accounted for over 12% of cases. Chemical irritants are known to cause conjunctival inflammation, chemical burns, and, in severe cases, secondary microbial infections due to compromised ocular surfaces [6]. The improper use of personal protective equipment (PPE) and direct hand-to-eye contamination during pesticide application may explain the high incidence. Studies have emphasized that workers often overlook the potential dangers of agrochemical exposure, especially during spraying, weeding, or seed treatment processes [16]. Other notable agents included sticks, tree trunks, and rice grains, all of which are indicative of mechanical injuries sustained during harvesting or land clearing. These materials can easily strike the eye or cause abrasions during high-speed movements, particularly when tools or heavy materials are handled. According to Adekoya, Owoeye, and Adepoju, blunt or penetrating ocular trauma from natural objects like sticks and grain stems was a significant cause of corneal ulceration and visual impairment in field workers [17]. Paddy water and seedlings, though less frequent, are equally important. Paddy water, in particular, may serve as a medium for microbial transmission, including bacteria and fungi, which can enter the eye through minor abrasions or contaminated hands. This mode of transmission has been previously described by Bialasiewicz et al., who documented a higher prevalence of infectious conjunctivitis and keratitis in wetland farming communities with prolonged exposure to untreated water sources [18].

Although stones accounted for the lowest number of casualties in this study, they remain important due to their potential to cause blunt trauma, which may result in more severe ocular outcomes if not promptly managed.

The findings in Table 3 align with a broad body of research emphasizing that both organic materials (e.g., vegetation, fruit, grains) and environmental hazards (e.g., water, chemicals, debris) contribute to the high incidence of ocular problems in outdoor

labor settings. This reinforces the need for routine eye safety education, availability of protective eyewear, and early ophthalmic intervention to reduce preventable vision loss among exposed individuals.

This study identified Pseudomonas aeruginosa and Staphylococcus aureus as the most frequently isolated bacteria in ocular infections, each accounting for 13.9% of all isolates. This finding is consistent with existing literature which highlights both organisms as common culprits in ocular surface infections, particularly Pseudomonas in contact lens-related keratitis due to its aggressive virulence mechanisms [19,20]. Staphylococcus aureus and Staphylococcus epidermidis also appeared prominently, especially in cases of keratitis, conjunctivitis, and corneal ulcers. This observation is supported by Bharathi, Ramakrishnan, Vasu, Meenakshi, and Palaniappan [21], who reported a similarly high prevalence of Staphylococcus species in ocular infections in South India. Staphylococcus epidermidis, although often part of the normal flora, is capable of becoming pathogenic under predisposing conditions such as trauma, surgery, or immunosuppression [22]. Streptococcus species (10.4%) and Klebsiella species (9.6%) were also notably frequent. Their presence in ocular infections aligns with other regional studies which reported these bacteria as secondary but significant contributors to ocular pathology, particularly in corneal and conjunctival infections [23,24]. The isolation of Escherichia coli, Corynebacterium, and Serratia species, though less frequent, is consistent with their known roles as opportunistic pathogens, especially in nosocomial environments and polymicrobial infections [25]. Micrococcus and Corynebacterium, traditionally viewed as commensals, have increasingly been recognized as potential pathogens in ocular infections, particularly in elderly or immunocompromised patients [26].

Endophthalmitis, an intraocular infection, exhibited limited bacterial diversity in this study, with only three organisms (P. aeruginosa, S. aureus, and Streptococcus species) implicated. This finding corresponds with the Endophthalmitis Vitrectomy Study [27], which documented Staphylococcus and Streptococcus species as the most common isolates in post-operative endophthalmitis.

Keratitis and corneal ulcers, in contrast, showed the greatest bacterial diversity, likely due to their exposure to the external environment and their susceptibility to trauma or contamination. The dominance of both Gram-positive cocci and Gram-negative bacilli highlights the need for broad-spectrum empirical antibiotic therapy in suspected ocular infections, pending culture results. This study's findings are consistent with global and regional trends in ocular microbiology, reinforcing the clinical significance of P. aeruginosa and S. aureus in both superficial and deep ocular infections.

Table 5 presents the seasonal distribution of fungal isolates implicated in ocular infections, highlighting significant differences between the planting and harvesting seasons. During the planting season, only *Candida albicans*, *Fusarium species*, and *Aspergillus niger* were isolated, each accounting for 60% of the total fungal infections. These fungi were found primarily in keratitis, corneal ulcers, and conjunctivitis, with no cases of endophthalmitis or keratoconjunctivitis. This trend suggests that fungal infections during planting are largely superficial and limited to anterior segment structures.

By contrast, the harvesting season showed an increased fungal diversity and deeper tissue involvement. Five fungal species were isolated: the three mentioned above plus Paecilomyces and Microsporium species. *Candida albicans* and *Aspergillus niger* were isolated in 100% of harvesting season infections, affecting all ocular tissues including endophthalmitis and keratoconjunctivitis. *Fusarium species* also increased in prevalence (80%) and was similarly widespread. The presence of Paecilomyces and Microsporium—rare fungal pathogens—reflects heightened environmental exposure and suggests that harvesting activities may facilitate traumatic inoculation or aerosol transmission of uncommon fungi.

These findings are consistent with several epidemiological studies that have documented seasonal variation in fungal keratitis. Bharathi et al. reported higher rates of fungal eye infections during post-monsoon and harvest periods in South India, attributing this to increased agricultural exposure and trauma from vegetative matter [28]. Similarly, Gopinathan et al. noted that Fusarium and Aspergillus were the most common fungi isolated in tropical agricultural zones, particularly during the dry season when dust and plant debris are prevalent [29]. Srinivasan emphasized that endophthalmitis due to filamentous fungi such as Aspergillus tends to follow penetrating trauma with organic material—events more likely to occur during crop harvesting [30]. The appearance of endophthalmitis exclusively in the harvesting season in the current study supports this observation. The absence of deep ocular infections in the planting season may be related to lower environmental fungal load, less frequent ocular trauma, or increased humidity, which supports bacterial over fungal growth. In contrast, dry and dusty harvest environments facilitate spore dispersal, contributing to increased risk of keratomycosis and intraocular invasion.

Table 5 demonstrates a clear seasonal pattern of fungal ocular infections, with the harvesting season showing greater fungal diversity and deeper ocular involvement. These trends are in agreement with existing literature and highlight the need for season-specific preventive strategies, including eye protection, early diagnosis, and prompt antifungal therapy, particularly among individuals with agricultural exposure.

Conclusion

This study identified Pseudomonas aeruginosa and Staphylococcus aureus as the predominant bacterial pathogens in ocular infections among rice farmers in Ishiagu L.G.A, Ebonyi State, Nigeria. Fungal infections were less common but showed notable seasonal variation, with increased diversity and deeper ocular involvement during the harvesting season. The detection of rare fungi such as Paecilomyces and Microsporium during this period highlights the

impact of environmental exposure during agricultural activities. These findings emphasize the need for improved ocular safety practices, early diagnosis, and season-specific interventions, especially during the harvest when fungal infections are more prevalent and severe.

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