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## Article

# Bacterial Conjunctivitis in Hadhramout Governorate-Yemen

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**Abstract:** **Background:** Bacterial conjunctivitis is one of the most commonly encountered eye complications in medicine, particularly in developing nations. In Hadhramout Governorate-Yemen, there is no data about bacterial conjunctivitis among patients. **Aim:** The present study aimed to determine the prevalence rate of bacterial conjunctivitis among patients seeking hospitals in Hadhramout Governorate, Yemen. **Methods:** A total of 1722 eye swabs were collected from patients attending different Hadhramout hospitals over a period of April to December 2018. The isolation and identification of bacteria are performed using standard bacteriological procedures. In addition, structured questionnaires were used to gather data from patients. **Results:** Out of 1722 eye swabs, 198 (11.49%) were positive for bacterial conjunctivitis, while 1524 (88.5%) were negative. The high prevalence rate of infection was among female participants and the age group between 31 and 40 years, at 15.25% and 29.29%, respectively. In addition, the prevalence of gram-positive bacteria was significantly greater among study patients than gram-negative bacteria (58.59% vs. 41.41%). The most predominant Gram-positive bacteria were *Staphylococcus aureus* (26.26%), followed by *Streptococci pneumoniae* (17.18%), Alpha-hemolytic *Streptococci* (8.08%), and *Staphylococcus epidermidis* (7.07%). Whereas the gram-negative bacteria were *Pseudomonas aeruginosa* (12.1%), followed by *Moraxella catarrhalis* (10.1%), *Haemophilus influenza* (7.07%), *Klebsiella* sp. (6.06%), *Enterobacter agglomerans* (4.04%), and *Neisseria gonorrhoeae* (2.02%). Additionally, the majority of study patients suffered from red eyes (100%), tearing eyes (93.93%), itching (90.9%), painful eyes (87.87%), purulent eyes (56.56%), and eye discharge (38.38%). **Conclusion:** The prevalence rate of bacterial conjunctivitis among patients in Hadhramout, Yemen, is relatively low compared with international investigations. Further investigation is required to assess and identify the antibiotic resistance to these agents that cause conjunctivitis.

**Keywords:** bacteria; conjunctivitis; hadhramout; yemen

## Introduction

Bacterial conjunctivitis most commonly affects otherwise healthy people worldwide, particularly in developing countries. Bacterial conjunctivitis can be transmitted from person to person through respiratory droplets, hand-to-eye contact, and eye contact with fomite, as well as exposure to infected persons, immunodeficiency states, past ocular disease, trauma, and birth exposure to agents of sexually transmitted disease [1,2].

Factors such as hygiene practices, living conditions, and access to healthcare can influence the incidence of the infection. Patients with bacterial conjunctivitis frequently complain of redness, tearing, and discharge from one or both eyes [3]. *Staphylococcus aureus*, *Streptococcus pneumoniae*, *Haemophilus influenzae*, and *Moraxella catarrhalis* are the most frequent causes of acute bacterial



conjunctivitis. While *Neisseria gonorrhoeae* or *Neisseria meningitidis*, *Chlamydia trachomatis*, *Moraxella lacunata*, or Gram-negative enteric flora, and *Chlamydia trachomatis* are extremely rare or less commonly [3].

*H. influenzae* is the most frequent causal organism for bacterial conjunctivitis in children, followed by *S. pneumoniae* and *M. catarrhalis* [5,6]. Adults are more frequently infected with staphylococcal types of bacteria, with a smaller percentage of cases being caused by *H. influenzae* and *S. pneumoniae*. *S. aureus* is more frequently detected in adults and the elderly, but it is also present in cases of bacterial conjunctivitis in children [7].

Most bacterial conjunctivitis is self-limiting. One systematic review found a clinical cure or significant improvement with a placebo within 2–5 days in 65% of people. Some organisms cause corneal or systemic complications, or both. Otitis media may develop in 25% of children with *H. influenzae* conjunctivitis, and systemic meningitis may complicate primary meningococcal conjunctivitis in 18% of people [5].

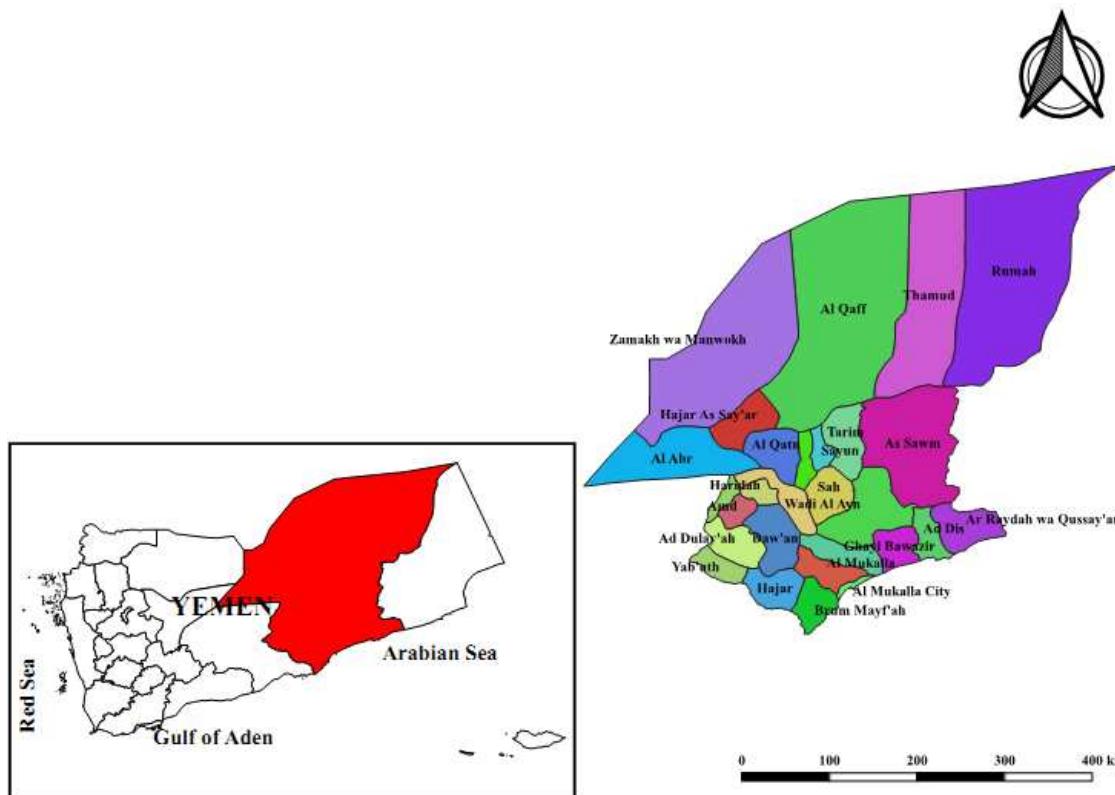
According to estimates, 23% of bacterial conjunctivitis cases in the United States occur in children under the age of two, 28% in children between the ages of three and nine, 13% in adolescents between the ages of 10 and 19 years old, and 36% in adults [8].

Yemen is considered to be among the world's poorest low-income nations. Recent data indicates that over 79% of the population is estimated to be living below the poverty line, with about 65 percent of these individuals being considered extremely poor. Furthermore, the majority of Yemenis lack access to clean drinking water; poor hygiene practices; unstable institutions; food insecurity; and restricted access to healthcare services are all factors that raise the risk of contracting infectious diseases [9–13].

There is only one study conducted in Sana'a City that revealed the prevalence rate of bacterial conjunctivitis among neonates was 51.7% [14]. There is currently no information available about the prevalence of bacterial conjunctivitis in Hadhramout Governorate, Yemen. Therefore, this study aimed to determine the prevalence rate of bacterial conjunctivitis among patients seeking hospitals in Hadhramout Governorate, Yemen.

## Materials and Methods

This study is a cross-sectional study conducted among 1722 patients with bacterial conjunctivitis in Hadhramout Governorate between April and December 2018. Hadhramout is the largest governorate of Yemen by area and is located in the southeastern part of the Republic of Yemen, 794 kilometers east of the capital of Sana'a, between Al-Mahra to the east and Al-Jawf, Marib, and Shabwah to the west. The governorate is divided administratively into 28 districts, with the city of Mukalla as its capital. It borders the Kingdom of Saudi Arabia in the north (Figure 1).



**Figure 1.** Map of Yemen indicating the study area in Hadhramaut governorate.

### **Patients study**

The patients included in this study are newborns, infants, children, and adults. Conjunctivitis cases were defined by a clinical diagnosis of conjunctivitis or an episode of one of the following symptoms: red or itchy eyes, pain, purulent eyes, eye discharge, and tearing. All identified cases underwent a bio-microscopic check with a slit lamp. Patients suspected of having or with a positive culture for fungal, viral, or *Acanthamoeba* infections were also excluded.

### **Data Collection**

A questionnaire was designed to collect relevant data from each participant. Demographic data such as age, sex, signs, and symptoms were collected by interviewing them face-to-face.

### **Samples Collection**

The conjunctival swabs were collected by trained healthcare staff using a cotton swab moistened with sterile saline. Two swabs from each patient were collected, one for each eye, even if the infection was in only one eye. Specimens were transported directly to the laboratory within half an hour for culture and other bacteriological analysis.

### **Microbiological Laboratory Analysis**

The collected swabs were inoculated onto Blood agar (5% sheep blood), MacConkey agar, and Chocolate agar (HiMedia Lab., India). The inoculated Blood and MacConkey agar were aerobically incubated at 37 °C for 27 hours, while the Chocolate agar plates were incubated under anaerobic conditions within a candle jar (7% CO<sub>2</sub> atmosphere) at 37 °C for 27 hours. Bacteria were identified using routine standard microbiological methods: culture characters of pure colonies, Gram staining, enzyme production, and biochemical tests. Biochemical tests such as the catalase test, coagulase test, and optochin test were applied for gram-positive bacteria, while carbohydrate tests were applied for gram-negative bacteria [15].

## Ethical Approval

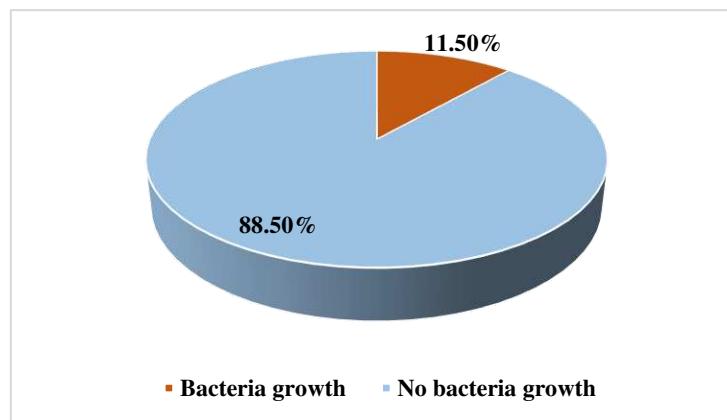
The project's ethical permission was approved by the Hadhramout University Ethics Committee. Before any data or specimens were collected, the patient participants were fully informed of the investigation's goals, and they gave their consent to participate in this investigation. In addition, the collected data was treated with confidentiality and was only used for research purposes within the scope of this study.

## Statistical Analysis

The obtained data was analyzed using descriptive analyses. The frequency and percentage representations of categorical variables are shown in tables and figures.

## Results

Out of 1722 patients enrolled in this study, it was found that 198 (11.49%) eye swabs were positive for bacterial growth in culture media, while 1524 (88.5%) eye swabs were negative (Figure 2).



**Figure 2.** Prevalence rate of bacterial conjunctivitis.

In this result, it was noticed that the female participants had a higher rate of bacterial conjunctivitis (15.25%) when compared with the males (8.04%), as illustrated in Table 1.

**Table 1.** Frequency of bacterial conjunctivitis according to gender.

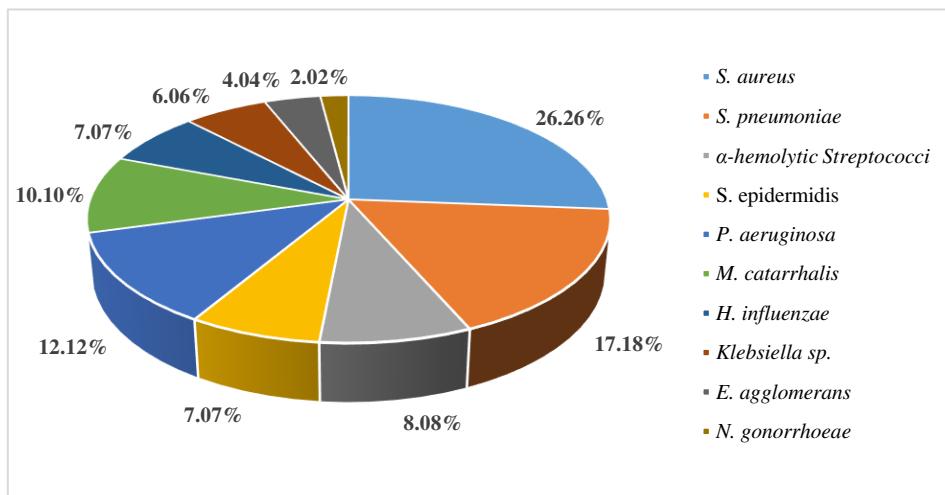
Gender	Examined		Infected		Non-infected	
	No. (%)	No	Rate (%)	No	Rate (%)	
Male	896 (52.03)	72	8.04	824	91.96	
Female	826 (47.97)	126	15.25	700	84.75	
<b>Total</b>	<b>1722</b>	<b>198</b>	<b>11.50</b>	<b>1524</b>	<b>88.5</b>	

Regarding age group, in general, a higher rate of bacterial conjunctivitis was observed among study subjects ages 31–40 years (29.29%), while the lowest rate was reported among babies younger than one year (2.02%). Additionally, the prevalence rate of bacterial conjunctivitis is significantly greater in males aged between 1 and 10 years (27.78%) compared to other age groups. While the females in the age group of 31–40 years had a higher rate of bacterial conjunctivitis (31.75%) when compared to other age groups (Table 2).

**Table 2.** Frequency of bacterial conjunctivitis concerning age group and gender.

Age (years)	Patients (n=198)		Male (n=72)		Female (n=126)	
	No	(%)	No	(%)	No	(%)
<1	4	2.02	0	0	4	3.17
1-10	42	21.21	20	27.78	22	17.46
11-20	26	13.13	10	13.89	16	12.70
21-30	36	18.19	14	19.44	22	17.46
31-40	58	29.29	18	25.0	40	31.75
41-50	8	4.04	0	0.0	8	6.35
>50	24	12.12	10	13.89	14	11.11

The current findings showed that the gram-positive bacteria were the most isolated from 116 patients (58.59%), while the gram-negative bacteria were isolated from 82 patients (41.41%). *S. aureus* was the most Gram-positive bacteria at 52 (26.26%), followed by *S. pneumoniae* 34 (17.18%), Alpha-hemolytic *Streptococci* 16 (8.08%), and *S. epidermidis* 14 (7.07%). In addition, *P. aeruginosa* was the most Gram-negative bacteria observed at 24 (12.1%), followed by *Moraxella catarrhalis* 20 (10.1%), *H. influenzae* 14 (7.07%), *Klebsiella* sp. 12 (6.06%), *E. agglomerans* 8 (4.04%), and *N. gonorrhoeae* 4 (2.02%), as shown in Figure 3.

**Figure 3.** Frequency of bacterial species among infected patients with conjunctivitis.

According to signs and symptoms associated with infected eyes, 100% of the study participants had red eyes; 93.93% had a tearing eye; 90.9% of them had itching; 87.87% had painful eyes; 56.56% had purulent eyes; and 38.38% had eye discharge (Table 3).

**Table 3.** Frequency of bacterial conjunctivitis concerning signs and symptoms.

Variables	Cases (n=198)	Percentage %
Red eye	198	100
Tearing	186	93.93
Itching	180	90.9
Pain	174	87.87
Purulent eye	112	56.56
Eye discharge	76	38.38

## Discussion

This study is the first to describe the clinical pattern of bacterial conjunctivitis in Hadhramout Governorate. In this study, the prevalence of bacterial conjunctivitis was 11.5% among participants. This result is lower than what was in a previous study that showed the prevalence rate of bacterial conjunctivitis at 14.2% in Nigeria [16], 15.8% in the UK [17], 51.7% in Sana'a, Yemen [14], 60% in Saudi Arabia [18], 69% in Iraq [19], 81.5% in the United Arab Emirates [20], and 80.5% in Iran [21].

The variation in prevalence rate might be due to variations in geographic regions, study population, sample size, racial and ethnic variations, environmental and behavioral patterns, economic status, and the methods of diagnosis used in this study.

Regarding the sex variable, the present finding showed that bacterial conjunctivitis was higher among females (15.25%) compared to males (8.04%). This result is similar to those documented in different countries [22–24]. In different statements, males and females have equal natural resistance to bacterial conjunctivitis [2]. Sex has less influence than age on the ocular microbiota composition. In fact, several studies have shown that there is no difference between males and females [25].

The fact that Yemeni customs and traditions obligate women in Yemen to wear the Islamic hijab, which covers their faces during activities outside their homes, may have contributed to the spreading of eye infections. This explains why bacterial conjunctivitis increased among females in this study.

Concerning the age group, study participants aged 31–40 years in this study had the highest rate of bacterial conjunctivitis (29.29%), whilst infants under one year old had the lowest rate (2.02%). The results align with those of other workers who reported that ocular infections are rising with increasing age [24,26,27]. In addition, Wen et al. noticed that older participants had a higher diversity of Shannon index values than younger individuals when analyzing the diversity of the ocular microbiome in people aged 28 to 84 years [28].

In contrast, the United States has a higher incidence of bacterial conjunctivitis in children than in adults; 23% of cases have been reported in children ages 0–2, 28% in children ages 3–9, 13% in children ages 10–19, and 36% in adults [8,29].

Additionally, compared to other age groups, males between the ages of 1 and 10 years had a considerably higher prevalence rate of bacterial conjunctivitis (27.78%). In contrast to other age groups, the females in the 31–40-year-old age group had a greater risk of bacterial conjunctivitis (31.75%). Depending on the age range, different bacteria can cause bacterial conjunctivitis, which affects children significantly more frequently than adults [30,31].

In this finding, gram-positive bacteria were found to be significantly more prevalent in patients than gram-negative bacteria (58.59% vs. 41.41%). This result is in compliance with findings regarding the most common isolated bacteria being gram-positive bacteria [32,33].

In this study, *S. aureus* was the most common pathogen isolated from participants (26.26%). This result is in consonance with other studies in South Florida [32], the UK [17], Nigeria [34], and Saudi Arabia [33]. The high prevalence of *S. aureus* in this study indicates that this bacterium is one of the normal resident flora of the conjunctiva, eyelids, and skin in a small number. In addition, this bacterium can spread through hand-to-eye contact or by colonizing nearby mucosal tissues, like the sinus or nasal mucosa [35]. Moreover, the high prevalence of *S. aureus* in the hospital environment is another reason for its transmission to patients during hospitalization [36–38].

These data showed that *S. pneumoniae* was the second bacteria isolated from study subjects (17.18%), and this is in line with reports [14,33,39]. *S. pneumoniae* is one of the top three most commonly isolated microorganisms from normal conjunctival flora [40]. *S. pneumoniae* kills an estimated 317,300 children aged 1–59 months, mostly in lower-income countries [41]. It is responsible for 7–44% of acute conjunctivitis and for 12–20% of conjunctivitis-otitis syndrome [42].

Overall, *P. aeruginosa* was the third one recovered, and most gram-negative bacteria were detected in the participants' study (12.1%). This result is in accordance with the results of Cavuoto et al. [32] and Alhazmi et al. [33]. In addition, several studies reported that the proportion rate of *P. aeruginosa* was reported at 11.4% in Ethiopia [43], 24.2% in Iran [44], 21% in Australia [45], and 20% between 2014 and 2015 in Baghdad [46].

*P. aeruginosa* is resistant to lens cleaning solutions, where they adhere and spread through the formation of lipid rafts in contact lens users [47]. *P. aeruginosa* is an opportunistic human pathogen and is a common cause of bacterial keratitis, which is more progressive with large infiltrations and scarring [48]. This type of bacteria has been noticed in several studies conducted among healthcare workers [49–51].

The prevalence rate of *S. epidermidis* was reported at 7.07% in this study. *S. epidermidis* inhabits the ocular surface, specifically the conjunctival sac [52]. Additionally, high incidences of ocular infection by *S. epidermidis* have been reported, even in some cases superior to those achieved by *S. aureus*. The previous reports are considerable because *S. epidermidis* does not have a variety of virulence factors such as *S. aureus* [53,54].

Furthermore, the other Gram-negative bacteria recovered in this work were *Moraxella catarrhalis* (10.1%), *H. influenzae* (7.07%), *Klebsiella* sp. (6.06%), *E. agglomerans* (4.04%), and *N. gonorrhoeae* (2.02%). In previous studies, *H. influenzae* and *M. catarrhalis* had a frequency rate of 61.8% and 19.1%, respectively, in children with infective conjunctivitis [42]. In a study by Bharathi et al. [55] in India, the prevalence of *M. catarrhalis*, *M. lacunata*, *Haemophilus* sp., and *Enterobacter* sp. was recorded at 53.17%, 63.83%, 25.5%, and 35.7%, respectively. A report by Cavuoto et al. [32] revealed that *H. influenzae* was the most frequent isolate recovered from patients under 7 years old (59.8%).

The transmission of *N. gonorrhoeae* occurs when the eyes come into contact with infected genital secretions from a person with genital gonorrhea [56]. *H. influenzae* is a frequent cause of conjunctivitis in children ages 6–36 months. Children younger than 2 years were the most vulnerable population to this syndrome, and *H. influenzae* was the most correlative pathogen [57].

The most common symptoms of bacterial conjunctivitis in the current study are red eye, tearing, and itching with 100%, 93.93%, and 90.9%, respectively. Other signs and symptoms include pain, purulent eyes, and eye discharge. A history of infectious conjunctivitis and itch both made the probability of current bacterial involvement less likely [58].

## Conclusion

From this study, it can be concluded that the prevalence of bacterial conjunctivitis among patients in the study area is low compared to other countries. *S. aureus* bacterium was the most predominant as well, and gram-positive cocci are still the most common isolates. Public education regarding eye health is necessary, as is the prompt referral of any occurrences of eye infections to an eye specialist to avoid complications that could result in blindness. Future studies that include a larger population and antibiotic profiles are warranted to provide a better understanding of bacterial conjunctivitis in Hadhramout.

**Conflict of Interest:** The authors declare that they have no competing interests.

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