• Investigation •

Characteristic of red eye related diseases of Han and Uygur population in Urumchi compared with Shanghai, China

Hui Zhao[1], Yi Shao[2], Shi-Nan Wu[2], Li-Ying Tang[3], Qi Zhang[1], Chen Zhao[1], Xue-Yi Chen[4], Jing Fu[4]

[1]Xinhua Hospital Affiliated to Shanghai Jiao Tong University School of Medicine, Shanghai 200092, China
[2]Department of Ophthalmology, the First Affiliated Hospital of Nanchang University, Jiangxi Province Ocular Disease Clinical Research Center, Nanchang 330006, Jiangxi Province, China
[3]Eye Institute of Xiamen University, Xiamen 361102, Fujian Province, China
[4]The First Affiliated Hospital of Xin Jiang Medical University, Urumqi 830011, Xinjiang Uygur Autonomous Region, China
Co-first authors: Hui Zhao, Yi Shao, and Shi-Nan Wu
Correspondence to: Jing Fu. The First Affiliated Hospital of Xin Jiang Medical University, 137 Liyushan South Road, Urumqi 830011, Xinjiang Uygur Autonomous Region, China. 77368620@qq.com; Hui Zhao. Xinhua Hospital Affiliated to Shanghai Jiao Tong University School of Medicine, Shanghai 200092, China. 20887787@qq.com
Received: 2021-07-16 Accepted: 2022-03-17

Abstract

● **AIM:** To study the characteristics, relative distribution and to compare causes of red eye in ophthalmic clinics in Urumchi and Shanghai, China.

● **METHODS:** Data on continuous cases of red-eye patients admitted to the Ophthalmology Center of Xinhua Hospital Affiliated to Shanghai Jiao Tong University and the First Affiliated Hospital of Xinjiang Medical University were collected between November 2018 and September 2019. Demographic data, the incidence of red eye and related disease distribution of all cases were obtained. The independent *t*-test method was used for age comparison, while the Chi-square test was used to compare classified data information.

● **RESULTS:** The information on 335 and 415 patients with red eyes in Shanghai and Urumchi were collected, respectively. The main causes of red eye were conjunctival disease and dry eye. The age of female patients with red eyes was significantly higher than that of males, and the proportion of female patients with dry eyes was also higher. Red-eye-related diseases occurred more frequently in patients over 46 years old than in those under 18, and dry eye was more common with increasing age. The incidence of infectious conjunctivitis in Urumchi was significantly higher than that in Shanghai, and allergic conjunctivitis occurred more frequently in spring, summer, or autumn than in winter (all $P<0.05$).

● **CONCLUSION:** Significant differences exist in the distribution of red-eye-related diseases in Urumchi and Shanghai regions of China, and distribution varies with age and season, the latter being an important feature of allergic conjunctivitis.

● **KEYWORDS:** distribution; red-eye-related diseases; characteristic

DOI:10.18240/ijo.2022.07.18

Citation: Zhao H, Shao Y, Wu SN, Tang LY, Zhang Q, Zhao C, Chen XY, Fu J. Characteristic of red eye related diseases of Han and Uygur population in Urumchi compared with Shanghai, China. *Int J Ophthalmol* 2022;15(7):1165-1173

INTRODUCTION

Red eye is a very common eye condition encountered in clinical examination by ophthalmologists. These patients usually have a good prognosis, but there are rare cases of severe symptoms and inflammation that can lead to serious visual impairment and life-threatening health risks. In clinical examination, common ocular diseases that lead to red eye include conjunctival disease, corneal disease, dry eye, blepharitis, pterygium, and glaucoma, which is common in the elderly[1]. Among the conjunctival diseases that cause red eye is bacterial, fungal, viral, and allergic conjunctivitis, the latter caused by allergens or seasonal changes[2]. Corneal diseases can also be categorized as infectious and non-infectious keratitis. It should also be noted that the incidence of dry eye is increasing due to the increasing frequency and time spent using video display terminals[3-5]. The proportion of red eye caused by dry eye is rising, while global climate

change and the aggravation of environmental pollution have triggered a rise in the incidence of allergic eye diseases caused by allergens[6]. As one of the most inland cities in China, the oasis city Kashgar was located in the desert area of western China, with an elevation of more than 1200 meters. It is one of the driest cities on earth, with hot summers and cold winters[7]. A multicenter Chinese allergy study shows that the high incidence of allergic rhinitis in Urumqi in Xinjiang lasts longer than in other areas, from April to August[8]. Related studies have further proved that the incidence of dry eyes in desert and plateau areas was significantly higher than that in coastal and low-altitude areas[9]. Environmental risk factors for dry eye disease include strong light exposure, excessive ultraviolet radiation, dry climate, strong winds and dust[10-11]. In the inland areas of Xinjiang, the above environmental risk factors are very common, and dry eyes are one of the most important causes of red eyes[2]. Therefore, an understanding of the related diseases and characteristics of red eye is important to improve the accuracy of red eye diagnosis. To this end, we retrospectively analyzed the continuous case data of red-eye patients in Urumchi and Shanghai ophthalmology clinics from the Western and Eastern regions of China, respectively, to determine the epidemiological characteristics of red eye, and provide a basis for the clinical diagnosis, treatment and research of red eye patients.

SUBJECTS AND METHODS

Ethical Approval All research methods were approved by the committee of the medical ethics of Xinhua Hospital Affiliated to Medical College of Shanghai Jiao Tong University and were in accordance with the Helsinki declaration and its later amendments or comparable ethical standards (XHEC-D-2020-023). All subjects were explained the purpose, method, potential risks and signed an informed consent form.

Clinical Data Data were collected from continuous cases of red-eye patients admitted to the Ophthalmology Center of Xinhua Hospital Affiliated to Shanghai Jiao Tong University and the First Affiliated Hospital of Xinjiang Medical University between November 2018 and September 2019. Demographic and clinical data were analyzed and compared between the two hospitals.

Patient and Public Involvement By collecting the ophthalmic clinical outpatient information of the subjects, we screened out the patients with red-eye as the chief complaint and studied the specific etiology of red eye. None of the subjects were recruited for this study. The results of this study can be used to analyze the specific etiology of red eye patients and contribute to the prevention of red eye and recurrence. This study was not a randomized controlled study. It is an epidemiological study of red eye in ophthalmology.

Diagnostic Disease Records of all patients presenting with ocular disease during the study period were collected. Eligible ocular conditions included infectious conjunctivitis, allergic conjunctivitis, trachoma, blepharitis, dry eye, progressive pterygium, other conjunctival diseases, infectious keratitis, palpebral keratitis, drug-derived epithelial lesions, other non-infectious keratitis, scleritis, glaucoma, uveitis, trauma, and other ocular diseases caused by eye surgery. Infectious conjunctivitis includes bacterial, fungal, and viral conjunctivitis as well as infectious conjunctivitis of indeterminate type.

Diagnostic criteria for conjunctivitis were as follows: inflammation or infection of the conjunctiva characterized by dilation of the conjunctival blood vessels, with conjunctival congestion and edema, with or without secretions. Ocular discharge type and symptoms were used to determine the cause of conjunctivitis. For example, purulent secretions are usually caused by bacterial conjunctivitis, while watery secretions are characteristic of viral conjunctivitis, and itching is also associated with allergic conjunctivitis[12]. The type of secretions or other clinical symptoms are not unique to one type of conjunctivitis. All other diagnoses of red-eye related diseases were differentiated by ophthalmologists with rich clinical diagnosis experience.

Statistical Methods In this study, SPSS26.0 software was used for statistical analysis of the data of each center. For the comparison of male and female ages, the independent *t*-test method was used. For other different groups of cases, we used the Chi-square test. Besides, we performed a binary Logistic regression analysis of risk factors for allergic conjunctivitis. All statistical thresholds were $P<0.05$.

RESULTS

Incidence of Red Eye in Different Sexes and the Distribution of Related Diseases in Shanghai Clinic Data were gathered from records of 125 males and 210 females aged 47.94±23.36 and 52.13±18.42, respectively ($P=0.035$) at the Shanghai Ophthalmology Clinic and included in the study. Of these, conjunctival diseases accounted for 39%, the majority (68%) of these being allergic conjunctivitis, followed by dry eye diseases accounting for 30%. Among cases of corneal disease, palpebral keratitis accounted for the largest proportion, at 47%. When cases were categorized by age a significant gender difference was found in the age of onset of red-eye ($\chi^2=15.206$, $P=0.002$). In children (aged 1 to 18y) the prevalence of red eye was 17% in males and only 4% in females.

The range of red-eye-related conditions included conjunctival disease, dry eye, corneal disease, conjunctival corneal disease, trauma or surgery, glaucoma, and other ocular diseases. Due to the very low prevalence of progressive pterygium, scleritis, and uveitis in in the Shanghai data, these were classified as ‘others’. No significant difference in disease distribution was

Table 1 The incidence of red eye in different genders and the distribution of related diseases in Shanghai center

Index	Male (n=125)	Female (n=210)	t/χ^2	P^c
Age	47.94±23.36	52.13±18.42		0.035[a]
All age groups			15.206	0.002[b]
1 to 18 years old	21 (17%)	9 (4%)		
19 to 45 years old	30 (24%)	54 (26%)		
46 to 60 years old	27 (22%)	52 (25%)		
More than 60 years old	47 (37%)	95 (45%)		
Distribution of diseases associated with red eye			11.872	0.063[b]
Conjunctiva disease	58 (46%)	82 (39%)		
Dry eye	28 (22%)	58 (28%)		
Corneal diseases	5 (4%)	25 (12%)		
Conjunctival corneal disease	7 (6%)	16 (7%)		
Injury or surgery	7 (6%)	10 (5%)		
Glaucoma	10 (8%)	7 (3%)		
Others	10 (8%)	12 (6%)		

P<0.05 indicates statistical significance. [a]Independent sample t-test. [b]Chi-squared test. [c]Comparison between the male and female. Data showed as mean±standard deviation or n (%).

found between males and females (χ^2=11.872, P=0.063). In both genders, the most frequent causes of red eye were conjunctival disease and dry eye. The above data are shown in Table 1, Figures 1 and 2.

Incidence of Red Eye in Different Genders and the Distribution of Related Diseases in Urumchi Center Data from 202 males (aged 37.98±23.11y) and 213 females (aged 43.50±20.53y; P=0.010) were gathered at the ophthalmology clinic of Xinjiang hospital, and included in the study. Conjunctival diseases accounted for the largest proportion of cases, at 42%. Among these, infectious conjunctivitis accounted for the largest proportion at 86%, and allergic conjunctivitis a relatively small 10%. In the category of corneal disease, non-infectious keratitis accounted for the largest proportion at 50%, followed by infectious keratitis, and corneal diseases caused by palpebral keratitis accounted for only 9%. Data were grouped according to the same age categories used for data at the Shanghai clinic, and a significant difference was again found in the age of onset of red eye between men and women (χ^2=10.651, P=0.014). Male children (aged 1 to 18y) accounted for 21 percent of all cases and females in this age group accounted for 10 percent. Due to the relatively high prevalence of progressive pterygium, scleritis, and uveitis among the subjects in the Urumchi center, these were categorized separately and not grouped as “others”. A significant difference in disease distribution was found between males and females (χ^2=24.969, P=0.002). In men, conjunctival diseases accounted for the largest proportion (38%), followed by trauma or surgery (19%). Conjunctival disease was also the most common cause of red-eye in women (45%), followed by dry eye and other causes (11%). Results are shown in Table 2, Figures 3 and 4.

Incidence of red eye and related disease distribution in different ethnic groups in Urumchi center Red eye cases at the ophthalmology clinic of Urumchi center included data from 314 Han people and 101 Uygur people, aged 39.87±22.47y and 43.72±20.18y, respectively (P=0.126). Significant differences were found in the age distribution of red eye incidence and the distribution of red-eye-related diseases between the two ethnic groups (χ^2=8.903, P=0.031, and χ^2=24.576, P=0.002 respectively). Conjunctival diseases accounted for a large proportion in the distribution of red-eye-related diseases in both ethnic populations. The incidence of red eye in children (1-18 years old) was higher in the Han than the Uygur population. Trauma or surgery explained a higher proportion of red-eye in the Uygur patients than the Han patients. No significant differences were found in the types of conjunctival and corneal diseases causing red eye in the two ethnic groups (χ^2=2.753, P=0.225, and χ^2=5.992, P=0.068). Results can be seen in Table 3 and Figure 5.

Comparison of Corneal and Conjunctival Diseases in Shanghai and Urumchi Centers Data from both centers indicated that red eye was related to infectious and allergic conjunctivitis, other conjunctival diseases, palpebral, infectious and non-infectious keratitis, and drug-derived epithelial lesions. A comparative analysis of the disease composition ratio between the two centers showed significant differences in the proportions of conjunctival and corneal diseases (χ^2=123.477, P<0.001 and χ^2=14.608, P=0.001). Specific data are shown in Table 4.

Results of Binary Logistic Regression Analysis of Allergic Conjunctivitis in Different Seasons and Different Genders in Shanghai Center Binary Logistic regression indicated that, spring, summer and autumn were all important risk factors

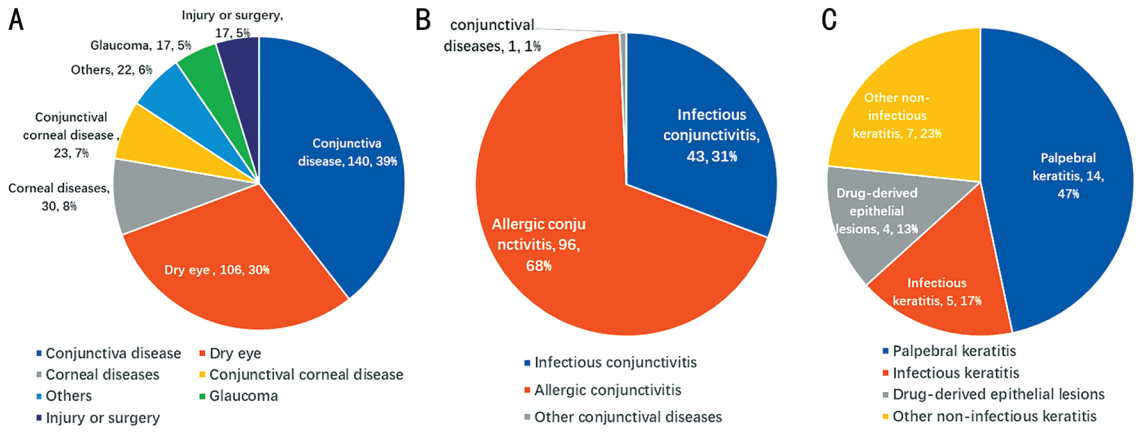

Figure 1 Distribution of red-eye-related diseases in Shanghai center A: Distribution of red-eye related diseases in the ophthalmology clinic of Shanghai center; B: Detailed classification of conjunctival diseases; C: Detailed classification of corneal diseases.

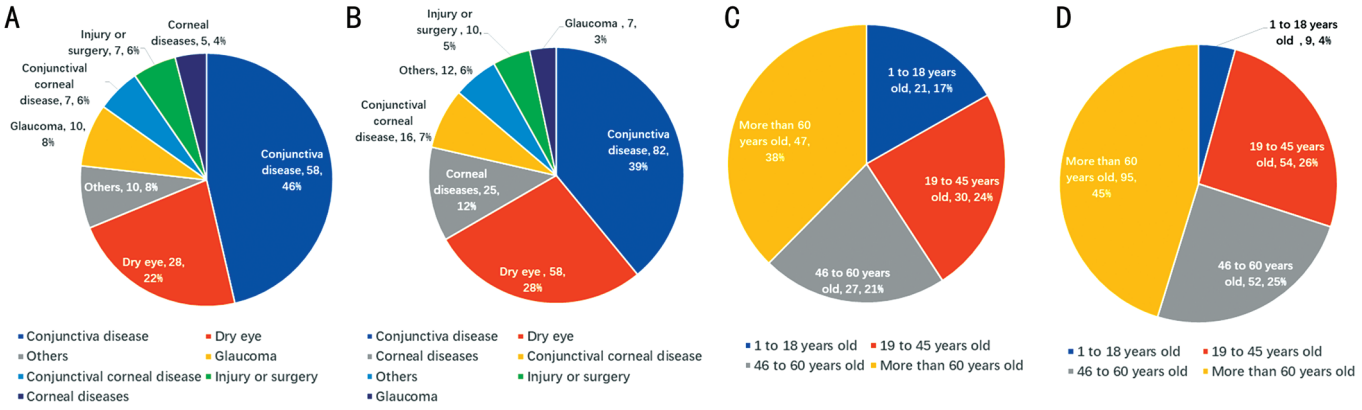

Figure 2 The distribution of red-eye-related diseases in different genders and different age groups in Shanghai center A: Distribution of red-eye related diseases in males in Shanghai center; B: Distribution of red-eye related diseases in females; C: Incidence of red eye in males of different age groups; D: Incidence of red eye in females of different age groups.

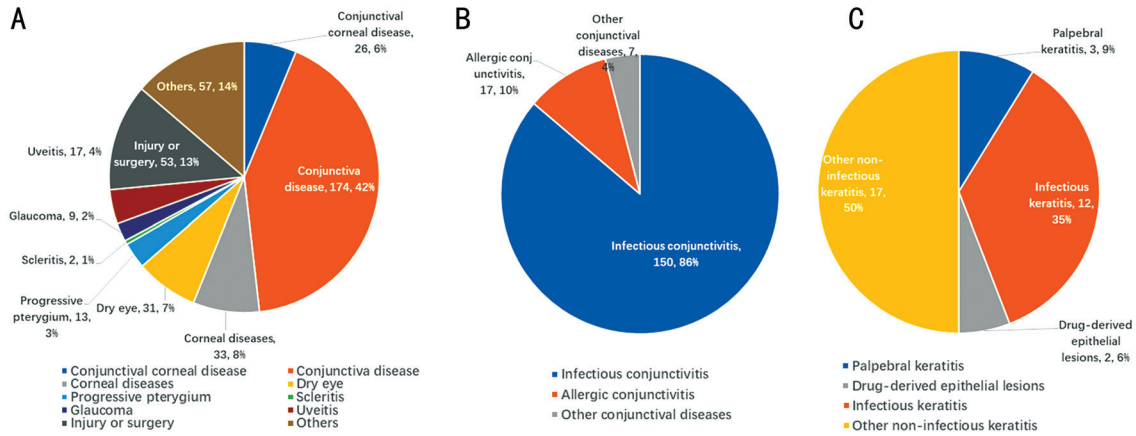

Figure 3 Distribution of red-eye-related diseases in Xinjiang center A: Distribution of red-eye related diseases in the ophthalmology clinic of Xinjiang center; B: Detailed classification of conjunctival diseases; C: Detailed classification of corneal diseases.

for the occurrence of allergic conjunctivitis, compared with winter (P=0.042, P=0.020; P=0.007 respectively), with highest risk in spring. No significant difference in risk for allergic conjunctivitis was found between genders (P=0.657). Specific statistical results can be seen in Table 5.

DISCUSSION

Red eye was defined as a general term to describe irritated or bloodshot eyes[2]. It was an identifiable marker of acute or chronic inflammation of the ocular surface, local or systemic inflammation. The main pathophysiological changes of red eye are the changes of corneal morphology due to potential inflammatory reaction on the eye surface, the influence of sub-basal plexus on the regeneration and coverage of corneal epithelium, and the effect of hormone or local mechanical

Table 2 The incidence of red eye and the distribution of related diseases in different genders in Xinjiang center

Index	Male (*n*=202)	Female (*n*=213)	t/χ^2	P^c
Age	37.98±23.11	43.50±20.53		0.010[a]
All age groups			10.651	0.014[b]
1 to 18 years old	43 (21%)	22 (10%)		
19 to 45 years old	79 (39%)	84 (39%)		
46 to 60 years old	43 (21%)	55 (26%)		
More than 60 years old	37 (19%)	52 (25%)		
Distribution of diseases associated with red eye			24.969	0.002[b]
Conjunctival corneal disease	14 (7%)	12 (6%)		
Conjunctiva disease	77 (38%)	97 (45%)		
Corneal diseases	18 (9%)	15 (7%)		
Dry eye	8 (4%)	23 (11%)		
Progressive pterygium	3 (2%)	10 (5%)		
Scleritis	1 (1%)	1(1%)		
Glaucoma	5 (2%)	4 (2%)		
Uveitis	7 (3%)	10 (5%)		
Injury or surgery	38 (19%)	15 (7%)		
Others	31 (15%)	26 (11%)		

P<0.05 indicates statistical significance. [a]Independent sample *t*-test. [b]Chi-squared test. [c]Comparison between the male and female. Data showed as mean±standard deviation or *n* (%).

Table 3 The incidence of red eye disease and related ocular disease distribution in different ethnic groups in Xinjiang center

Index	Han nationality (*n*=314)	Uyghur nationality (*n*=101)	Total	t/χ^2	P^c
Age	39.87±22.47	43.72±20.18			0.126[a]
All age groups				8.903	0.031[b]
1 to 18 years old	58 (18%)	7 (7%)	65		
19 to 45 years old	119 (38%)	44 (44%)	163		
46 to 60 years old	75 (24%)	23 (23%)	98		
More than 60 years old	62 (20%)	27 (27%)	89		
Distribution of diseases associated with red eye				24.576	0.002[b]
Conjunctival corneal disease	13 (4%)	13 (13%)	26		
Conjunctiva disease	137 (44%)	37 (37%)	174		
Corneal diseases	25 (8%)	8 (8%)	33		
Dry eye	24 (8%)	7 (7%)	31		
Progressive pterygium	10 (3%)	3 (3%)	13		
Scleritis	2 (1%)	0	2		
Glaucoma	5 (2%)	5 (5%)	10		
Uveitis	14 (4%)	3 (3%)	17		
Injury or surgery	36 (11%)	27 (27%)	63		
Others	48 (15%)	9 (9%)	57		
Conjunctiva disease				2.753	0.225[b]
Infectious conjunctivitis	118 (86%)	32 (86%)	150		
Allergic conjunctivitis	15 (11%)	2 (5%)	17		
Other conjunctival diseases	4 (3%)	3 (8%)	7		
Corneal diseases				5.992	0.068[b]
Palpebral keratitis	7 (28%)	5 (56%)	12		
Infectious keratitis	1 (4%)	2 (22%)	3		
Drug-derived epithelial lesions	2 (8%)	0	2		
Other non-infectious keratitis	15 (60%)	2 (22%)	17		

P<0.05 indicates statistical significance. [a]Independent sample *t*-test. [b]Chi-squared test. [c]Comparison between the Han nationality and Uyghur nationality. Data showed as mean±standard deviation or *n* (%).

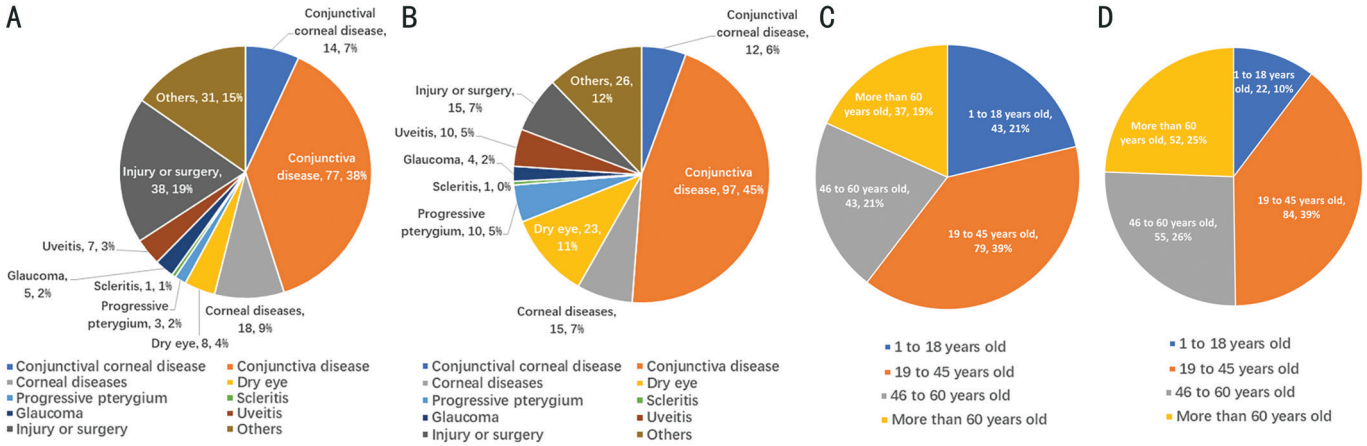

Figure 4 The distribution of red-eye-related diseases in different genders and different age groups in Xinjiang center A: Distribution of red-eye related diseases in males in Xinjiang center; B: Distribution of red-eye related diseases in females; C: The distribution of red eye in males of different age groups; D: The distribution of red eye in females of different age groups.

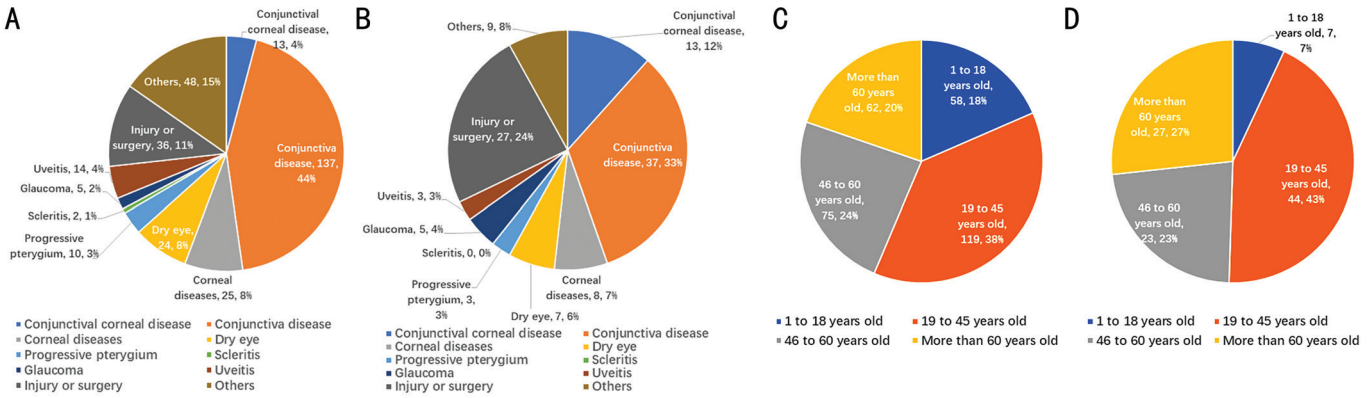

Figure 5 Comparison of distribution and age of red-eye related diseases among different ethnic groups in Xinjiang center A: Distribution of red-eye related diseases in Han population; B: Distribution of red-eye diseases in Uygur population; C: Distribution of red eye in different ages of Han nationality; D: Distribution of red eye in Uygur people of different ages.

Table 4 Comparison of corneal and conjunctival diseases in Shanghai and Xinjiang sub-centers

Diseases	Shanghai	Xinjiang	χ^2	P^b
Conjunctiva disease			123.477	<0.001[a]
Infectious conjunctivitis	43 (31%)	150 (86%)		
Allergic conjunctivitis	96 (69%)	17 (10%)		
Other conjunctival diseases	1 (1%)	7 (4%)		
Corneal diseases			14.608	0.001[a]
Palpebral keratitis	14 (47%)	3 (9%)		
Other non-infectious keratitis	7 (23%)	17 (50%)		
Drug-derived epithelial lesions	4 (13%)	2 (6%)		
Infectious keratitis	5 (17%)	12 (35%)		

P<0.05 indicates statistical significance. [a]Chi-squared test. [b]Comparison between Shanghai and Xinjiang.

Table 5 Results of binary Logistic regression analysis of allergic conjunctivitis in different seasons and different genders in Shanghai center

Factors	B	Exp (B)	OR (95%CI)	P
Season				
Winter[d]				
Spring	1.114	3.048	1.042-8.912	0.042
Summer	1.008	2.741	1.175-6.396	0.020
Autumn	0.956	2.602	1.307-5.182	0.007
Gender				
Male[d]				
Female	-0.113	0.893	0.542-1.472	0.657

[d]Control group. P<0.05 denoted statistical significance.

compression on the formation of tear film. inflammatory mediators and hypersensitivity can lead to high permeability of tear film[13]. In the ophthalmology clinic, red eye is one of the most common symptoms of ocular discomfort. Red-eye patients usually seek urgent care, and their clearly apparent symptoms may be the first indicators of local or systemic disease at an early stage. For ophthalmologists, it is important to identify the various causes of red eye so that appropriate treatments are prescribed. Therefore, understanding the epidemiological characteristics of red eye is very important for the treatment of related disease.

Compared with other systemic diseases, eye diseases are thought to be less associated with gender. Therefore, little ophthalmological research exists on gender as a factor in ocular disease. This may be due in part to the fact that there is little difference in eye shape between males and females, and to the relatively small number of ocular diseases showing sex-specific differences. However, studies have suggested that estrogen plays an important role in the etiology of certain eye diseases[14] and have shown that sex hormones are an important factor in controlling corneal thickness[15]. In addition, estrogen plays an important role in down-regulating inflammatory genes and thus inhibiting acute anterior uveitis[16]. In the present study, the age of onset of red-eye in females was significantly later than in males. Perhaps the relatively high estrogen levels in premenopausal women inhibit ocular inflammation, and after menopause this protective effect abates, equalizing red eye susceptibility in males and females. This may explain the later onset of red eye in females than males in the present study. Gender difference was also found in young patients, with higher incidence of red eye in males than females 1-18 years old. Therefore, clinical ophthalmologists also need to pay attention to red-eye conditions in children, especially boys. Matossian *et al*[17] indicated that the prevalence of dry eye increased from 14% in females aged 50 to 22% in those aged 80 and over, while this increase was not significant for males. Other research indicates that on average dry eye may be diagnosed at an earlier age in females than males, and identified female gender as a risk factor for dry eye[18]. This is consistent with our finding that in Urumchi red eye is related to conjunctival disease and dry eye in females, but conjunctival disease and trauma or surgery in males. A 2017 epidemiological study of dry eye by the Tear Film and Ocular Surface society noted a significant increase in the prevalence of dry eye every decade[19]. Therefore, we can further speculate that dry eye is an important factor influencing the varied incidence of red-eye-related diseases with age. This is in alignment with the increased proportion of dry eye with age in our sample of patients with red eye.

Conjunctivitis has been found to be the most common cause of red eye[20-21], and may be infectious or non-infectious. Infectious conjunctivitis mainly includes bacterial, viral, and fungal forms, while non-infectious conjunctivitis is mainly the allergic form[22]. Dry eye is another important cause of red eye[23-24] and is characterized by insufficient tears or excessive tear evaporation, eye irritation, and visual impairment. Severe dry eye can lead to corneal ulcers and conjunctivitis[25]. Trauma and surgery were also important risk factors for red eye. In the present study, conjunctival disease and dry eye were the main causes of red eye in the Shanghai center. Conjunctival disease and trauma or surgery were the main causes of red eye in the Urumchi center. Previous evidence indicates that climate and air pollution levels are important risk factors for conjunctivitis and that females or people under 18 years of age are at high risk of conjunctivitis caused by air pollution[26-28]. Reducing air pollution is therefore an important measure to protect susceptible groups. In our study, the proportion of infectious conjunctivitis in the sample of red-eye patients in Western China represented by the Urumchi center was much higher than that in Eastern China represented by the Shanghai center. In our analysis, a possible explanation may be that air pollution is higher in Western than Eastern China due to dry climate and heavy sandstorms. Moreover, the local economic level is lower in Western than Eastern China, and public awareness of health care is relatively low, factors which may contribute to higher incidence of infectious conjunctivitis. In the Eastern location of Shanghai, however, the proportion of allergic conjunctivitis was higher than that of infectious conjunctivitis in the patients with red eye. Studies have shown that nitrogen oxides, sulfur dioxide and carbon monoxide in automobile exhausts are important allergy-related pollutants[29]. Shanghai is one of the busiest cities in China, with high levels of automobile exhaust pollution, and this may be one of the important reasons for the high incidence of allergic conjunctivitis in eastern China. In addition, our study showed that spring was an important risk factor for allergic conjunctivitis, consistent with other research categorizing allergic research as seasonal (with high incidence in spring) or perennial[30]. Although studies have shown that females have a higher incidence of conjunctivitis than males[31], gender was not a risk factor for allergic conjunctivitis in our study.

However, there are some limitations to our study. First of all, further enlargement of the sample size is needed. In addition, only the composition ratio of red-eye-related diseases was studied, and the assistance of accurate diagnosis is only provided. Further studies are needed for its treatment and rehabilitation. Moreover, we need to strengthen the follow-up of the subjects in our further research, to observe the changes in the time direction.

In conclusion, in our study, the onset of red eye occurred later in females than in males, and in children (1 to 18y) its incidence was higher in males than females. In the Eastern city as Shanghai, the most common eye diseases causing red eye were conjunctival disease and dry eye, and the incidence of infectious conjunctivitis was significantly lower than in the Western region as Urumchi. Red eye in males in Urumchi was mainly caused by conjunctival disease, trauma or surgery. In females, conjunctival disease and dry eye were the main causes. With age, the proportion of red eye caused by dry eye increased, but the proportion caused by conjunctival disease decreased significantly. Finally, spring, summer and autumn

are high risk factors for allergic conjunctivitis compared with Winter. This epidemiological study summarizes and compares the distribution of red-eye-related diseases in the Urumchi and Shanghai regions of China, which can assist in guiding ophthalmologists in the diagnosis of red eye related diseases. Ophthalmologists in each region can accurately diagnose patients with red eye related symptoms according to the epidemiological characteristics of their region.

ACKNOWLEDGEMENTS

Authors' contributions: Zhao H, Shao Y and Wu SN analyzed the data and draft the manuscript; Zhang Q and Zhao C assisted with data interpretation and figure composing; Chen XY collected the data; Zhao H and Fu J conceived, designed and directed the study, and final revised and approved the manuscript.

Foundation: Supported in part by the Medicine & Engineering Collaboration Research Fund of Shanghai Jiao Tong University (No.ZH2018QNB27).

Conflicts of Interest: Zhao H, None; **Shao Y,** None; **Wu SN,** None; **Tang LY,** None; **Zhang Q,** None; **Zhao C,** None; **Chen XY,** None; **Fu J,** None.

REFERENCES

1 Leibowitz HM. The red eye. *N Engl J Med* 2000;343(5):345-351.

2 Tarff A, Behrens A. Ocular emergencies: red eye. *Med Clin North Am* 2017;101(3):615-639.

3 Hanyuda A, Sawada N, Uchino M, *et al*. Physical inactivity, prolonged sedentary behaviors, and use of visual display terminals as potential risk factors for dry eye disease: JPHC-NEXT study. *Ocular Surf* 2020;18(1):56-63.

4 Zhao H, Wu SN, Zhang Q, Zhao C, Shu HY, Ge QM, Shao Y. Video display terminal use and other risk factors for abnormal blinking in children: gender differences. *BMC Ophthalmol* 2021;21(1):428.

5 Zhao H, Wu SN, Cheng Z, Xiao D, Shu HY, Ge QM, Tian T, Shao Y. Mean tear-film lipid layer thickness and video display terminal time as risk factors for abnormal blinking in children. *Front Med* (*Lausanne*) 2021;8:785901.

6 Hong JX, Zhong TL, Li HL, *et al*. Ambient air pollution, weather changes and outpatient visits for allergic conjunctivitis: a retrospective registry study. *Sci Rep* 2016;6:23858.

7 Gong YY, Zhang F, Zhou J, Li J, Zhang GH, Wang JL, Gu ZS. Prevalence of dry eye in uyghur and Han ethnic groups in Western China. *Ophthalmic Epidemiol* 2017;24(3):181-187.

8 Zheng M, Wang XD, Wang M, *et al*. Clinical characteristics of allergic rhinitis patients in 13 metropolitan cities of China. *Allergy* 2021;76(2):577-581.

9 Li-Xing HU, Zhang YQ, Nie Q, Wang M, Jia CR. Investigation of dry eye prevalence rate in Inner Mongolia normal people above 40 years. *Journal of Clinical Ophthalmology* (2009).

10 Lu P, Chen XM, Liu XY, Yu L, Kang Y, Xie QH, Ke L, Wei XY. Dry eye syndrome in elderly Tibetans at high altitude: a population-based study in China. *Cornea* 2008;27(5):545-551.

11 Guo B, Lu P, Chen XM, Zhang WF, Chen RT. Prevalence of dry eye disease in mongolians at high altitude in China: the Henan eye study. *Ophthalmic Epidemiol* 2010;17(4):234-241.

12 Azari AA, Barney NP. Conjunctivitis: a systematic review of diagnosis and treatment. *JAMA* 2013;310(16):1721-1729.

13 Sabatino F, di Zazzo A, de Simone L, Bonini S. The intriguing role of neuropeptides at the ocular surface. *Ocular Surf* 2017;15(1):2-14.

14 Kazama S, Kazama JJ, Ando N. Eye diseases in women. *Fukushima J Med Sci* 2019;65(2):30-36.

15 Ghahfarokhi NA, Vaseghi A, Ghahfarokhi NA, Ghoreishi M, Peyman A, Dehghani A. Evaluation of corneal thickness alterations during menstrual cycle in productive age women. *Indian J Ophthalmol* 2015;63(1):30-32.

16 Miyamoto N, Mandai M, Suzuma I, Suzuma K, Kobayashi K, Honda Y. Estrogen protects against cellular infiltration by reducing the expressions of E-selectin and IL-6 in endotoxin-induced uveitis. *J Immunol* 1999;163(1):374-379.

17 Matossian C, McDonald M, Donaldson KE, Nichols KK, MacIver S, Gupta PK. Dry eye disease: consideration for women's health. *J Womens Health* (*Larchmt*) 2019;28(4):502-514.

18 Schaumberg DA, Uchino M, Christen WG, Semba RD, Buring JE, Li JZ. Patient reported differences in dry eye disease between men and women: impact, management, and patient satisfaction. *PLoS One* 2013;8(9):e76121.

19 Stapleton F, Alves M, Bunya VY, Jalbert I, Lekhanont K, Malet F, Na KS, Schaumberg D, Uchino M, Vehof J, Viso E, Vitale S, Jones L. TFOS DEWS II epidemiology report. *Ocular Surf* 2017;15(3):334-365.

20 Alfonso SA, Fawley JD, Lu XA. Conjunctivitis. *Prim Care* 2015;42(3):325-345.

21 Petersen I, Hayward AC, on behalf of the SACAR Surveillance Subgroup. Antibacterial prescribing in primary care. *J Antimicrob Chemother* 2007;60(suppl_1):i43-i47.

22 Høvding G. Acute bacterial conjunctivitis. *Acta Ophthalmol* 2008;86(1):5-17.

23 Watkinson S, Seewoodhary R. Assessment, care and management of patients with red eye. *Nurs Stand* 2017;32(15):43-50.

24 Verjee MA, Brissette AR, Starr CE. Dry eye disease: early recognition with guidance on management and treatment for primary care family physicians. *Ophthalmol Ther* 2020;9(4):877-888.

25 Schaumberg DA, Gulati A, Mathers WD, Clinch T, Lemp MA, Nelson JD, Foulks GN, Dana R. Development and validation of a short global dry eye symptom index. *Ocular Surf* 2007;5(1):50-57.

26 Chen RC, Yang J, Zhang CL, Li BX, Bergmann S, Zeng FF, Wang H, Wang BG. Global associations of air pollution and conjunctivitis diseases: a systematic review and meta-analysis. *Int J Environ Res Public Health* 2019;16(19):3652.

27 Fu QL, Mo Z, Lyu DN, Zhang LF, Qin ZW, Tang QM, Yin HF, Xu PW, Wu LZ, Lou XM, Chen ZJ, Yao K. Air pollution and outpatient

visits for conjunctivitis: a case-crossover study in Hangzhou, China. *Environ Pollut* 2017;231(Pt 2):1344-1350.

28 Perkin MR, Bader T, Rudnicka AR, Strachan DP, Owen CG. Inter-relationship between rhinitis and conjunctivitis in allergic rhinoconjunctivitis and associated risk factors in rural UK children. *PLoS One* 2015;10(11):e0143651.

29 Miyazaki D, Fukagawa K, Okamoto S, Fukushima A, Uchio E, Ebihara N, Shoji J, Namba K, Shimizu Y. Epidemiological aspects of allergic conjunctivitis. *Allergol Int* 2020;69(4):487-495.

30 Leonardi A, Castegnaro A, Valerio AL, Lazzarini D. Epidemiology of allergic conjunctivitis: clinical appearance and treatment patterns in a population-based study. *Curr Opin Allergy Clin Immunol* 2015;15(5):482-488.

31 Michailopoulos P, Almaliotis D, Georgiadou I, Papakosta D, Gougoulias K, Giouleka P, Gioulekas D, Siempis T, Karampatakis V. Allergic conjunctivitis in patients with respiratory allergic symptoms; a retrospective study in Greece. *Med Hypothesis Discov Innov Ophthalmol* 2017;6(1):3-9.