• Investigation •

Eyelid disorders and morphologies among older individuals: a cross-sectional survey in China

Yan-Yan Lin, Hai-Rui Jiao, Ya-Qi Peng, Xi Chen, Fan Lyu, Xin-Ting Liu

National Clinical Research Center for Ocular Diseases, Eye Hospital of Wenzhou Medical University, Wenzhou 325000, Zhejiang Province, China

Co-first Authors: Yan-Yan Lin and Hai-Rui Jiao

Correspondence to: Fan Lyu and Xin-Ting Liu. National Clinical Research Center for Ocular Diseases, Eye Hospital of Wenzhou Medical University, 270 Xueyuan West Road, Lucheng District, Wenzhou 325000, Zhejiang Province, China. lufan@eye.ac.cn; liuxt@eye.ac.cn

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Abstract

● **AIM:** To investigate the prevalence and types of eyelid disorders among an elderly population in China, underscoring the significance of eyelid health for the aging demographic.

● **METHODS:** A cross-sectional epidemiological survey was conducted on 3038 individuals over the age of 50, all of whom were evaluated at the community health center. Each participant underwent routine ophthalmic examinations and eyelid morphology evaluations by an ophthalmologist. Eyelid disorders and morphology were assessed through slit-lamp examination and direct visual inspection. The study analyzed the characteristics of common eyelid disorders, including blepharoptosis, dermatochalasis, eyelid tumors, entropion, lower eyelid retraction (LER) and ectropion, as well as eyelid morphologies such as sunken and bulging eyelids. Descriptive statistics were used for demographic data, Chi-square test analyzed gender distribution differences, and logistic regression calculated odds ratios for blepharoptosis (P<0.05 considered significant).

● **RESULTS:** The study revealed that eyelid disorders were present in 1250 (41%) individuals, with blepharoptosis being the most common disorder (25%), followed by severe dermatochalasis (16%), eyelid tumors (9.3%), LER and ectropion (11%), and entropion (1.2%). Sunken eyelids were more prevalent in men (26%) than in women (17%). The study found significant associations between the presence of blepharoptosis and sunken upper eyelids [P=0.01, odds ratio (OR)=1.33], as well as male gender (P=0.038, OR=1.22). Additionally, the prevalence of blepharoptosis increased with age.

● **CONCLUSION:** Eyelid disorders are highly prevalent in older people and increase steeply with age. This study highlights the need for increased awareness of eyelid health among older individuals at risk for eyelid disorders and the importance of ophthalmic examination for early diagnosis and management of these disorders.

● **KEYWORDS:** eyelid disorder; eyelid morphology; elder people; blepharoptosis; eyelid tumor; sunken eyelid

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INTRODUCTION

Life expectancy is increasing in many countries around the world. As individuals age, they are more likely to experience various eyelid conditions such as ectropion, entropion, and blepharitis. These conditions can affect the stability of the ocular surface and cause discomfort, including tearing, itching, sensitivity to light, and blurred vision[1]. Additionally, eyelid disorders such as blepharoptosis and eyelid tumors may obscure vision and bring about aesthetic problems, in severe cases, even threaten lives[2].

Previous studies report that eyelid disorders significantly impair life quality by interfering with daily activities and work[3]. However, most of the published epidemiological studies on eyelid disorders are hospital-based, and the epidemiologic profile of eyelid disorders and morphologies is lacking. Furthermore, the influence of the morphologies in the pathogenesis of these disorders is not yet clear. For all these reasons, there is an increasing need for epidemiological studies that will investigate the present burden of eyelid problems and propose possible interventions. This study aims to evaluate the prevalence of eyelid disorders and morphologies among individuals over the age of 50 in China.

PARTICIPANTS AND METHODS

Ethical Approval All participants provided written informed consent before participating in the study. The study protocol was approved by the Ethics Committee of Wenzhou Medical University (Approval Number: 2021-166-K-143-01) and was

conducted in accordance with the ethical standards of the institutional and/or national research committee and with the Helsinki Declaration and its later amendments or comparable ethical standards.

Study Design A cross-sectional survey was performed in the Yaoxi Community of Wenzhou, Zhejiang Province in China, which is located in the east region of Wenzhou and exhibits nationally representative demographic and socioeconomic characteristics. With a stable population of 34 164 (including 12 474 individuals aged 50y or older in the 2020 census), the Yaoxi Community's social and economic demographics are representative of China's middle class, with a GDP per capita of 98 693 yuan (approximately 14 932 US dollars).

Participants A total of 3114 individuals aged 50y or older who attended annual routine health check-ups organized by the Yaoxi Community Health Center were recruited for this study between September and November, 2021. These check-ups are a regular part of the local public health program and are open to all residents. After applying exclusion criteria, 3038 participants were included in the final analysis. The exclusion criteria were: history of eyelid surgery, eyelid trauma, facial paralysis, severe eyebrow ptosis, globe atrophy, anophthalmic socket, exophthalmos, orbital fractures and congenital abnormalities affecting eyelid morphology.

In this study, severe eyebrow ptosis refers to cases with significant drooping of the eyebrows, such as that caused by facial paralysis, which can severely alter the upper eyelid's morphology and hinder accurate assessment. Mild to moderate eyebrow ptosis, which is common among older adults, was not excluded, as it does not significantly interfere with the evaluation of eyelid parameters.

Examinations and Data Collection All participants underwent routine ophthalmic examinations at the community health center. These examinations included medical history collection, slit-lamp examination, and standardized frontal-view photographs of the eyelids. An ophthalmologist with over five years of clinical experience performed all examinations and made the diagnoses. Two standardized frontal view photographs of each participant were acquired by a digital camera (CANON EOS 550D, Japan), with their head and chin placed on the holders in a natural, upright posture. The first photograph was taken with the participant's brows relaxed and eyes naturally open in a primary gaze, while the second photograph was taken with their eyes gently closed. A scale bar of 20 mm was included in each photograph, enabling calibration to avoid measurement bias due to focal distance. The camera was aligned with the axial plane of the eyes to standardize the photographs.

Diagnostic Criteria of Eyelid Disorders In this study, the eyelid disorders described included: 1) blepharoptosis, 2) eyelid tumor, 3) entropion, 4) significant loss of the lower lid tone: lower eyelid retraction (LER) and ectropion, 5) severe dermatochalasis that occludes vision. A participant was diagnosed with an eyelid disorder if they presented any of the following clinical signs in either eye, and the categories were recorded based on the severity in the worse eye, if asymmetrical.

Assessment of blepharoptosis Blepharoptosis is a common age-related ocular problem, defined as an abnormal, low-lying eyelid margin within the eye in a primary gaze. The marginal reflex distance 1 (MRD1) is defined as the distance from the upper eyelid margin to the corneal light reflex in the primary gaze position[4]. If the eyelid margin is obscured by redundant skin, the examiner gently lifts the drooping upper eyelid skin to expose the eyelid margin and records the MRD1, excluding the effects of dermatochalasis or brow ptosis. The MRD1 value was measured and categorized into four subgroups: 1) MRD1≥4 mm; 2) 2≤MRD1<4 mm; 3) 0≤MRD1<2 mm; 4) MRD1<0 mm. Blepharoptosis was defined as an MRD1 of <2 mm in either eye.

Assessment of eyelid tumors Eyelid tumors are prevalent in ophthalmology practice and histopathological examination is considered the diagnostic standard. However, in primary care, visual inspection is fundamental to diagnose eyelid tumors and make decisions about referring, treating, or reassuring patients[5]. In this study, the distinction between a benign and suspicious malignant tumor in either eye was diagnosed by a well-trained clinician (Lin YY) through visual inspection. The specific types of eyelid tumors, such as xanthelasma and eyelid margin tumors, were clearly recorded.

Entropion Entropion, defined as an inward rotation of the eyelid margin, can be classified into congenital, acute spastic, involutional, and cicatricial etiologies[1]. After excluding eyelid trauma and facial palsy, most cases were considered involutional, commonly seen in lower eyelids.

Assessment of dermatochalasis Dermatochalasis, or sagging eyelid, refers to the laxity or redundancy of eyelid skin and muscle caused mainly by aging-related changes such as loss of elastic tissues, thinning of the epidermis, and weakening of connective tissue in the eyelid[6]. In this study, dermatochalasis specifically refers to the upper eyelid. According to the position of the lower edge of the upper eyelid, participants were categorized into three subgroups: 1) absence of or mild dermatochalasis, with upper eyelid skin above or touching the eyelashes; 2) moderate, where the upper eyelid skin hangs over the eyelashes; 3) severe, where the upper eyelid skin hangs over the eye and reduces visual fields[7]. As dermatochalasis is a physiological aging process, only severe dermatochalasis that occluded vision was considered an eyelid disorder in this study. Dermatochalasis with mild or moderate severity was recorded

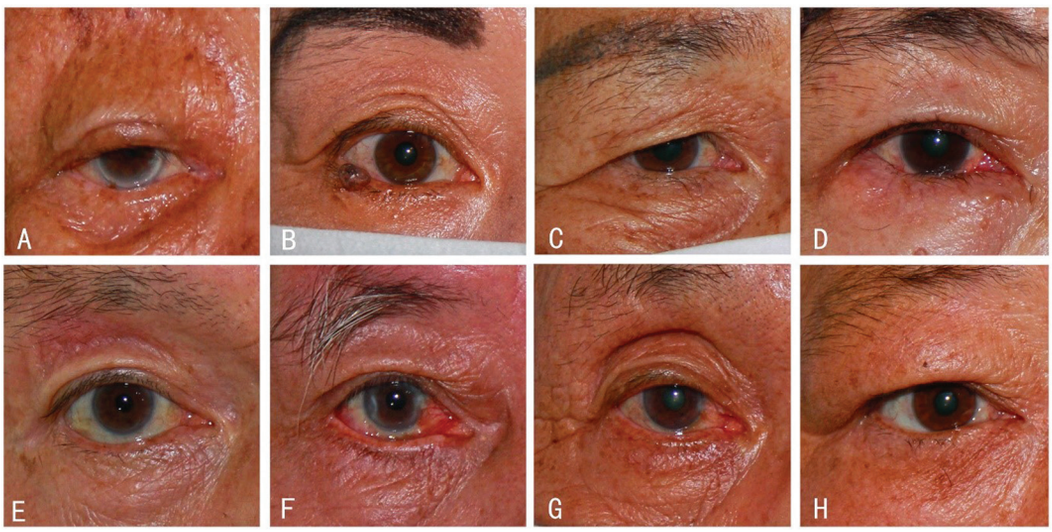

Figure 1 Typical eyelid disorders and morphologies A: Blepharoptosis with MRD1<0 mm; B: Eyelid tumor located on the lower eyelid margin; C: Severe dermatochalasis that reduces visual fields; D: Lower eyelid entropion; E: Lower eyelid retraction; F: Ectropion with lower punctum eversion; G: Sunken upper eyelid; H: Bulging eyelid. MRD1: The marginal reflex distance 1.

for descriptive analysis but not classified as a disorder.

Significant loss of the lower lid tone: lower eyelid retraction and ectropion A normal lower lid is well-adjacent to the globe at the level of the inferior limbus. LER is commonly defined as a lid margin position below the inferior limbus without eyelid eversion, referred to as ectropion[8]. Since involutional ectropion and LER are the results of laxity in the lower eyelid support system, Participants were classified into three subgroups: 1) normal, 2) LER, 3) ectropion.

Assessment of eyelid morphologies This study also recorded eyelid morphologies such as sunken upper eyelids and bulging eyelids. For statistical analysis, the right eye was chosen for convenience.

Sunken upper eyelids and bulging upper eyelids In previous research, sunken upper eyelid and bulging eyelid were defined as the presence of an enlarged invaginated or bulging skin space between the brow bone and the upper eyelid[9]. In this study, participants were categorized into three subgroups: 1) sunken upper eyelids, 2) bulging upper eyelids, 3) neither.

The same clinician (Lin YY) examined all participants, ensuring consistent diagnostic criteria throughout the study. Some examples of typical eyelid disorders and morphologies are shown in Figure 1.

Statistical Analysis Descriptive statistics used mean±standard deviation (SD) to elucidate the demographic data. Continuous variables were expressed as mean±SD and categorical variables as percentages. The Chi-square test was used to assess gender distribution differences among various eyelid disorders and morphologies. Binary logistic regression analysis was conducted to examine the odds ratio (OR) and 95% confidence interval (CI) for blepharoptosis. $P<0.05$ was considered as statistically significant.

RESULTS

The study included a total of 3038 participants, comprising of 1319 (43%) males and 1719 (57%) females. The mean age of the participants was 67.5±7.5y, with 413 (14%) aged 50-59y, 1509 (50%) aged 60-69y, 915 (30%) aged 70-79y, and 201 (6.6%) aged 80y or older.

Table 1 shows the prevalence of MRD1, eyelid disorders, and morphologies according to gender. The most common eyelid disorder was blepharoptosis, followed by dermatochalasis occluding vision, eyelid tumors, LER and ectropion, and entropion. Of the diagnosed eyelid tumors, 273 (97%) were benign, and 10 (3.5%) were suspicious malignant. Specific eyelid tumors included xanthelasma (n=44, 1.4%) and eyelid margin tumor (n=68, 2.2%). Benign eyelid tumors were more prevalent in younger participants (68.5±7.2y) than suspicious malignant eyelid tumors (71.1±5.9y).

Gender comparison revealed that blepharoptosis, eyelid laxity occluding vision, loss of lower lid tone (LER and ectropion), and sunken eyelids were significantly more common in men than women, whereas women had a higher prevalence of xanthelasma and bulging eyelids. There were no significant gender differences in eyelid tumors and entropion.

The prevalence of eyelid disorders increased significantly with age. At least one eyelid disorder was found in 1250 (41%) participants, 22% in those aged 50-59y, 38% in those aged 60-69y, 50% in those aged 70-79y, and 64% in those aged 80 or older. Figure 2 shows the proportions of eyelid disorder types in different age groups.

Regarding eyelid morphologies, sunken eyelids were found in 14% of participants aged 50-59y, 19% in those aged 60-69y, 25% in those aged 70-79y, and 35% in those aged 80y or older, while bulging eyelids presented the opposite trend, with 32%,

Table 1 The prevalence of eyelid disorders, and morphologies according to the participants' gender *n* (%)

Eyelid disorders and morphologies	Prevalence (*n*=3038)	Sex		*P*
		Male (*n*=1319)	Female (*n*=1719)	
Blepharoptosis (MRD1<2 mm)	769 (25)	369 (28)	400 (23)	0.002
Eyelid tumor	283 (9.3)	136 (10)	147 (8.6)	0.056
Entropion	37 (1.2)	16 (1.2)	21 (1.2)	1.000
Dermatochalasis				
No or mild	1456 (48)	608 (46)	848 (49)	0.042
Moderate	1095 (36)	462 (35)	633 (37)	0.162
Severe	487 (16)	249 (19)	238 (14)	<0.001
Significant loss of lower lid tone (LER+ectropion)	326 (11)	202 (15)	124 (7.2)	<0.001
LER	301 (9.9)	189 (14)	112 (6.5)	<0.001
Ectropion	25 (0.8)	13 (1.0)	12 (0.7)	0.251
Bulging eyelid (right eye)	603 (20)	212 (16)	391 (23)	<0.001
Sunken eyelid (right eye)	638 (21)	341 (26)	297 (17)	<0.001

MRD1: The marginal reflex distance 1; LER: Lower eyelid retraction. A *P*<0.05 was considered significant. Gender distribution differences are based on Chi-square test.

21%, 14%, and 10%, respectively. Gender differences were significant for sunken and bulging eyelids.

Binary logistic regression analysis revealed significant OR for blepharoptosis (dependent variable) and sunken eyelids (OR=1.33, 95%CI=1.07, -1.65, *P*=0.010), as well as male gender (OR=1.22, 95%CI=1.01, 1.47, *P*=0.038). In addition, the binary logistic regression comparing age groups and blepharoptosis (dependent variable) showed a significant odds ratio for blepharoptosis and older age groups (Figure 3).

DISCUSSION

This survey provides a comprehensive overview of eyelid disorders and morphologies among Chinese older adults, revealing a significant 41% prevalence in individuals over 50, escalating with age. Prior to this study, little epidemiological research focused on eyelid disorders had been published. Doan *et al*[3] conducted a hospital-based epidemiological study that reported a prevalence of eyelid disorders up to 78%. It is not surprising that the prevalence of eyelid disorders in a population presenting for ophthalmologic consultation is higher than in a general population community survey.

As individuals age, various eyelid changes occur, such as morphological alterations, skin laxity, reduced eye-opening strength, retraction of the lower eyelid margin[10], and deepening of the upper eyelid sulcus[11]. This study provides valuable insights into eyelid morphologies such as sunken and bulging eyelids within an East Asian population. Given the unique anatomical features of East Asian eyelids, the findings are particularly relevant for understanding age-related changes in this ethnic group.

In current study, blepharoptosis is the most prevalent eyelid disorder among older adults (25%), increasing with age. A previous community survey reported an incidence of 12% of blepharoptosis in adults over 50[12], while a Korean study reported a 5.4% in their 40's, and 33% in those over 70[13-14]. This can be explained by aponeurotic dehiscence or disinsertion in involutional ptosis[15]. Involutional

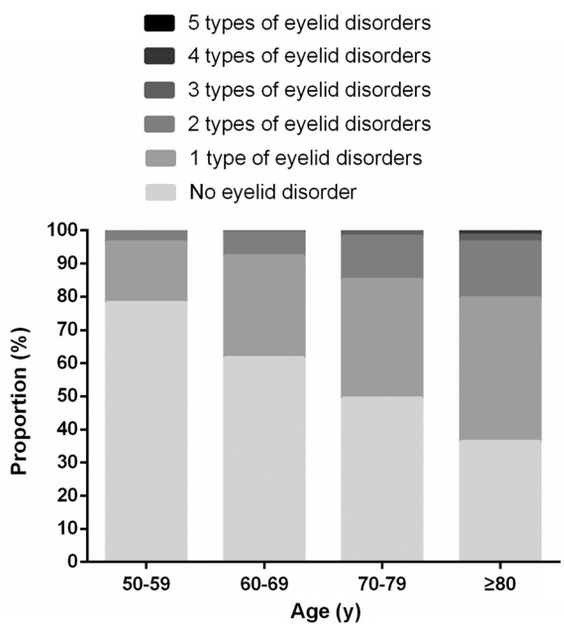

Figure 2 Proportion of the number of eyelid disorder types in a single participant, in different age groups Eyelid disorders included 1 blepharoptosis, 2 eyelid tumor, 3 entropion, 4 significant loss of the lower lid tone: lower eyelid retraction and ectropion, 5 severe dermatochalasis.

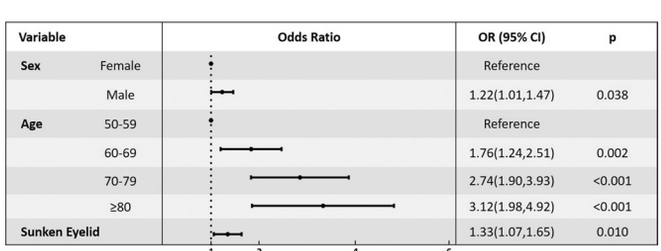

Figure 3 Binary logistic regression analysis between blepharoptosis (dependent variable) and gender, age, and sunken eyelids.

blepharoptosis results from aging process combined with periorbital changes. A sunken upper eyelid, defined as the sunken appearance of the eyelid and a deepening of the upper eyelid sulcus[9], is another common age-related condition that increases with age, reaching 14% in the 50s and 35% over 80. Both blepharoptosis and sunken upper eyelids are senescence-related. A previous study conducted in a primarily Caucasian population reported that sunken upper eyelids could cause blepharoptosis, as observed through decades-long follow-up on 21 adult patients[16]. Sunken upper eyelids act as a risk factor for blepharoptosis (OR=1.33, *P*=0.010), which can be explained anatomically. The aging-related sunken upper eyelid is likely a combination of loss of volume and an increase in the orbital capacity[16]. When upright, orbital contents drop, stretching and weakening Whitnall's ligament, which impairs the ligament fulcrum function and can result in ptosis[9].

Dermatochalasis, an aging process facilitated by gravity and defined by a loss of elastic tissue, weakening of connective tissue, thinning of the epidermis, and redundancy of the skin[6]. In this study, the prevalence of moderate and severe dermatochalasis was 52%, which is considerably higher than 18% reported in the Rotterdam Study, conducted among 5578 older Dutch European adults[7]. Differences in sample size, demographics, and ethnicity may account for the discrepancy. Men tend to present more severe dermatochalasis (*P*<0.001) and normal or mild dermatochalasis (*P*=0.042), with no gender differences in moderate dermatochalasis, which is consistent with the previous study[7]. The gender difference is likely explained by biological variations and lifestyle choices, for example, smoking or ultraviolet exposure.

Previous epidemiological results were based on medical records of patients who underwent eyelid tumor excision in a tertiary service[17]. While the diagnoses with histology were validated, the results from disease-based treatments do not reflect the true prevalence. However, this community-based study classified the properties of eyelid tumors by visual inspection, which was inevitably less accurate than a histological diagnosis, but closer to the actual community prevalence. To decrease the discrepancy between studies, eyelid tumors were categorized into ambiguous subgroups, such as benign and suspicious malignant tumors. The prevalence of xanthelasma, a benign tumor, was 1.4%, with a female predominance, which was lower than 6.9% reported in a retrospective study conducted in a hospital[18]. Malignant tumors tend to occur in older patients compared to benign counterparts and were consistent with previous studies[19-22]. No relative gender predominance was observed between patients with benign and suspicious malignant eyelid tumors. Previous studies have reported conflicting results regarding gender differences in malignant eyelid tumors[2,20-21].

Involutional LER and ectropion are caused by laxity in eyelid support system, presenting as more scleral show and eyelid margin eversion[23]. Involutional entropion, defined as eyelid margin inversion, is associated with several structural features, including medial and lateral canthal laxity or dehiscence, disinsertion or stretching of the lower lid retractor complex, overriding the preseptal orbicularis over the pretarsal component[1]. In the current study, the prevalence of ectropion and entropion were 0.8% and 1.2%, respectively, in an older Asian population, which were notably lower than the prevalence rates reported in studies from Brazil and Australia (2.9%-3.9% and 2.1%, respectively)[23-24]. Ethnic differences in eyelid anatomy may partially explain this variation. Asians are thought to have stronger periorbital fibrous and elastic tissues, which could contribute to the lower prevalence of involutional entropion and ectropion[25]. Besides, the larger tarsal plate observed in Caucasians has been linked to a higher risk of ectropion. Furthermore, discrepancies may also stem from differences in exclusion criteria; for example, this study excluded cases with facial palsy, trauma, and surgical history, which were included in other investigations.

Study limitations include the cross-sectional design, hindering causal inference, and potential underestimation of prevalence due to excluding residents with severe eyelid disorders. While systematic assessments of specific causes were lacking, this population-based study is pioneering in unveiling eyelid disorders and morphologies among older individuals. Although major confounding diseases were excluded, and most cases were considered to be involutional. Despite these limitations, this is the first population-based study to reveal eyelid disorders and morphologies in an older Asian population.

In conclusion, this study confirms a high prevalence of eyelid disorders in the older population. Considering the steep age association of eyelid disorders and the changing age structure of the population, an increasing number of patients with eyelid disorders are expected in the future. For one thing, there will be an increasing demand for oculoplastic surgeries. For another, since older individuals tend to have a higher threshold for complaining about eyelid disorders and may be unaware of the potential impairment of vision and health, it is crucial for public health policy and education to improve the health status of older individuals.

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