The prevalence of lower eyelid epiblepharon and its association with refractive errors in Chinese preschool children: a cross-sectional study

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Abstract

Background: To assess the prevalence and demographics of lower eyelid epiblepharon in Chinese preschool children and to evaluate its association with refractive errors.

Methods: In this population-based, cross-sectional study , a total of 3,170 children aged 3 to 6 years from Beijing, China underwent examinations including weight, height, cycloplegic autorefraction and slit-lamp examination of external eyes. The adjusted odds ratios (AORs) and 95% confidence intervals (CI) were calculated to evaluate. The prevalence of lower eyelid epiblepharon in preschool children and its association with refractive errors were analyzed.

Results: The prevalence of lower eyelid epiblepharon was 26.2%, which decreased with age with 3-, 4-, 5-, and 6-year-old being 30.6%, 28.0%, 15.0%, and14.3%, respectively. Boys had a higher risk of having epiblepharon than girls with ORs = 1.41 (95%CI, 1.20-1.66) and no significant correlation was detected between BMI and epiblepharon after adjustment of age and sex. Epiblepharon was associated with significantly higher risk of refractive errors including astigmatism (OR = 3.41; 95% CI, (2.68-4.33)), myopia (OR = 3.55; 95%CI, (1.86-6.76)), and hyperopia (OR = 1.53; 95% CI, (1.18-1.99)). Among astigmatic epiblepharon preschoolers, with-the-rule is predominant (80.9%) and epiblepharon severity was associated with astigmatism severity (p = 0.019).

Conclusions: There is a high prevalence of lower eyelid epiblepharon in Chinese preschool children, particularly among boys and the youngers. Preschoolers with lower eyelid epiblepharon are subject to higher risk of developing astigmatism, myopia, and hyperopia, than those without. An increased attention should be paid to this eyelid abnormality in preschool population.

Background

Epiblepharon is an eyelid disorder characterized by a horizontal skinfold that can overlap eyelid margin, which results in the eyelashes brushing against the ocular surface[1,2]. This eyelid anomaly usually affects the lower eyelid bilaterally and is reported to be common among East Asian descendants[3]. Although it more commonly involves no or mild symptoms, there are still considerable numbers of patients subject to epiblepharon-related discomforts such as tearing, irritation, and photophobia combined with keratopathy given the ever increasing Oriental population worldwide[4–6].

Several researchers have attempted to document its prevalence and demographic or clinical characteristics in Orientals including but not limited to Japanese[3,7], Koreans[8–10], and Chinese[4,5,11,12]. Whereas, to the best of our knowledge, its prevalence in Chinese preschool children are currently unknown. In addition, although the correlation between epiblepharon and refractive errors particularly astigmatism has been previously evaluated[4,5,8–12]; this association has yet been assessed in the general population since previous researchers retrospectively reviewed clinical data exclusively from epiblepharon patients who seek for medical or surgical treatment at local hospitals[4,5,8–12].

In this study, we conduct a population-based study with an aim to explore the prevalence and demographic characteristics of lower eyelid epiblepharon in Chinese preschool children and to assess its correlation with refractive errors including astigmatism, myopia and hyperopia.

Methods

Subjects

This is a cross-sectional school-based study of lower eyelid epiblepharon conducted from July to September 2017 in Xicheng District, a district of about 20,000 kindergartners in Beijing. Two-stage stratified cluster sampling was used to select students for study inclusion. In the first stage, 20 kindergartens were randomly selected from 120 kindergartens in Xicheng District. In the second stage, all preschoolers from the 20 kindergartens were selected to undergo the health examination at Xicheng Maternal and Child Health Care Hospital. The sample size was calculated with a prevalence rate of 10% for lower eyelid epiblepharon which was taken from a study done in Noda S[3], with a 2% error rate and a 95% confidence interval. The calculated sample size was 3457. A total of 3,721 children aged 3–6 years completed all the examination items, yielding a completion rate of 85.2%,and they accounted for 18.1% of kindergarten students in the Xicheng District. All participants and their parents or guardians were given full knowledge of the study and written informed consents were obtained from at least one of their parents or guardians. All guardians also gave permission for information in their medical records to be used for research or publication.

Physical and Eye Examinations

All the examinations were conducted under the room temperature (~ 26–28 °C). The height of the children was measured in meters without shoes, and the weight in kilograms. The BMI was calculated as weight in kilograms divided by the square of height in meters.

All participants underwent external-eye examination of both eyes by the same ophthalmologist (ZD) using a slit-lamp biomicroscope. Photographs of both eyes were taken using a digital camera against a white background for further diagnosis and classification of epiblepharon. Refractive error was determined by cycloplegic refraction performed with a handheld autorefractor (SureSight® Autorefractor, Welch Allyn) ≥ 30 min after cycloplegia which was induced by 3 drops of 1% cyclopentolate (Cyclogyl, Alcon, Belgium) with an interval of 10 min. For quality control, the autorefractor should be calibrated every day before measuring the refractive error. About 5% of the students were randomly selected to repeat the refractive test.

Definitions of Lower Eyelid Epiblepharon

Lower eyelid epiblepharon is diagnosed as a redundant skinfold in the lower eyelid with inverted eyelashes touching the corneal surface, but no inward rotation of eyelid margin[3]. According to Khwarg's classification, the severity of skinfold was categorized into 4 classes according to its height and the

degree to which it concealed the eyelid margin in the primary eye position[8]; the severity of cilia-cornea touch was classified into 3 classes according to the area of inverted cilia touching the ocular surface in the primary position (Fig. 1)[8].The children were thereafter considered to have mild epiblepharon if they had any signs of class Ⅰ, moderate epiblepharon if they demonstrated any signs of class Ⅱ, and severe epiblepharon if they presented any signs of class Ⅲ or worse[13]. The diagnosis of lower eyelid epiblepharon was performed independently by two authors (ZD and CS) where disagreement was resolved by discussion with a senior specialist (XL).

Definitions of Myopia, Hyperopia and Astigmatism

Spherical equivalent (SE) refractive error was expressed as sphere power + ½ × cylinder power. Myopia was defined as SE ≤ − 0.50 diopter (D), and hyperopia as SE ≥ + 2.00 D. Emmetropia was defined as SE between − 0.50 D and + 1.00 D, non-inclusive. Astigmatism was defined as cylindrical refractive error (CYL) of at least 1.50 D with cylindrical refractive error presented as negative correcting cylinder form and was classified into three categories, i.e. with-the-rule astigmatism (WTR; cylinder axis between 1° and 15° or 165° and 180°), against-the-rule astigmatism (ATR; cylinder axis between 75° to 105°), and oblique astigmatism (OBL; cylinder axis between 16° and 74° or 106°and 164°). For children with lower eyelid epiblepharon, if both eyes had equal severity of this condition, refractive error of the right eye was used for analysis; or else, the worse eye was selected. For those without epiblepharon, if both eyes had equivalent refractive error, data of the right eye was used for analysis; or else, the worse eye was used.

Statistical analysis

All data were coded and entered into Epi-Info version 7.0.9.7 for using double-entry customizing and the differences were resolved by checking with the original paper record. Chi-square test was employed to analyze the differences in gender, age, and refractive errors between children with and without lower eyelid epiblepharon. Pearson t-test was used to compare the difference in the height, weight and BMI between children with and without lower eyelid epiblepharon. One-way analysis of variance (ANOVA) was used to assess the differences in the cylindrical power among astigmatic children with different severity of epiblepharon. Multivariate logistic regression analysis was used to evaluate the factors associated with low eyelid epiblepharon, and odds ratio (OR) and the 95% confidence interval (CI) were calculated. All analyses were performed using SPSS (version 22, SPSS Inc., Chicago, Illinois), and two-sided $p < 0.05$ was considered to be statistically significant.

Results

There were 1,652 boys and 1,518 girls aged 3–6 years included in the analysis and 551 children were excluded owing to incompletion of the study (n = 548), true entropion (n = 1) and external hordeolum (n = 2). There was no statistical difference in age between boys (4.10 ± 0.75 yrs) and girls (4.08 ± 0.76 yrs) of all included subjects (Pearson t-test; p = 0.46). Overall, 26.2% (830 out of 3,170) children had lower eyelid

epiblepharon, which could be further grouped into mild (54.3%), moderate (29.6%) and severe (16.1%) classes based on the severity of skin-fold height and cilia-corneal touch (Table 1).

Table 1
Classification of lower eyelid epiblepharon

Class of cilia-cornea touching	Class of skin fold height				Total
	I	II	III	IV	
I	451 (54.3%)*	84 (10.1%)†	1 (0.1%)‡	0 (0%)‡	536 (64.5%)
II	2 (0.2%)†	160 (19.3%)†	66 (8.0%)‡	1 (0.1%)‡	229 (27.6%)
III	0 (0%)‡	3 (0.5%)‡	36 (4.3%)‡	26 (3.1%)‡	65 (7.9%)
Total	453 (54.5%)	247 (29.9%)	103 (12.4%)	27 (3.2%)	830 (100%)

Table 2 summarizes the general profile of all included children. Statistically significant differences were detected in the gender, age, SE, CYL, astigmatism type (Chi-square tests; $p = < 0.001$, < 0.001, < 0.001, < 0.001, and 0.022, respectively) and BMI (Pearson t-test; $p = 0.018$) between epiblepharon and non-epiblepharon children (Table 2); no significant differences were identified in either height or weight between these two groups (Pearson t-test; $p = 0.303$ and 0.413, respectively) (Table 2).

Table 2
Characteristics of children with and without lower eyelid epiblepharon

	Epiblepharon (n = 830)	No epiblepharon (n = 2340)	P value
Gender, n (%)			< 0.001*
boys	487 (29.5)	1165 (70.5)	
girls	343 (22.6)	1175 (77.4)	
Age (yrs), n (%)			< 0.001*
3	152 (30.6)	344 (69.4)	
4	601 (28.0)	1547 (72.0)	
5	39 (15.0)	221 (85.0)	
6	38 (14.3)	228 (85.7)	
SE (D), n (%)			< 0.001*
≤ − 0.5	22 (56.4)	17 (43.6)	
− 0.5 to 2	713 (25.0)	2141 (75.0)	
≥ 2	95 (34.3)	182 (65.7)	
CYL (D), n (%)			< 0.001*
0 to ⊠1	541 (22.3)	1890 (77.7)	
1 to ⊠1.5	132 (30.6)	300 (69.4)	
1.5 to ⊠2	68 (43.0)	90 (57.0)	
2 to < 2.5	44 (57.1)	33 (42.9)	
2.5 to < 3	32 (65.3)	17 (34.7)	
> 3.0	13 (56.5)	10 (43.5)	
Astigmatism type, n (%)			0.022*
WTR	127 (52.3)	112 (47.4)	
ATR	7 (35.5)	20 (64.5)	
OBL	23 (56.1)	18 (43.9)	
Height (ms), mean (SD)	1.01 (0.07)	1.01 (0.07)	0.303

**p* is statistically significant at 5%. BMI: body mass index, SD: standard deviation, CI: confidence interval, SE: spherical equivalent refractive error, CYL: cylindrical refractive error, D: diopters, WTR: with-the-rule, ATR: against-the-rule, OBL: oblique.

	Epiblepharon (n = 830)	No epiblepharon (n = 2340)	P value
Weight (kgs), mean (SD)	15.72 (2.92)	15.63 (2.73)	0.413
BMI, mean (SD)	15.43 (1.83)	15.26 (1.69)	0.018*

**p* is statistically significant at 5%. BMI: body mass index, SD: standard deviation, CI: confidence interval, SE: spherical equivalent refractive error, CYL: cylindrical refractive error, D: diopters, WTR: with-the-rule, ATR: against-the-rule, OBL: oblique.

Differentiated by the ages, the prevalence of lower eyelid epiblepharon was 30.6%, 28.0%, 15.0%, and 14.3% for 3, 4, 5, and 6 year-old children, respectively (Table 2). Figure 2 further illustrated the age-specific prevalence of lower eyelid epiblepharon by its severity according to criteria based on skin-fold height only (Fig. 2A), cilia-cornea touching area only (Fig. 2B), and criteria established by both (Fig. 2C). At different degrees of severity, the younger roughly demonstrated higher prevalence of epiblepharon than the older (Fig. 2).

Lower Eyelid Epiblepharon Associated Risk Factors

As statistically significant differences in age, gender and BMI were detected in children with and without lower eyelid epiblepharon (Table 2), multivariate logistic regression analysis was performed to further evaluate the correlation between lower eyelid epiblepharon and these three variables to screen for the risk factors of this eyelid disorder (Table 3). After adjustment of potential confounders, epiblepharon was statistically significant associated with gender and age. Specifically, boys were more likely to have epiblepharon than girls (OR = 1.41 with $p < 0.001$); younger children at 3-, 4-, and 5- year-old demonstrated higher possibilities of having epiblepharon with reference to the older (6-year-old), although no statistically significant difference was identified between 5- and 6-year-old children (OR = 3.68, 2.95, and 1.24 with p = < 0.001, < 0.001 and 0.402, respectively). Whereas, adjusted for gender and age, the association between BMI and epiblepharon was no longer statistically significant ($p = 0.561$).

Table 3
Correlation between lower eyelid epiblepharon and age, gender and BMI

Risk factors	OR	95%CI	p value
Gender			
Boys vs girls	1.41	(1.20, 1.66)	P < 0.001
Age(yrs)			
3 vs 6	3.68	(2.38, 5.68)	p < 0.001
4 vs 6	2.95	(2.01, 4.32)	p < 0.001
5 vs 6	1.24	(0.75, 2.03)	p = 0.402
OR = odds ratio, CI = confidential interval.			

Relation between lower eyelid epiblepharon and astigmatism

Astigmatism with CYL ≥ 1.5 D was identified in 307 children (9.68%) and 157 of them have epiblepharon. Statistically significant higher prevalence of astigmatism was detected in epiblepharon children than non-epiblepharon children (18.9% vs 6.4%) (Chi-square test; p < 0.001). Meanwhile, in both populations, the astigmatism type was largely WTR (80.9% for epiblepharon vs 74.7% for non-epiblepharon). Stratified by epiblepharon severity, WTR astigmatism remained to be predominant relative to ATR and OBL astigmatism (Fig. 3).

To further evaluate the correlation between lower eyelid epiblepharon and astigmatism, Multivariate logistic regression analysis was performed (Table 4). Overall, epiblepharon children presented an increased risk of astigmatism relative to nonepiblepharon children (OR = 3.41; 95%CI, (2.68, 4.33)), and the risk of astigmatism seemed to be higher in severe epiblepharon (Table 4). Besides, after adjustment of age and gender, the astigmatism of epiblepharon children was much more likely to be WTR (OR = 3.59; 95%CI, (2.75, 4.70)) or OBL (OR = 3.68; 95%CI, (1.97, 6.85)) compared with that of non-epiblepharon children; this phenomenon remained true in epiblepharon at different degrees of severity, except that the correlation between OBL astigmatism and Class I skin-fold height epiblepharon was not statistically significant (OR = 2.32; 95%CI, (1.00, 5.37)).

Table 4
Correlation between lower eyelid epiblepharon and refractive errors

	Astigmatism (≥ 1.5D)	**Astigmatism Type[b]**		**Myopia (≤-0.5D)**	**Hyperopia (≥ 2.0D)**
	OR (95%CI)	WTR OR (95%CI)	OBL OR (95%CI)	OR (95%CI)	OR (95%CI)
No Epiblepharon	1.00 (ref)	1.00 (ref)	1.00 (ref)	1.00 (ref)	1.00 (ref)
Epiblepharon (Skin fold height)					
□	3.23 (2.41, 4.32)*	3.70 (2.69, 5.07)*	2.32 (1.00, 5.37)	4.36 (2.13, 8.91)*	1.50 (1.08, 2.09)*
□	3.61 (2.54, 5.15)*	3.39 (2.27, 5.07)*	5.44 (2.48, 11.93)*	3.99 (1.64, 9,71)*	1.52 (1.00, 2.31)
□	3.09 (1.81, 5.28)*	3.39 (1.90, 6.05)*	3.87 (1.12, 13.35)*	-	1.87 (1.04, 3.34)*
□	6.15 (2.65, 14.28)*	4.52 (1.68, 12.2)*	10.32 (2.27, 46.86)*	-	0.95 (0.22, 4.04)
Epiblepharon (Cilia-cornea touching area)					
□	3.11 (2.35, 4.10)*	3.44 (2.54, 4.67)*	2.45 (1.13, 5.34)*	3.93 (1.95, 7.93)*	1.61 (1.19, 2.17)*
□	3.28 (2.26, 4.76)*	3.23 (2.13, 4.91)*	5.28 (2.34, 11.89)*	3.68 (1.44, 9.42)*	1.32 (0.84, 2.09)
□	6.97 (4.04, 12.02)*	6.50 (3.58, 11.78)*	8.46 (2.78, 25.74)*	-	1.66 (0.78, 3.54)
Epiblepharon (Skin fold height + Cilia-cornea touching area)					
Mild	3.15 (2.35, 4.22)*	3.59 (2.61, 4.94)*	2.33 (1.01, 5.39)*	4.38 (2.14, 8.95)*	1.51 (1.09, 2.10)*

*data was statistically significant with $p < 0.05$.

†against-the-rule astigmatism was not displayed as none of the *p* values were statistically significant.

OR: odd ratio, WTR: with the rule, OBL: oblique.

	Astigmatism (≥ 1.5D)	Astigmatism Type[b]		Myopia (≤-0.5D)	Hyperopia (≥ 2.0D)
Moderate	3.82 (2.69, 5.42)*	3.63 (2.45, 5.39)*	5.47 (2.50, 11.98)*	4.00 (1.64, 9.75)*	1.52 (1.00, 2.32)
Severe	3.55 (2.24, 5.62)*	3.52 (2.11, 5.88)*	5.04 (1.84, 13.79)*	-	1.62 (0.94, 2.79)
ALL Epiblepharon	3.41 (2.68, 4.33)*	3.59 (2.75, 4.70)*	3.68 (1.97, 6.85)*	3.55 (1.86, 6.76)*	1.53 (1.18, 1.99)*
*data was statistically significant with p < 0.05.					
†against-the-rule astigmatism was not displayed as none of the *p* values were statistically significant.					
OR: odd ratio, WTR: with the rule, OBL: oblique.					

In addition, to explore the association between the severity of epiblepharon and the severity of astigmatism, we analyzed the cylindrical power among 156 epiblepharon children with astigmatism after excluding one outlier (circle in Fig. 4). Astigmatism severity increased with epiblepharon severity where statistically significant differences could be detected using all three classification methods (Fig. 4) (one-way ANOVA; p = 0.045, 0.001, and 0.019, respectively).

Relation between lower eyelid epiblepharon and myopia and hyperopia

Myopia (SE ≤ -0.5 D) was recognized in 39 children (1.23%) with 22 of them having epiblepharon; hyperopia (SE ≥ 2 D) was found in 277 children (8.74%) with 95 of them being epiblepharon-positive. Higher prevalence of myopia (2.7% vs 0.7%) and hyperopia (11.4% vs 7.8%) were identified in epiblepharon children than non-epiblepharon children (Chi-square tests; p = < 0.01 and 0.002, respectively). Grouped by its severity, no statistical differences were detected among epiblepharon severities in either myopic or hyperopic children.

Further multivariate logistic regression analysis showed that epiblepharon preschoolers had higher risk of having myopia (OR = 3.55; 95%CI, (1.86, 6.76)) and hyperopia (OR = 1.53 95%CI, (1.18, 1.99)) than non-epiblepharon children (Table 4).

Discussion

This population-based cross-sectional study investigates the prevalence and demographics of lower eyelid epiblepharon and explores its correlation with refractive errors in 3–6 year-old Chinese children. To

the best of our knowledge, this study for the first time discloses the prevalence of this eyelid disorder in Chinese preschoolers and analyzes the relationship between epiblepharon and refractive errors including not only astigmatism but also myopia and hyperopia. We observe an prevalence of 26.2% in 3–6 year-old Chinese children, much higher than Noda S. et al's study in Japanese where 13.8% of the 766 children at the age of 3–6 years old are diagnosed with epiblepharon[3]. We assume the relatively lower prevalence in Noda's study is possibly owing to that they adopted a relatively strict criteria for disease diagnosis when the widely-accepted Khwarg's classification has yet been established then based on the following clues. First of all, when we excluded children with mild epiblephaorn, the prevalence decreased to 11.9% which is similar to 13.8% as reported in the Japanese children. Second, in their study, the cilia-cornea touching was confirmed only when the cornea is positively stained after topical fluorescein staining; whereas, later studies by Khwang S. et al and Young S. et al indicate that a considerable number of epiblepharon (usually mild epiblepharon) may not have the ocular manifestation of corneal erosion that could be stained with fluorescein[8,13].

Given such a high prevalence in Asian infants and children, deducing the demographic characteristics of epiblepharon is helpful for a better understanding of this eyelid disorder. Till now, limited data are available based on either observations of general population[3,7] or retrospective data from patients that underwent surgical treatment[4]. Agreed with those previous studies[3,4,7], our results in Chinese preschool children show that the younger have a higher risk of epiblepharon comparing to the older, supporting the widely-accepted hypothesis that the anatomical defects in Asians decrease with facial bone growth and thus epiblepharon tends to disappear spontaneously with aging[6]. Whereas, there are discrepancies in the sexual predilection between our study and others. Different from results in Japanese and Singaporeans where no sexual predilection was recognized[3,4,7], the present study demonstrates that boys are subject to a higher risk of having lower eyelid epiblepharon than girls with an adjusted OR = 1.41 in the multivariate logistic regression model. Differences in the diagnostic criteria[3], subjects' age range[7], epiblepharon severity, as well as possible sample selection bias in a clinic-based study[4] may all contribute to the discrepancy in sex predilection between our study and others.

We also evaluated the relationship between BMI and epiblepharon. Our results showed that epiblepharon children have slightly higher BMI than nonepiblepharon children; whereas, after adjustment of age and gender in the regression analysis, the difference was no-longer statistically significant. Furthermore, we compared the BMI between epiblepharon and nonepiblepharon children in boys and girls, respectively, and none of the groups gives a statistically significant difference in BMI (data not shown). Comparing to previous studies where the relation between epiblepharon and BMI has been reported in 6–14 year-old Japanese[7], 6–15 years Korean[10] and 1–12 year-old Chinese[5] without achieving a consensus themselves, our results are partly in agreement with the Chinese study where no statistically significant differences in BMI are detected between epiblephaorn and noepiblepharon girls[5]. In boys, the BMI of epiblepharon children do be slightly higher than that of nonepiblepharon children, yet without statistical significance (15.44 vs 15.32; data not shown). The reason why we did not recognize a correlation between epiblepharon and high BMI in preschool boys as in that study is possibly owing to the differences in age,

gender, sample size and epiblepharon severity between our population-based study and that clinic-based study[5].

Although lower eyelid epiblepharon has a trend to resolve spontaneously with age, its occurrence during the critical period of visual development makes it crucial to disclose if it is correlated with refractive errors, which may ultimately lead to permanent visual impairment such as amblyopia or retinopathy[14–17]. In this study, the overall prevalence of astigmatism (CYL ≥ 1.5 D) in Chinese preschoolers is 9.68%, similar to the previous reported 8.2–8.3% in Asian infants and preschoolers[18–20]; by contrast, in those with lower eyelid epiblepharon which is unknown till now, the prevalence could be as high as 18.9%, 34.8%, or 72.8% when astigmatism was defined as CYL ≥ 1.5 D, CYL ≥ 1.0 D, or CYL ≥ 0.5 D, respectively. In this study, using data from general population we disclose for the first time that epiblepharon children are subject to a significantly higher risk of astigmatism, largely being with-the-rule, and these findings agree well with previous retrospective studies in clinical patients[9,11,12]. What's more, the epiblepharon severity is positively associated with the astigmatism severity. According to previous research on astigmatism genesis, the high risk of astigmatism in particular WTR astigmatism in epiblepharon children may result from the change in corneal curvature by eyelid pressure from abnormal horizontal skinfold and eyelid squeezing from corneal irritation[8,21].

In addition, we also evaluated the relationship between lower eyelid epiblepharon and spherical refractive errors, i.e. myopia and hyperopia, which has not been disclosed in previous studies. These epiblepharon preschoolers are as 3.55 times likely to have myopia as those without epiblepharon, and as 1.53 times likely to have hyperopia. The significantly increased risk of myopia in epiblepharon children agrees with the observations in clinical patients that severe myopia commonly accompanied with a large number of cilia touching the cornea[9]. Whereas, considering the relatively small sample size (22 out of 39 epiblepharon preschoolers being myopic) and absence of severe myopia (-2.75 D to -0.5 D), further study with a larger sample size and stratified by myopia severity level should be conducted to further validate the association between epiblepharon and myopia.

The strength of this study lies in that the demographics of epiblepharon and its correlation with refractive errors are evaluated in Chinese preschool population with by far the largest sample size. Nevertheless, there are several limitations in this study. First, the children included in this study are all enrolled from urban area, which may result in bias from sample selection. Further studies ideally from multicenters including children from both rural and urban area would improve our understandings on the risk factors related to lower eyelid epiblepharon and its association with refractive errors. Second, the prevalence of epiblepharon may be underestimated because children can be missed out for epiblepharon when their cilia touching the cornea only in downward gaze but not in primary gaze. Another limitation is that we use only the skinfold height and the cilia-cornea touching area as criteria for the diagnosis of lower eyelid epiblepharon without considering areas of corneal erosion. Whereas, owing to the concerns on the risk of fluorescein dying procedure and limited time allowance in a screening circumstance, an approach both safe and simple must be adopted; besides, this limitation can be mitigated since there are high

agreement among the three criteria for the diagnosis of epiblepharon[8]. In addition, we did not evaluate the visual impairment such as amblyopia in this population and thus this part of work will be open for further study.

In conclusion, our study demonstrates a relatively high prevalence of lower eyelid epiblehaorn in Chinese preschoolers, particularly in boys and young children, and shows that there are significant correlations between lower eyelid epiblepharon and refractive errors including astigmatism, myopia, and hyperopia. Given such a high prevalence combined with the increased risk for refractive errors, it would be of great significance to be aware of the necessity and importance to establish an effective screening strategy for this disease, to conduct a closer follow-up of the clinical manifestations of involved children, and to consider giving early interventions and visual rehabilitation when warranted.

Abbreviations

AORs
adjusted odds ratios
ORs
odds ratios
CI
confidence intervals
BMI
body mass index
SD
standard deviation
SE
spherical equivalent refractive error
CYL
cylindrical refractive error
WTR
with-the-rule
ATR
against-the-rule
OBL
oblique

Declarations

Availability of data and materials

The datasets during and/or analysed during the current study available from the corresponding author on reasonable request.

Competing Interests

No authors have conflict of interest to declare.

Consent for publication

Not applicable.

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Ethics Declarations

The Ethics Committee of Beijing Shijitan Hospital, Capital Medical University approved the study and all procedures conformed to the tenets of the declaration of Helsinki. 2017 Research ethics NO.69, Beijing Shijitan Hospital, Affiliated to Capital Medical University, 2017-5-20.

Author contributions

Concept and design: all authors.

Acquisition, analysis, or interpretation of data: ZD, CS, RX, WB, LL.

Drafting of the manuscript: CS, LL.

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Figures

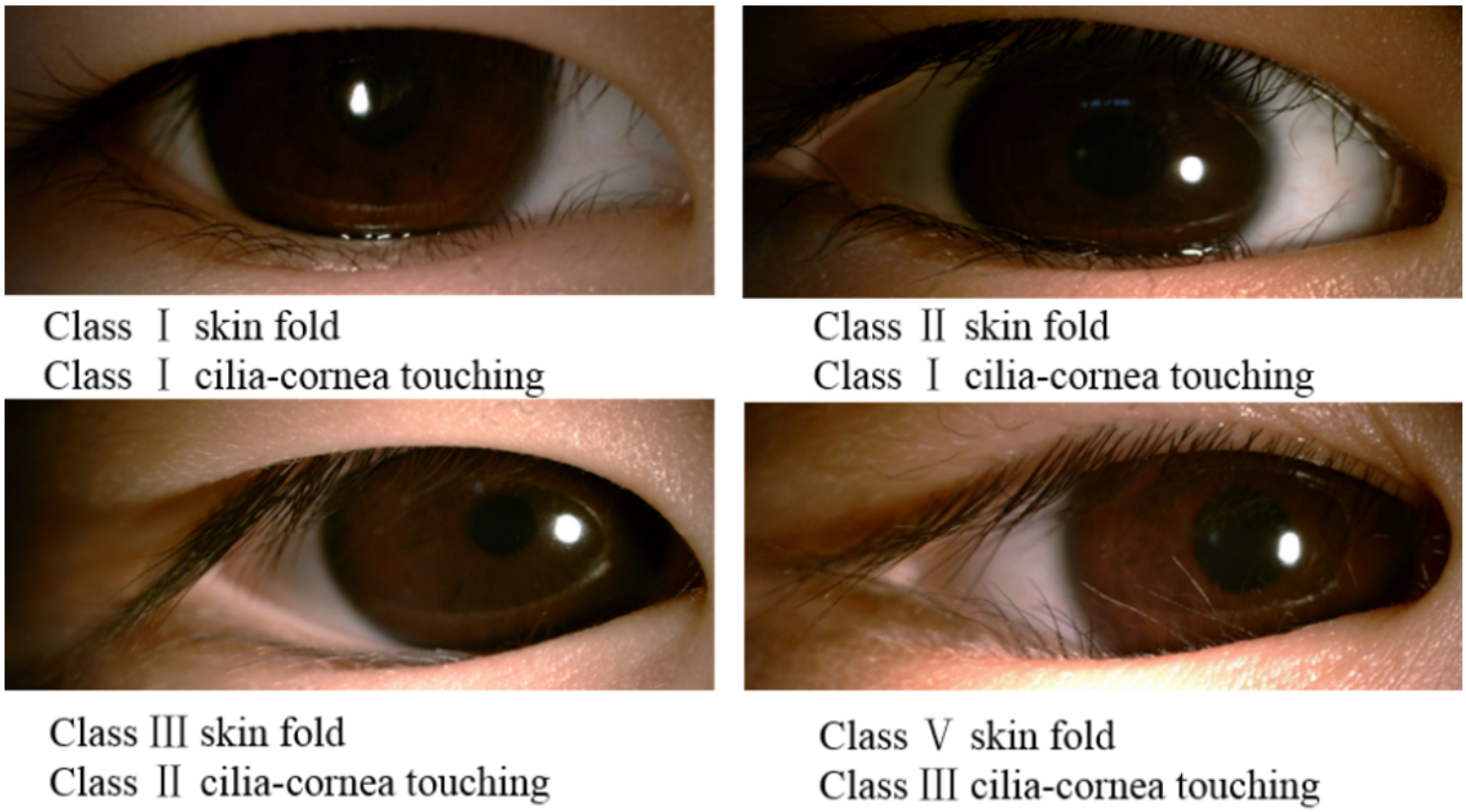

Figure 1

Classification of lower eyelid epiblepharon.

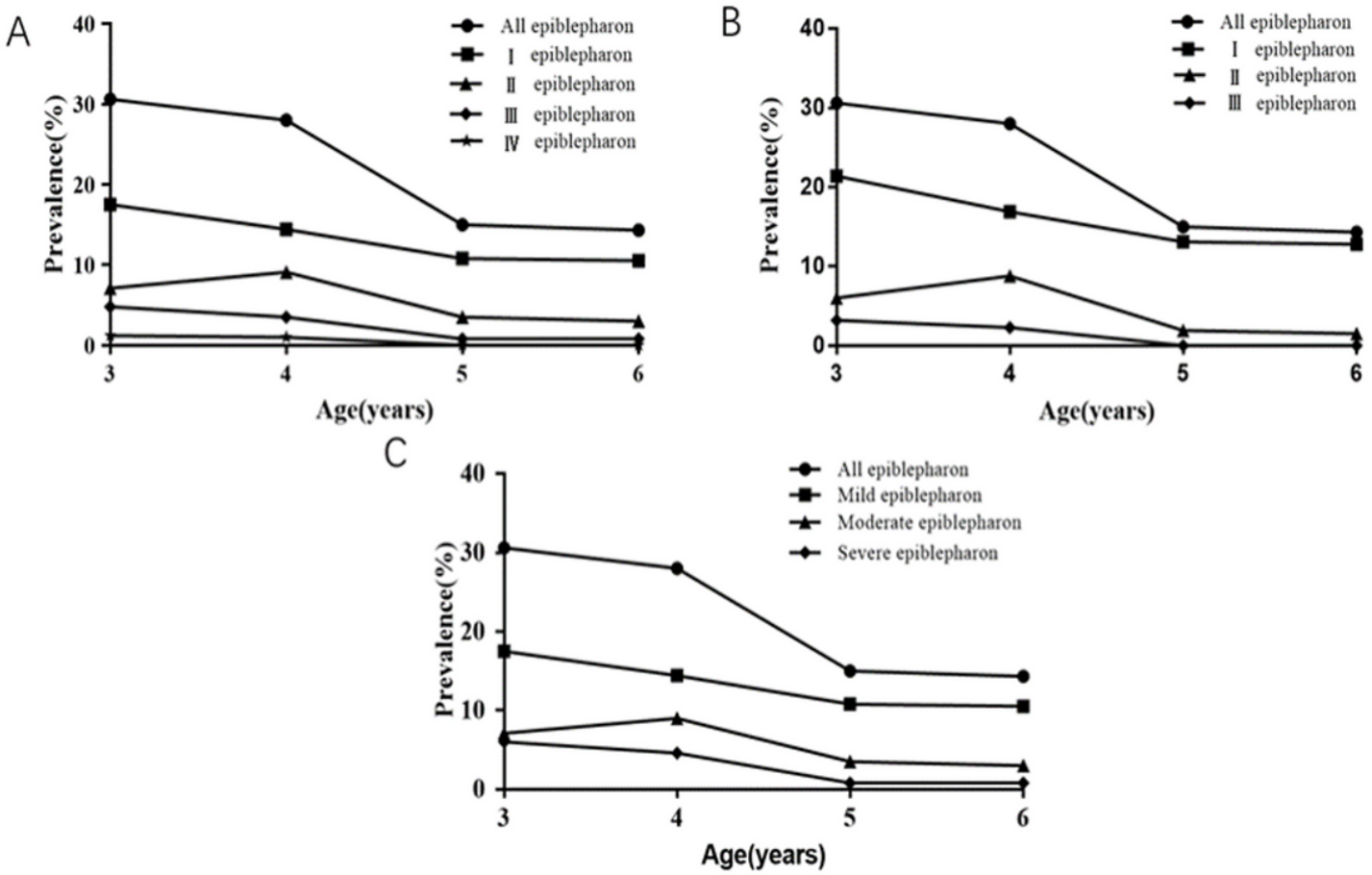

Figure 2

Age-specific prevalence of lower eyelid epiblepharon by its severity. Epiblepharon classified by skin fold height (A), by cilia-cornea touching area (B), and by both skin-fold height and cilia-cornea touching area (C).

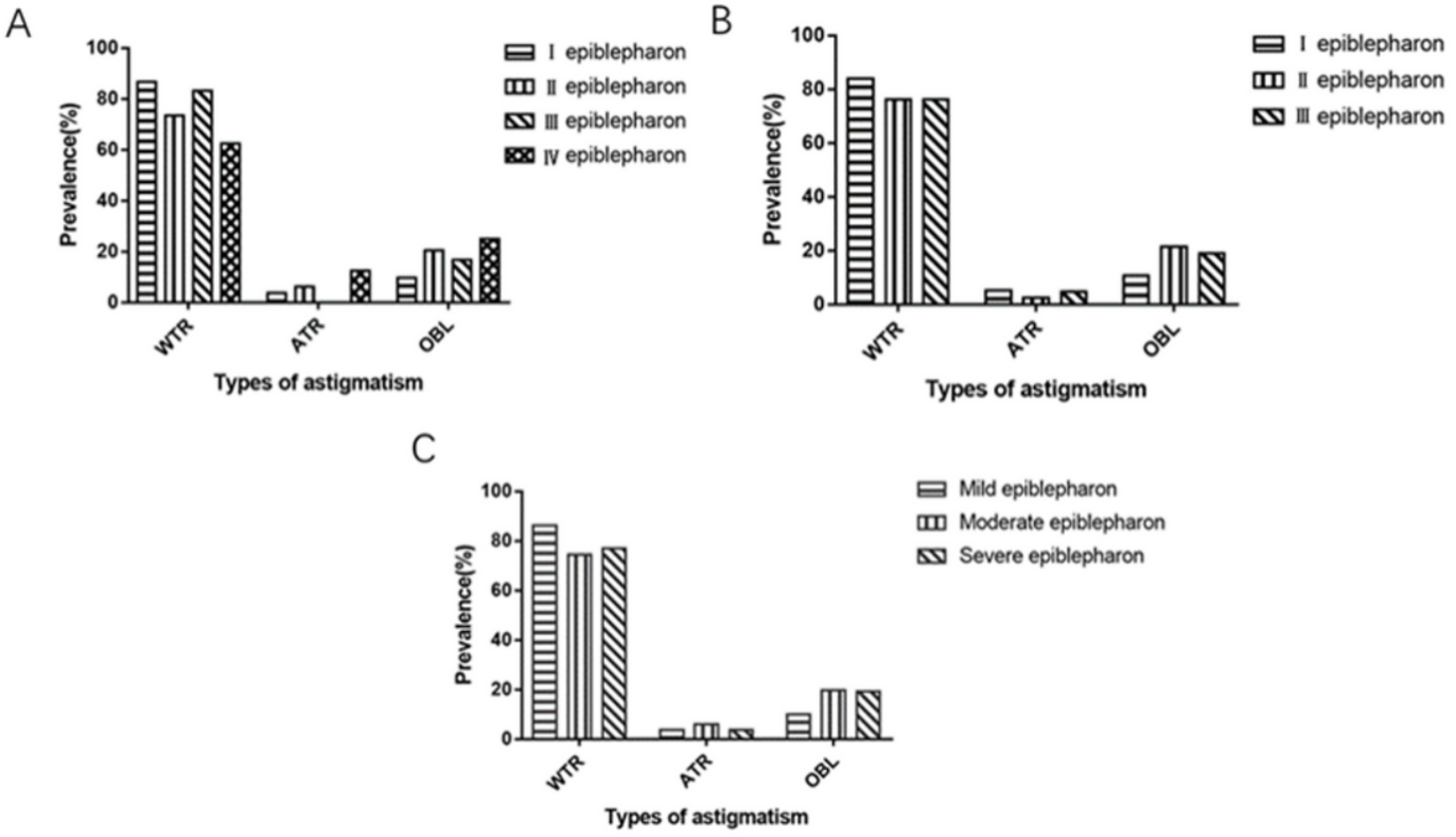

Figure 3

The percentage of astigmatism types in children with different degrees of lower eyelid epiblepharon. Epiblepharon classified by skin fold height (A), by cilia-cornea touching area (B), and by both the skin-fold height and the cilia-cornea touching area (C). WTR: with the rule; ATR: against the rule; OBL: oblique.

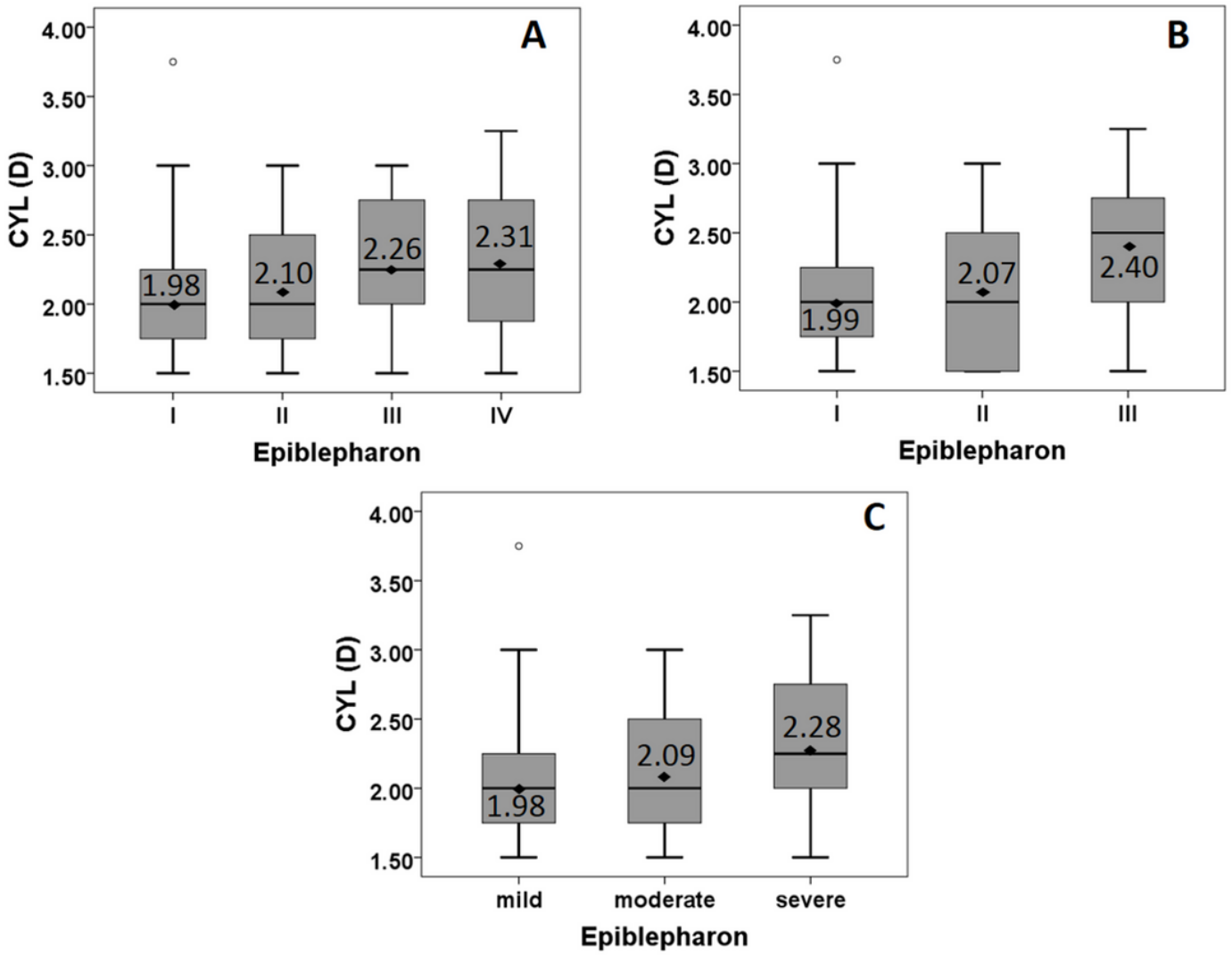

Figure 4

Boxplots of cylindrical power in epiblepharon children with astigmatism (CYL ≥ 1.5 D). Epiblepharon classified by skin fold height (A), by cilia-cornea touching area (B), and by both the skin-fold height and the cilia-cornea touching area (C). CYL: cylindrical refractive error; D: diopter; circles indicate outliers and diamonds show mean values.

Supplementary Files

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