Contact Lens and Anterior Eye 47 (2024) 102287

Contents lists available at ScienceDirect

Contact Lens and Anterior Eye

journal homepage: www.elsevier.com/locate/clae

Association between vision-related quality of life and mental health status in myopia children using various optical correction aids

Wen Zhang [1], Shuai Chang [1], Jinyun Jiang, Mengting Yu, Shuoshuo Chen, Yin Hu, Zhouyue Li [*], Xiao Yang [*]

State Key Laboratory of Ophthalmology, Zhongshan Ophthalmic Center, Sun Yat-sen University, Guangzhou, China

ARTICLE INFO

Keywords:
Vision-related quality of life
Optical corrections
Mental health
Myopia
Children

ABSTRACT

Purpose: To evaluate the relationship between vision-related quality of life and mental health in myopia children with various optical aids.

Methods: This cross-sectional study enrolled children aged 8–13 years, exhibiting myopia ranging from −4.50 to −0.75 D, and utilizing various optical aids for correction. Full ocular examinations and completion of two questionnaires were performed. Vision-related quality of life was evaluated using the Paediatric Refractive Error Profile (PREP), and mental health status was assessed utilising the Screen for Child Anxiety Related Emotional Disorders (SCARED). Univariate and multivariate analyses were conducted to evaluate the association between vision-related quality of life and mental health status.

Results: The study sample comprised 209 children with corrected myopia using single vision spectacles (100 [47.8 %]), soft contact lenses (66 [31.6 %]), and orthokeratology lenses (43 [20.6 %]). The mean age was 10.31 ± 1.65 y, and males accounted for 50.7 % of the sample. The distribution of demographic characteristics showed no significant difference among all correction types, except that the myopia duration was longer for orthokeratology lens wearers than those using spectacles (P=0.03). Contact lens showed clear benefits in almost all dimensions of vision-related quality of life, especially in appearance, satisfaction, activity and peer perceptions dimensions. The prevalence of anxiety disorders among spectacle wearers was 25.0 %, the highest among all groups. For myopia children with optical corrections, not being in the top 30 percent of their class rank, reporting lower PREP scores on symptoms, handling and peer perceptions dimensions were related with a higher prevalence of anxiety disorders.

Conclusions: Lower vision-related quality of life was associated with worse mental health status of myopia children with optical corrections. Identifying this association is crucial for protecting the mental health of myopia children and enhancing corrective measures.

1. Introduction

Myopia is the most common ocular condition worldwide [1]. It affects 80%-90% of young adults in East Asia [2,3]. The prevalence of myopia continues to increase, especially in children and teenagers, particularly who spend an immense amount of time on near tasks during the essential developmental stage [4]. Besides progressing to pathological myopia, young myopes bear a high risk of suffering from mental problems, such as anxiety and depression [5,6]. It is of great importance to identify and manage mental disorders as early as possible to avoid delayed treatment and poor prognosis and decrease the burden of family and society [7].

Currently, young myopia individuals and their parents exhibit a high acceptance of optical corrections, such as spectacles, soft contact lenses, and orthokerotology (*ortho*-k), primarily owing to their perceived safety, despite of the variability in therapeutic efficacy [8]. Other methods including low-concentration atropine eye drops show high efficacy in myopia prevention but require strict risk factor evaluation and supervision of adverse effects [9]. In addition, repeated low-level red light demonstrates excellent myopia control [10]. However, its safety needs to be further considered [11]. Nevertheless, an increasing number of children and parents are trying to find alternatives to spectacles that are

* Corresponding authors.
E-mail addresses: 583390741@qq.com (Z. Li), yangx_zoc@163.com (X. Yang).
[1] Wen Zhang and Shuai Chang contributed equally to this work and should be regarded as co-first authors.

https://doi.org/10.1016/j.clae.2024.102287
Received 20 November 2023; Received in revised form 30 June 2024; Accepted 13 August 2024
Available online 26 August 2024

aesthetically pleasing and provide better myopia control [12–14]. Children wearing contact lenses tend to perform well in self-concept [15], especially appearance, sports and social acceptance [15,16]. Additionally, better peripheral vision quality has been reported in contact lens wearers [17]. According to cross-sectional and longitudinal studies, the compliance of children to wearing spectacles for free was suboptimal, as low as 13.4 % in 18 months [12,13,18,19]. The focus group discussion emphasised a dislike for spectacles, attributed to their unsatisfactory appearance, inconvenience during sports, and the weight on the nose. Children also complained about isolation and ridicule from their classmates, which prevented them from wearing their spectacles [18]. While spectacles effectively enhance visual acuity, they exert substantial pressure on children, surpassing our expectations.

Self-perception is reportedly related to mental health status [20]. However, as a reflection of self-evaluation, it remains unclear whether the decreased vision-related quality of life will affect the mental health status of myopia children. Hence, this cross-sectional study was conducted to evaluate the relationship between vision-related quality of life and anxiety scores among myopia children with optical corrections. It is hypothesised that myopic children who wear contact lenses maintain better mental health status than spectacle wearers and variations in the refractive correction's impact on vision-related quality of life contribute to a portion of the observed differences.

2. Materials and methods

This observational study was conducted at the Zhongshan Ophthalmic Center between November 2022 and March 2023. All study procedures were conducted in accordance with the Declaration of Helsinki [21] and were approved by the ethics committee of the Zhongshan Ophthalmic Centre, Sun Yat-sen University, Guangzhou, China (ethics approval id: 2023KYPJ209). The study followed the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) Reporting Guidelines for cross-sectional observational studies [22].

Medical records and basic ophthalmic examination results of children visiting the myopia control and prevention clinics were screened to identify those who met the inclusion criteria. After verbal and written informed consents being obtained from children and their parents, children who met the following criteria were included in the study: (1) aged 8 to 13 years; (2) corrected myopia with optical aids, including single-vision spectacles, daily-disposable single-vision soft contact lenses and *ortho*-k (wearing for a minimum of 8 h/day) for at least 3 months; (3) subjective cycloplegic spherical equivalent (SE) −0.75 to −4.50D, cylindrical refraction no more than 1.50D, and anisometropia less than 1.50D; (4) monocular best corrected visual acuity (BCVA) for both eyes no less than 0.00 logMAR (6/6); (5) no other ophthalmic diseases except for refractive error and no history of ophthalmic surgery or trauma; (6) no systemic diseases which could affect vision quality; and (7) no reported mental disorders. Children with following conditions were excluded: (1) inability to communicate; (2) treatment history other than optical corrections, such as atropine drops, repeated low-does red light, or refractive surgery; (3) parents refusing to participate in the study. All participants received subjective cycloplegic refraction, slit-lamp, non-contact tonometer, and fundus photography examinations to ensure that they met the inclusion criteria. No compensation or incentives were offered to the families.

Children's basic information was acquired from the parent's information questionnaire, which included sex, age, family income, parents' education level, type of family, parenting style, life stress events, after-class study time, academic performance, and myopia duration. Children were required to complete the Paediatric Refractive Error Profile (PREP) and the Screen for Child Anxiety Related Emotional Disorders (SCARED) [23,24]. Parents were requested to refrain from being present while children filled out questionnaires to prevent any potential disruptions. A doctor helped the children understand the questionnaire items. All children were given the following instructions: read the question and choose one answer that best matches your feelings. There are no correct or incorrect responses. Do not skip any of the questions. If you find it challenging to understand, ask the doctor for clarification.

The PREP is a questionnaire specifically designed to quantify the vision-related quality of life in children and teens affected only by refractive errors. The original English version has been translated into Chinese, and its validity has been assessed among single-vision spectacle and *ortho*-k wearers [25]. According to previous studies, PREP for soft-contact lens wearers (PREP-CL) and *ortho*-k wearers (PREP-OK) were modified from the original questionnaire for spectacle-wearers (PREP-SPE) by changing the word 'glasses' to 'contact lens' and 'ortho-k' and the clause 'When I wear my glasses' to 'When I wear my contact lens' and 'After I wore *ortho*-k lens' [23,25,26]. The reliability of the questionnaires for the three different vision aids was assessed in the current study, considering the limited sample size and variety of vision aids in the previous assessment. There are 26 items in each PREP version, containing ten factors: overall vision, near vision, far vision, symptoms, appearance, satisfaction, activities, academic performance, handling of optical corrections, and peer perceptions. For each question, participants choose one answer that best matches their experiences from 'strongly agree', 'agree', 'neutral', 'disagree', and 'strongly disagree'. The statements were scored from 5 (most positive) to 1 (most negative), and then scaled up from 0 (low quality) to 100 (high quality) by subtracting 1 from the original score and multiplying by 25. The factor score was calculated as the average of all questions contained [23].

SCARED is a 41-item anxiety screening instrument popularly used by children and teens aged 6–18 years in varies countries [27]. The Chinese version, developed approximately 15 years ago, showed high internal consistency and moderate test–retest reliability in a sample of 12 city schoolchildren [28]. Meanwhile, the SCARED showed satisfactory discriminant validity, suggesting a solid power to detect DSM-IV anxiety disorders [29]. It contains questions on five factors: somatic/panic, generalised anxiety, separation anxiety, social phobia and school phobia. A total score higher than 22 was defined as positive screening for anxiety disorder.

Statistical analyses was performed using SPSS software (IBM SPSS Statistics 25). The internal consistency of the three versions of the PREP (PREP-SPE, PREP-SCL, PREP-OK) was assessed using Cronbach's alpha. Normally distributed data were described as mean and standard deviation (SD), whereas non-normal distributed data were described as median and interquartile range (IQR). Normally distributed data were compared using the one-way analysis of variance, whereas non-normally distributed data were compared using the rank sum test. Bonferroni correction was used for pairwise comparisons. The prevalence of anxiety was compared using the chi-square test. To identify the factors that potentially affect the positive screening rate of anxiety disorders, a univariate analysis was performed. A multivariate logistic regression model was used to identify the factors contributing to the prevalence of anxiety disorders. During the analysis, the 95 % confidence interval (CI) of the difference was calculated to determine estimation precision. Statistical significance was set at $P \leq 0.05$.

3. Results

A total of 212 myopia children who met the inclusion criteria were included in this study. Three children corrected with spectacles were excluded: one was lack of time, one could not cooperate, and one's parent refused to complete the information questionnaire. A total of 209 myopic children were enrolled, including 100 single-vision spectacle wearers, 66 single-vision daily-disposable contact lens wearers and 43 *ortho*-k wearers. As Table 1 shown, the mean [SD] age and sex composition were matched among the children with different optical corrections. Factors reported to affect mental status, such as average family income, parents' education level, family type, parenting style, life stress events, after-class study time, and academic performance, were comparable among the groups. Among the three types of optical correction,

Table 1
Demographic and family characteristics of participants.

Characteristic	SPE (n = 100)	SCL (n = 66)	OK (n = 43)	χ^2/F	*P*
Sex, No. (%)				2.709	0.258
Male	47 (47.0)	39 (59.1)	20 (46.5)		
Female	53 (53.0)	27 (40.9)	23 (53.5)		
Age, mean (SD), y	10.12 (1.64)	10.52 (1.63)	10.44 (1.68)	1.318	0.270
Average family income, No. (%), yuan per month				11.418	0.076
3 k-6 k	16 (16.0)	4 (6.1)	2 (4.7)		
6 k-10 k	28 (28.0)	18 (27.3)	9 (20.9)		
10 k-15 k	42 (42.0)	26 (39.4)	19 (44.2)		
>15 k	14 (14.0)	18 (27.3)	13 (30.2)		
Education level of father, No. (%)				2.357	0.884
Junior high school or lower	12 (12.0)	5 (7.6)	4 (9.3)		
Senior high school	29 (29.0)	19 (28.8)	15 (34.9)		
Bachelor's degree	53 (53.0)	38 (57.6)	20 (46.5)		
Master's degree or higher	6 (6.0)	4 (6.1)	4 (9.3)		
Education level of mother, No. (%)				4.495	0.610
Junior high school or lower	7 (7.0)	7 (10.6)	4 (9.3)		
Senior high school	36 (36.0)	16 (24.2)	12 (27.9)		
Bachelor's degree	55 (55.0)	39 (59.1)	25 (58.1)		
Master's degree or higher	2 (2.0)	4 (6.1)	2 (4.7)		
Family type, No. (%)				0.023	0.989
Two-parent family	93 (93.0)	61 (92.4)	40 (93.0)		
Single-parent family	7 (7.0)	5 (7.6)	3 (7.0)		
Parenting style, No. (%)				0.762	0.943
Indulgence pattern	8 (8.0)	4 (6.1)	3 (7.0)		
Democratic pattern	82 (82.0)	57 (86.4)	37 (86.0)		
Authoritarian pattern	10 (10.0)	5 (7.6)	3 (7.0)		
Life stress events, No. (%)				0.793	0.673
No	87 (87.0)	56 (84.8)	39 (90.7)		
Yes	13 (13.0)	10 (15.2)	4 (9.3)		
After-class study time, No. (%), hours per day				0.320	0.988
0–0.5	19 (19.0)	11 (16.7)	7 (16.3)		
0.5–2	42 (42.0)	30 (45.5)	19 (44.2)		
>2	39 (39.0)	25 (37.9)	17 (39.5)		
Academic performance, No. (%)				3.688	0.158
Top 30 % of the class	46 (46.0)	22 (33.3)	14 (32.6)		
Below top 30 % of the class	54 (54.0)	44 (66.7)	29 (67.4)		
Myopia duration, median (IQR), month	12 (12)	12 (18)	12 (14)	8.055	0.018*
SE of right eye,median (IQR), D	−2.25 (1.21)	−2.44 (1.25)	−2.75 (1.38)	1.119	0.571
SE of left eye, median (IQR), D	−2.50 (1.50)	−2.50 (1.37)	−2.75 (1.12)	4.225	0.121
BCVA of right eye, median (IQR), LogMAR	0.00 (0.00)	0.00 (0.10)	0.00 (0.10)	2.188	0.335
BCVA of left eye, median (IQR), LogMAR	0.00 (0.10)	0.00 (0.10)	0.00 (0.00)	0.502	0.778

Abbreviations: SPE, spectacle wearers; SCL, soft-contact lens wearers; OK, *ortho*-k wearers; SE, spherical equivalent; IQR, interquartile range; D, dioptres; BCVA, best corrected visual acuity; LogMAR, the logarithm of the minimal angle of resolution.
P: Multiple comparisons among SPE, CL and OK using K-W test or Chi-square test. Statistical significance set at $P \leq 0.05$.
* Pairwise test using Bonferroni adjustment only showed a significant difference between OK and SPE (*P*=0.037).

Table 2
Reliability of 3 versions of Paediatric Refractive Error Profile (PREP).

Factors	Cronbach's α		
	SPE	SCL	OK
Overall vision	0.805	0.619	0.832
Near vision	0.794	0.823	0.808
Far vision	0.855	0.602	0.891
Symptoms	0.880	0.731	0.725
Appearance	0.737	0.612	0.637
Activities	0.791	0.741	0.878
Academics	0.929	0.820	0.748
Handling	0.744	0.819	0.832
Peer perceptions	0.743	0.659	0.814

Abbreviations: SPE, spectacle wearers; SCL, soft-contact lens wearers; OK, *ortho*-k wearers.

no significant difference were found in BCVA, SE or any demographic characteristics (all *P*-values > 0.05) except for myopia duration. Children wearing *ortho*-k had a longer duration of myopia than those wearing spectacles (12; IQR 14 vs.12; IQR 12 months, *P*=0.037) (Table 1).

The Cronbach's alpha of the three questionnaire versions for all nine factors (except satisfaction, which only contained one item) were higher than 0.6 (Table 2), indicating an acceptable internal consistency. As shown in Fig. 1, multiple comparisons indicated significantly higher scores in total performance, near vision, far vision, symptoms, appearance, satisfaction, activities, handling, and peer perceptions for soft contact lens wearers than for spectacle wearers (all *P*-values < 0.05). Similarly, *ortho*-k wearers performed better than spectacle wearers in all aspects except for symptoms (*P*=0.87), handling (*P*=0.07) and academics (*P*=0.55). Interestingly, no significant difference was found between *ortho*-k and soft contact lens wearers for any factor (all *P*-values > 0.05). Upon combining *ortho*-k and soft contact lens users, their performance was significantly better than that of the spectacle users alone, except for academics (*P*=0.68) (Table 3).

The SCARED scores indicated different mental health statuses among children with various types of optical corrections (Fig. 2). In general, spectacle wearers had the highest anxiety scores among all the myopic participants. They performed poorer than soft contact lens wearers (17 (9, 23) vs. 8 (5, 15), *P*<0.001) and *ortho*-k wearers (17 (9, 23) vs. 11 (5, 20), *P*=0.03). The positive screening rate of anxiety disorder was calculated for each group, which was 17.7 % for all the participants; 25.0 %, spectacle wearers; 11.0 %, contact lens wearers, 9.1 %, soft contact lens wearers; and 14.0 %, *ortho*-k wearers. Compared to contact lens wearers, spectacle wearers had a higher positive screening rate of anxiety disorder (χ^2 = 7.007, *P*=0.008). There was no significant difference between soft contact lens and *ortho*-k wearers (*P*>0.05).

Univariate logistic analysis showed that positive screening result of anxiety disorder was related to the female sex (OR: 3.41, 95 %CI: 1.56 to 7.48, *P*=0.002), occurrence of life stress events in recent 3 months (OR: 3.38, 95 %CI: 1.40 to 8.15, *P*=0.007), after-class studying time over 2 h per day (OR: 4.77, 95 %CI: 1.34 to 17.05, *P*=0.02), academic performance below the top 30 % of the class (OR: 2.29, 95 %CI: 1.02 to 5.16, *P*=0.04), and lower score of total PREP or any one of PREP factors. However, the total PREP score was not included in the multivariate analysis because its statistical tolerance was less than 0.1. The final multivariate logistic model showed that positive screening result of

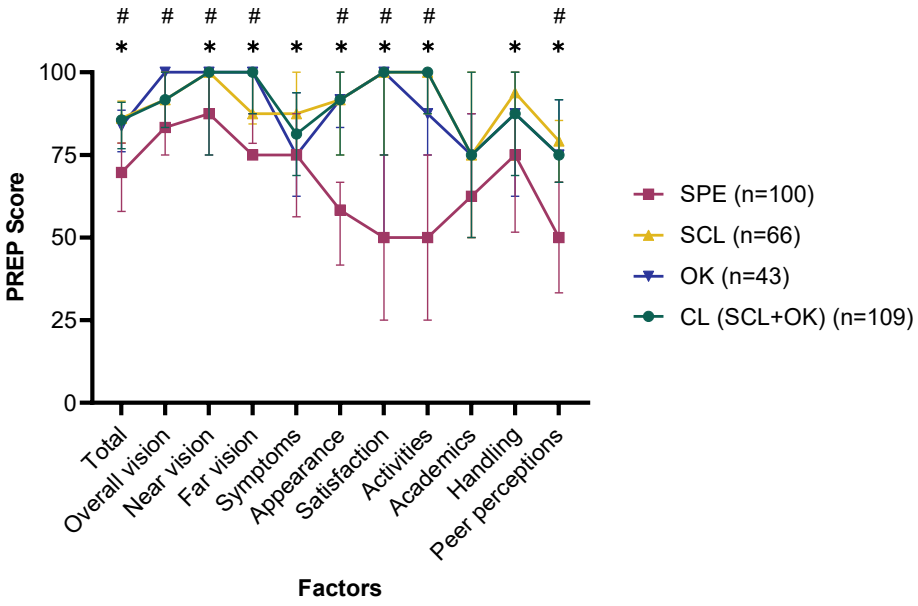

Fig. 1. Median score on the PREP for corrected myopia children. Error bars indicate the interquartile range. Contact lens wearers, including soft contact lens wearers and *ortho*-k wearers, showed a trend of better performance than spectacle wearers in nearly all aspects. Minor differences between the evaluation of contact lens and *ortho*-k were noted. * and # denote significant differences between soft contact lens and spectacle wearers, as well as *ortho*-k and spectacle wearers, respectively. Abbreviations: SPE, spectacle wearers; SCL, soft contact-lens wearers; OK, *ortho*-k wearers; CL, contact lens wearers; PREP, Pediatric Refractive Error Profile.

Table 3
Paediatric Refractive Error Profile (PREP) scores of different refractive aids.

PREP (score 0–100)	Median (IQR)					P^*	$P^\dagger$	$P^\ddagger$	$P^\S$
	Total (n = 209)	SPE (n = 100)	SCL (n = 66)	OK (n = 43)	CL (n = 109)				
Total	78.8 (67.3, 86.5)	69.7 (57.9, 78.6)	86.1 (78.6, 91.3)	83.7 (76.0, 88.5)	85.6 (76.9, 90.9)	<0.001	<0.001	>0.99	<0.001
Overall vision	91.7 (75.0, 100.0)	83.3 (75.0, 100.0)	91.7 (83.3, 100.0)	100.0 (91.7, 100.0)	91.7 (83.3, 100.0)	0.43	<0.001	0.14	0.001
Near vision	87.5 (87.5, 100.0)	87.5 (75.0, 100.0)	100.0 (87.5, 100.0)	100.0 (87.5, 100.0)	100.0 (87.5, 100.0)	0.05	0.05	>0.99	0.03
Far vision	87.5 (75.0, 100.0)	78.5 (75.0, 87.5)	87.5 (84.4, 100.0)	100.0 (87.5, 100.0)	100.0 (87.5, 100.0)	<0.001	<0.001	>0.99	<0.001
Symptoms	81.3 (62.5, 93.8)	75.0 (56.3, 87.5)	87.5 (75.0, 100.0)	75.0 (62.5, 93.8)	81.3 (68.8, 93.8)	0.01	0.87	0.059	0.043
Appearance	75.0 (50.0, 91.7)	58.3 (41.7, 66.7)	91.7 (75.0, 100.0)	91.7 (83.3, 100.0)	91.7 (75.0, 100.0)	<0.001	<0.001	0.98	<0.001
Satisfaction	75.0 (50.0, 100.0)	50.0 (25.0, 75.0)	100.0 (75.0, 100.0)	100.0 (50.0, 100.0)	100.0 (75.0, 100.0)	<0.001	<0.001	>0.99	<0.001
Activities	100.0 (75.0, 100.0)	50.0 (25.0, 75.0)	100.0 (87.5, 100.0)	87.5 (75.0, 100.0)	100.0 (87.5, 100.0)	<0.001	<0.001	>0.99	<0.001
Academics	75.0 (50.0, 87.5)	62.5 (50.0, 87.5)	75.0 (50.0, 100.0)	75.0 (62.5, 87.5)	75.0 (50.0, 100.0)	0.20	0.55	0.87	0.68
Handling	75.0 (62.5, 93.8)	75.0 (51.6, 87.5)	93.8 (73.4, 100.0)	87.5 (62.5, 100.0)	87.5 (68.8, 100.0)	<0.001	0.07	0.60	<0.001
Peer perceptions	66.7 (50.0, 83.3)	50.0 (33.3, 66.7)	79.2 (66.7, 85.4)	75.0 (66.7, 91.7)	75.0 (66.7, 91.7)	<0.001	<0.001	0.89	<0.001

Abbreviations: SPE, spectacle wearers; SCL, soft-contact lens wearers; OK, *ortho*-k wearers; PREP, Paediatric Refractive Error Profile.
P^*: SCL vs. SPE, $P^\dagger$: OK vs. SPE, $P^\ddagger$: OK vs. SCL, using non-parametric K-W test with Bonferroni adjustment. $P^\S$: Non-contacted vs. contacted, using non-parametric K-W test.
Statistical significance set at $P \leq 0.05$ was significant.

anxiety disorder among myopia children wearing optical corrections was related with academic performance below the top 30 % of the class (OR: 4.19, 95 %CI: 1.11 to 15.77, P=0.03), poorer symptoms (OR: 0.96, 95 %CI: 0.94 to 0.99, P=0.004), poorer handling (OR: 0.96, 95 %CI: 0.93 to 1.00, P=0.02) and poorer peer perceptions (OR: 0.94, 95 %CI: 0.91 to 0.98, P=0.001) (Table 4).

4. Discussion

There is growing concern regarding children's mental health status because of its substantial impact on individuals, families and society [30]. In recent years, most studies have found a relationship between myopia and anxiety or depressive disorders [5,6]. However, limited research has been conducted to determine the possible reasons for this phenomenon. The current cross-sectional study is the first to find an association between refractive correction and anxiety disorder in myopia children. A poor evaluation of vision-related quality of life, especially symptoms, handling, and peer perceptions, contributed to a portion of childhood anxiety. As a result, contact lens wearers, regardless of using soft contact lenses or *ortho*-k, faced a reduced risk of anxiety disorders, because of lighter symptoms on the nose and head when wearing the aids, easier handling and better peer acceptance. Moderate academic performance was another risk factor for anxiety disorders in myopia children. This aligns with a previous study suggesting that students who wear spectacles and do not achieve excellent grades may be at risk of anxiety disorders [19]. They may value their peers' comments over their own achievements.

This study used the PREP as an assessment tool to evaluate vision-related quality of life in myopic children with various optical corrections. Reliability analysis reached an acceptable level with a larger sample than in a previous study [25], confirming the PREP as a reliable questionnaire. Children wearing soft contact lenses preformed better in vision, appearance, peer perception, and activity scores on the PREP than those wearing single-vision spectacles [23,26], although the results differ slightly in the vision score based on the design of the soft lens. Another study reported improved scores in the same aspects in *ortho*-k wearers [25]. Regarding handling, these studies showed conflicting results for contact lens wearers. Although wearing contact lens, especially

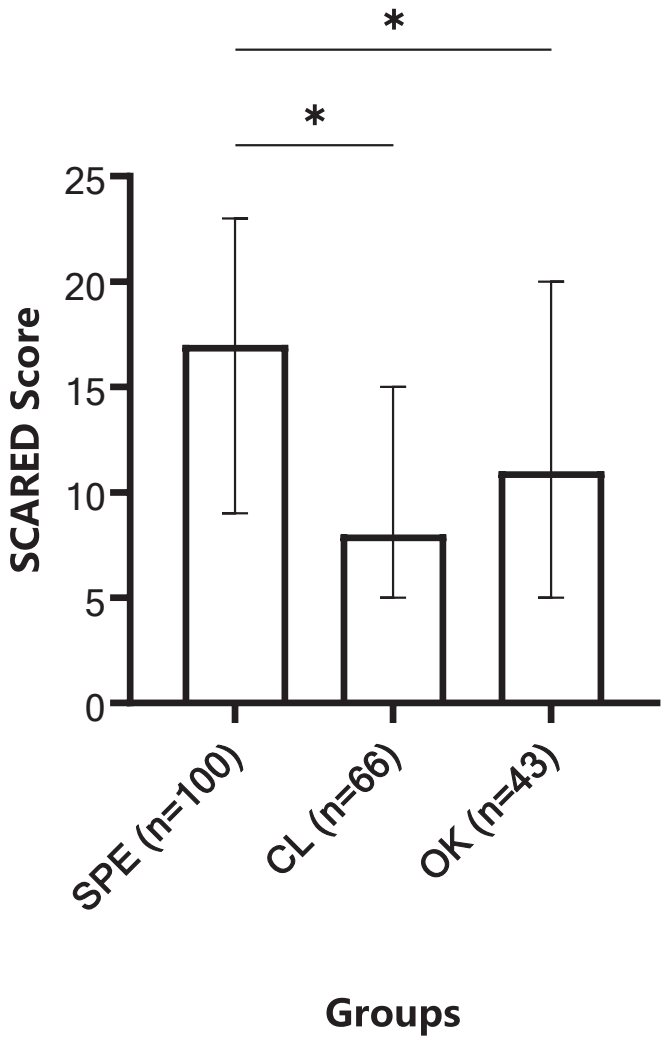

Fig. 2. Median score on the SCARED for participants. Error bars indicate the interquartile range. Myopia children with spectacles showed significantly higher scores on anxiety than those of corrected myopia with soft contact lenses and *ortho*-k. * indicates significant differences between groups. Abbreviations: SPE, spectacle wearers; SCL, soft contact-lens wearers; OK, *ortho*-k wearers; SCARED, the Screen for Child Anxiety Related Emotional Disorders.

ortho-k lenses, necessitates adherence to standardised procedures to ensure safety, existing research has shown that children and adolescents demonstrate comparable proficiency in handling contact lenses after training [31]. Children may highly value contact lenses because of a strong desire to experience the vision correction and convenience that they provide [26].

The result showed a significant increase in the prevalence of anxiety disorders in children wearing spectacles. The final regression model indicated that moderate grades, severe symptoms, difficulties in handling and poor peer perceptions accounted for a higher anxiety risk. Recently, researchers have speculated that myopia children with poor academic performance receive fewer benefits from free spectacles because they tend to place greater emphasis on self-appearance and concern for others' assessments [19]. Studies on various diseases have found a clear relationship between chronic ophthalmologic symptoms and mental health, which can partly explain the results of the current study [32,33]. Moreover, peer perception plays an essential role in building children's self-confidence and damage on self-confidence easily leads to negative mental states, such as depression and anxiety [34]. Among spectacle wearers, difficulties in handling, such as loss and contamination of spectacles, are common among those with poor

Table 4
Potential relevant factors analyses of anxiety disorders in myopic children with optical corrections.

	Univariate model		Multivariate model *	
Variables	OR (95 %CI)	*P*	OR (95 % CI)	*P*
Sex, No. (%)				
Male	1 [Reference]	NA	NA	NA
Female	3.41 (1.56, 7.48)	0.002	3.29 (0.91, 11.88)	0.07
Age, mean (SD), y	0.98 (0.79, 1.22)	0.86	NA	NA
Average family income, No. (%), yuan per month				
3 k ~ 6 k	1 [Reference]	NA	NA	NA
6 k ~ 10 k	0.33 (0.09, 1.16)	0.08	NA	NA
10 k ~ 15 k	0.60 (0.20, 1.78)	0.36	NA	NA
>15 k	0.67 (0.20, 2.19)	0.50	NA	NA
Education level of father, No. (%)				
Junior high school or lower	1 [Reference]	NA	NA	NA
Senior high school	1.19 (0.23, 6.22)	0.84	NA	NA
Bachelor's degree	2.76 (0.60, 12.67)	0.19	NA	NA
Master's degree or higher	2.59 (0.37, 17.98)	0.34	NA	NA
Education level of mother, No. (%)				
Junior high school or lower	1 [Reference]	NA	NA	NA
Senior high school	0.98 (0.19, 5.20)	0.98	NA	NA
Bachelor's degree	2.24 (0.48, 1.36)	0.30	NA	NA
Master's degree or higher	2.67 (0.30, 23.43)	0.38	NA	NA
Family type, No. (%)				
Two-parent family	1 [Reference]	NA	NA	NA
Single-parent family	2.53 (0.81, 7.90)	0.11	NA	NA
Parenting style, No. (%)				
Indulgence pattern	1 [Reference]	NA	NA	NA
Democratic pattern	1.28 (0.28, 5.99)	0.75	NA	NA
Authoritarian pattern	3.25 (0.55, 19.32)	0.20	NA	NA
Life stress events, No. (%)				
No	1 [Reference]	NA	NA	NA
Yes	3.38 (1.40, 8.15)	0.007	2.77 (0.65, 11.76)	0.07
After-class study time, No. (%), hours per day				
0 ~ 0.5	1 [Reference]	NA	NA	NA
0.5 ~ 2	1.40 (0.36, 5.40)	0.63	NA	NA
>2	4.77 (1.34, 17.05)	0.02	1.95 (0.31, 12.16)	0.47
Academic performance, No. (%)				
Top 30 % of the class	1 [Reference]	NA	NA	NA
Below top 30 % of the class	2.29 (1.02, 5.16)	0.04	4.19 (1.11, 15.77)	0.03
Myopia duration, median (IQR), month	1.01 (0.98, 1.05)	0.44	NA	NA
SE of right eye, median (IQR), D	0.91 (0.59, 1.41)	0.68	NA	NA
SE of left eye, median (IQR), D	1.15 (0.74, 1.78)	0.53	NA	NA
BCVA, median (IQR), logMAR	0.00 (0.00, 0.00)	0.45	NA	NA

(*continued on next page*)

Table 4 (*continued*)

Variables	Univariate model		Multivariate model *	
	OR (95 %CI)	*P*	OR (95 % CI)	*P*
Total PREP	0.89 (0.85, 0.92)	<0.001	NA	NA
Overall vision	0.96 (0.94, 0.99)	0.003	0.98 (0.92, 1.05)	0.61
Near vision	0.97 (0.95, 0.99)	<0.001	0.99 (0.95, 1.04)	0.70
Far vision	0.97 (0.95, 0.99)	0.002	1.01 (0.97, 1.05)	0.63
Symptoms	0.94 (0.92, 0.96)	<0.001	0.96 (0.94, 0.99)	0.004
Appearance	0.96 (0.95, 0.98)	<0.001	1.00 (0.97, 1.03)	0.86
Satisfaction	0.97 (0.96, 0.98)	<0.001	1.00 (0.97, 1.02)	0.87
Activities	0.97 (0.96, 0.98)	<0.001	1.00 (0.98, 1.03)	0.77
Academics	0.98 (0.97, 1.00)	0.04	1.02 (0.99, 1.05)	0.18
Handling	0.94 (0.92, 0.96)	<0.001	0.96 (0.93, 0.99)	0.02
Peer perceptions	0.94 (0.92, 0.96)	<0.001	0.94 (0.91, 0.98)	0.001

Abbreviations: SPE, spectacle wearers; SCL, soft-contact lens wearers; OK, *ortho*-k wearers; SE, spherical equivalent; IQR, interquartile range; D, dioptres; BCVA, best corrected visual acuity; LogMAR, the logarithm of the minimal angle of resolution; PREP, Paediatric Refractive Error Profile.
Statistical significance set at $P \leq 0.05$.
* Variables $P \leq 0.05$ were included in the multivariate logistic regression analysis.

compliance [35]. It can be inferred that a lower assessment of spectacles regarding handling may stem from other unsatisfactory factors including appearance, thereby aggravating the burden on daily life and activities. This, in turn, could lead to a poor mental health status for children.

This study provides important empirical evidence and support for clinical practice. First, it introduces a novel outlook on the decision-making process concerning the prevention and control of clinical myopia. In addition to considering the effects of vision correction and myopia control, the mental health of myopia children deserves significant attention. Most importantly, it may be worth considering the provision of soft-contact lenses and *ortho*-k to students who struggle academically, under the guidance of standard medical protocols and regular follow-up appointments. The measures may contribute to the promotion of children's mental health, provided that the safety and efficacy of the treatment are ensured. Second, on account of the relationship between vision-related quality of life and mental health among myopia children with optical aids, optimizing the weight, material, and appearance design of spectacles has the potential to minimize its negative influence. This approach is highly advantageous for students who come from low-income backgrounds and are unable to afford contact lenses for vision correction as well as for those who exhibit an unwillingness to learn to operate them. Third, this research underscores the need for psychological health education for children. Both families and schools need to pay closer attention to children who have myopia and have been corrected with optical aids, with a focus on their social performance and self-perception. Additionally, timely psychological support should be provided to these children if deemed necessary.

This study has limitations due to its cross-sectional design. Further longitudinal studies will make the causality of the relationship more clear. Besides, because the study was conducted in a tertiary ophthalmic centre in an economically developed area of China, the results may not be extended to rural children, considering that high economic pressure from contact lenses may depress sensitive children. Additionally, further research is needed to investigate the implications of multi-focal soft contact lenses featuring diverse myopia control designs on the mental health of children, as these lenses may present varying implications for aspects of visual-related quality of life.

5. Conclusion

Vision-related quality of life was associated with anxiety disorders in myopia children with optical refractive aids. Poorer performance on symptoms, handling and peer perceptions aspects of vision-related quality of life was related with a higher prevalence of anxiety disorders, especially for students with moderate academic grades. Ophthalmologists and psychologists should be attentive to the mental health of myopic children. A favourable consideration of contact-lens for young myopia individuals should be established, given their advantages in mental health, under comparable medical circumstances with spectacles. Simultaneously, the safety of the treatment should not be overlooked.

Funding

This work was supported by a Grant of National Natural Science Foundation of China (grant number 81900899).

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

References

[1] Baird PN, Saw SM, Lanca C, Guggenheim JA, Smith Iii EL, Zhou X, et al. Myopia Nat Rev Dis Primers 2020;6(1):99. https://doi.org/10.1038/s41572-020-00231-4.
[2] Chua J, Wong TY. Myopia-the silent epidemic that should not be ignored. JAMA Ophthalmol 2016;134(12):1363–4. https://doi.org/10.1001/jamaophthalmol.2016.4008.
[3] Ding BY, Shih YF, Lin L, Hsiao CK, Wang IJ. Myopia among schoolchildren in east asia and singapore. Surv Ophthalmol 2017;62(5):677–97. https://doi.org/10.1016/j.survophthal.2017.03.006.
[4] Jonas JB, Ang M, Cho P, Guggenheim JA, He MG, Jong M, et al. IMI prevention of myopia and its progression. Invest Ophthalmol vis Sci 2021;62(5):6. https://doi.org/10.1167/iovs.62.5.6.
[5] Zhang H, Gao H, Zhu Y, Zhu Y, Dang W, Wei R, et al. Relationship between myopia and other risk factors with anxiety and depression among chinese university freshmen during the COVID-19 pandemic. Front Public Health 2021;9:774237. https://doi.org/10.3389/fpubh.2021.774237.
[6] Li D, Chan VF, Virgili G, Piyasena P, Negash H, Whitestone N, et al. Impact of vision impairment and ocular morbidity and their treatment on depression and anxiety in children: A systematic review. Ophthalmology 2022:-.. https://doi.org/10.1016/j.ophtha.2022.05.020.
[7] Dunn V, Goodyer IM. Longitudinal investigation into childhood- and adolescence-onset depression: psychiatric outcome in early adulthood. Br J Psychiatry 2006;188:216–22. https://doi.org/10.1192/bjp.188.3.216.
[8] Wolffsohn JS, Whayeb Y, Logan NS, Weng R. IMI-global trends in myopia management attitudes and strategies in clinical practice-2022 update. Invest Ophthalmol vis Sci 2023;64(6):6. https://doi.org/10.1167/iovs.64.6.6.
[9] Ha A, Kim SJ, Shim SR, Kim YK, Jung JH. Efficacy and safety of 8 atropine concentrations for myopia control in children: a network meta-analysis. Ophthalmology 2022;129(3):322–33. https://doi.org/10.1016/j.ophtha.2021.10.016.
[10] Dong J, Zhu Z, Xu H, He M. Myopia control effect of repeated low-level red-light therapy in chinese children: A randomized, double-blind. Controlled Clinical Trial Ophthalmology 2023;130(2):198–204. https://doi.org/10.1016/j.ophtha.2022.08.024.

[11] Liu H, Yang Y, Guo J, Peng J, Zhao P. Retinal damage after repeated low-level red-light laser exposure. JAMA Ophthalmol 2023;141(7):693–5. https://doi.org/10.1001/jamaophthalmol.2023.1548.
[12] Dhirar N, Dudeja S, Duggal M, Gupta PC, Jaiswal N, Singh M, et al. Compliance to spectacle use in children with refractive errors- a systematic review and meta-analysis. BMC Ophthalmol 2020;20(1):71. https://doi.org/10.1186/s12886-020-01345-9.
[13] Du K, Zhu J, Guan H, Zhang Y, Wang H, Wang D, et al. Factors associated with the spectacle wear compliance among primary school students with refractive error in rural china. Ophthalmic Epidemiol 2022:1–10. https://doi.org/10.1080/09286586.2022.2028295.
[14] Yamada T, Hatt SR, Leske DA, Holmes JM. Spectacle wear in children reduces parental health-related quality of life. J AAPOS 2011;15(1):24–8. https://doi.org/10.1016/j.jaapos.2010.11.003.
[15] Walline JJ, Jones LA, Sinnott L, Chitkara M, Coffey B, Jackson JM, et al. Randomized trial of the effect of contact lens wear on self-perception in children. Optom vis Sci 2009;86(3):222–32. https://doi.org/10.1097/OPX.0b013e3181971985.
[16] Yigit DD, Turhan SA, Toker E. Daily disposable contact lens use in adolescents and its short-term impact on self-concept. Cont Lens Anterior Eye 2021;44(5):101389. https://doi.org/10.1016/j.clae.2020.11.009.
[17] Walline JJ, Bailey MD, Zadnik K. Vision-specific quality of life and modes of refractive error correction. Optom vis Sci 2000;77(12):648–52. https://doi.org/10.1097/00006324-200012000-00011.
[18] Narayanan A, Kumar S, Ramani KK. Spectacle compliance among adolescents: A qualitative study from southern india. Optom Vis Sci 2017;94:582–587-.
[19] Guan H, Wang H, Du K, Zhao J, Boswell M, Shi Y, et al. The effect of providing free eyeglasses on children's mental health outcomes in china: A cluster-randomized controlled trial. Int J Environ Res Public Health 2018;15(12). https://doi.org/10.3390/ijerph15122749.
[20] Doyle I, Catling JC. The influence of perfectionism, self-esteem and resilience on young people's mental health. J Psychol 2022;156(3):224–40. https://doi.org/10.1080/00223980.2022.2027854.
[21] World Medical Association Declaration of Helsinki: ethical principles for medical research involving human subjects. JAMA, 2013,310(20):2191-2194. DOI: 10.1001/jama.2013.281053.
[22] von Elm E, Altman DG, Egger M, Pocock SJ, Gøtzsche PC, Vandenbroucke JP. The strengthening the reporting of observational studies in epidemiology (STROBE) statement: guidelines for reporting observational studies. Lancet 2007;370(9596):1453–7. https://doi.org/10.1016/S0140-6736(07)61602-X.
[23] Walline JJ, Gaume A, Jones LA, Rah MJ, Manny RE, Berntsen DA, et al. Benefits of contact lens wear for children and teens. Eye Contact Lens 2007;33(6 Pt 1):317–21. https://doi.org/10.1097/ICL.0b013e31804f80fb.
[24] Birmaher B, Khetarpal S, Brent D, Cully M, Balach L, Kaufman J, et al. The screen for child anxiety related emotional disorders (SCARED): scale construction and psychometric characteristics. J Am Acad Child Adolesc Psychiatry 1997;36(4):545–53. https://doi.org/10.1097/00004583-199704000-00018.
[25] Yang B, Ma X, Liu L, Cho P. Vision-related quality of life of Chinese children undergoing orthokeratology treatment compared to single vision spectacles. Cont Lens Anterior Eye 2021;44(4):101350. https://doi.org/10.1016/j.clae.2020.07.001.
[26] Pomeda AR, Pérez-Sánchez B, Cañadas Suárez M, Prieto Garrido FL, Gutiérrez-Ortega R, Villa-Collar C. MiSight assessment study spain: A comparison of vision-related quality-of-life measures between misight contact lenses and single-vision spectacles. Eye Contact Lens 2018;44(Suppl 2):S99–104. https://doi.org/10.1097/ICL.0000000000000413.
[27] Runyon K, Chesnut SR, Burley H. Screening for childhood anxiety: A meta-analysis of the screen for child anxiety related emotional disorders. J Affect Disord 2018;240:220–9. https://doi.org/10.1016/j.jad.2018.07.049.
[28] Su L, Wang K, Fan F, Su Y, Gao X. J Anxiety Disord 2008;22(4):612–21. https://doi.org/10.1016/j.janxdis.2007.05.011.
[29] Boyd RC, Ginsburg GS, Lambert SF, Cooley MR, Campbell KD. Screen for child anxiety related emotional disorders (SCARED): psychometric properties in an african-american parochial high school sample. J Am Acad Child Adolesc Psychiatry 2003;42(10):1188–96. https://doi.org/10.1097/00004583-200310000-00009.
[30] Das JK, Salam RA, Lassi ZS, Khan MN, Mahmood W, Patel V, et al. Interventions for adolescent mental health: An overview of systematic reviews. J Adolesc Health 2016;59(4S):S49–60. https://doi.org/10.1016/j.jadohealth.2016.06.020.
[31] Walline JJ, Long S, Zadnik K. Daily disposable contact lens wear in myopic children. Optom vis Sci 2004;81(4):255–9. https://doi.org/10.1097/00006324-200404000-00011.
[32] Zhang SY, Li J, Liu R, Lao HY, Fan Z, Jin L, et al. Association of allergic conjunctivitis with health-related quality of life in children and their parents. JAMA Ophthalmol 2021;139(8):830–7. https://doi.org/10.1001/jamaophthalmol.2021.1708.
[33] Lee YH, Repka MX, Borlik MF, Velez FG, Perez C, Yu F, et al. Association of strabismus with mood disorders, schizophrenia, and anxiety disorders among children. JAMA Ophthalmol 2022;140(4):373–81. https://doi.org/10.1001/jamaophthalmol.2022.0137.
[34] Byrne B. Relationships between anxiety, fear, self-esteem, and coping strategies in adolescence. Adolescence 2000;35(137):201–15.
[35] Gogate P, Mukhopadhyaya D, Mahadik A, Naduvilath TJ, Sane S, Shinde A, et al. Spectacle compliance amongst rural secondary school children in pune district. India Indian J Ophthalmol 2013;61(1):8–12. https://doi.org/10.4103/0301-4738.99996.