• Investigation •

Binocular vision disorders and refractive errors on university students' quality of life

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Abstract

● **AIM:** To evaluate the effects of refractive errors and binocular vision anomalies on the quality of life (QOL) of university students.

● **METHODS:** This cross-sectional analytical study was conducted on university students using simple random sampling. Objective refraction, ocular alignment, vergence and accommodative performance were measured and assessed in all participants. Data on QOL were collected using the College of Optometrists in Vision Development-Quality of Life (COVD-QOL) Questionnaire. The effect of mentioned parameters on the QOL were evaluated.

● **RESULTS:** Totally 726 students with mean age of 21.35±1.88y were evaluated in this study, 51.5% of whom were female. Esophoria was caused significantly lower QOL in the domains of somatic symptoms and occupational-physical symptoms (P<0.05); Besides, esotropia decreased QOL in domains of somatic symptoms P=0.002 and psychological factors (P=0.023). Students with accommodation insufficiency experienced more symptoms in all domains (P<0.05) except for psychological factors (P=0.07). Increasing in the near point of convergence and accommodation and decreases QOL and increasing accommodative facility increases QOL (all P<0.05). Myopia and astigmatism cause decrease in QOL (both P<0.05), but hyperopic students had better QOL in comparison with others (P<0.05).

● **CONCLUSION:** Screening programs and treatment of refractive errors and binocular vision anomalies, especially phoria and accommodative insufficiency, positively impact the QOL and academic achievements of university students.

● **KEYWORDS:** quality of life; binocular vision disorders; refractive errors; accommodation; convergence; university students

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INTRODUCTION

The prevalence of non-strabismic binocular vision dysfunction, such as accommodative and heterophoric vergence problems, is higher among university students who spend more time on near activities compared to others[1]. A university-based study reported a prevalence of 1.5%-7.7% for binocular vision disorders and 6.2%-10.8% for accommodative problems[2]. In another study, the prevalence of these disorders was reported to be as high as 13.5% among university students[3]. Accommodative problems may be associated with symptoms such as asthenopia, discomfort during near work, and blurred vision[4]. Decompensated heterophoria may be accompanied by symptoms such as eye fatigue, headache, blurred vision, diplopia, movement of words on the page,

skipping lines while reading, lack of focus, feeling sleepy while reading, and decreased comprehension over time. In addition, the prevalence of refractive errors has been reported to be as high as 49% in university students[5]. Distance blurred vision is the most common complaint among patients with uncorrected myopia. Eye strain and headaches are also reported in individuals who develop pseudomyopia due to excessive near work and computer use[6]. Uncorrected refractive errors can cause a range of symptoms, including burning sensation, red eyes, epiphora, eye strain, frequent blinking, blurred vision, concentration difficulties, impaired binocular vision, difficulty reading, and headaches following prolonged activities[7].

These issues, due to their impact on reading and studying, may adversely affect students' academic achievement and learning[8]. Besides, these symptoms may affect students' quality of life, which is closely linked to overall life satisfaction[9]. People's perception of issues related to visual disorders is referred to as vision-related quality of life, which is a subjective measure[10]. The mentioned indices can serve as a supplementary tool for assessing visual abilities, alongside other objective and subjective indicators such as visual acuity and visual field testing[11].

Different questionnaires are used to assess the vision-related quality of life. Some of these scales have been utilized in previous Iranian studies; for instance, the Visual Function Questionnaire (NEI-VFQ) and Quality of Life Vision Questionnaire (QOVD-QOL) instruments have been applied in patients with ocular diseases[12].

The vision-related quality of life under the influence of binocular vision anomalies has been evaluated in various studies across different age groups. A common finding among these studies is the impact of binocular vision problems on quality of life[10,13]. However, despite the large number of students and the potential for a high prevalence of binocular vision problems in this group due to ocular activities, the evaluation of quality of life related to these issues in students has been explored in very few studies[13]. To the best of our knowledge, no study has assessed the vision-related quality of life of Iranian university students. Therefore, we employed a questionnaire designed by the College of Optometrists in Vision Development, which has undergone psychometric analysis tailored to Iranian culture, to evaluate the vision-related quality of life of these students. This study aimed to evaluate the effects of refractive errors and binocular vision anomalies on the quality of life of university students.

PARTICIPANTS AND METHODS

Ethical Approval The Ethics Committee of Mashhad University of Medical Sciences approved the study protocol, which was conducted in accordance with the principles of the Helsinki Declaration. All participants provided written informed consent (Ethical code: IR.MUMS/REC.1395.449).

This cross-sectional analytical study was conducted on 726 students aged 18-25y at Shahrekord Azad University in 2017. The study was designed according to the STROBE checklist recommendations. Simple random sampling was used to select subjects from a list of all students. Students with a history of ocular surgery or those unwilling to participate were excluded from the study.

Visual acuity was measured using a distance Snellen E chart at 6 m, followed by assessment of refraction. Manifest refraction was evaluated using an autorefractometer (Topcon RM8800, Topcon Corp, Tokyo, Japan), and verified with retinoscope (Heine Beta 200, Heine Optotechnik, Herrsching, Germany). An alternate cover test was performed to assess near phoria using an accommodative target of 20/30 at 40 cm, as well as distance phoria at 6 m. A unilateral cover test was conducted to evaluate tropia at 40 cm, and a prism bar was utilized to measure the amount of deviation through the bracketing method[14]. It is noteworthy to say that all the binocular vision assessments were performed with corrected ametropia most plus (CAMP) lenses in place to neutralize the effect of refractive errors.

Near point of convergence (NPC) were measured with an accommodative target slowly moving toward the eyes until the patient reported diplopia or the examiner observed a break in fusion[15]. The distance between the spectacle plane (or lateral cantus in emmetropic patients) was measured; the mentioned procedure repeated three times and the mean of them considered as NPC. Convergence insufficiency in the present study defines as NPC>6 cm, near exophoria at least 4 prism greater than far exophoria and normal amplitude of accommodation (based on the minimum values of Hofstetter formula)[16].

The amplitude of accommodation was measured with push-up method, an accommodative target was slowly brought closer to the eye until the first sustain blur was reported; the dioptric power of this distance from the eye regarded as amplitude of accommodation[4]. Hofstetter formula was used to calculate the value of amplitude of accommodation for every person (minimum value=15-0.25×age and mean value= 18.5-0.3×age). Accommodation insufficiency is defined as amplitude of accommodation 2.00 diopter (D) or more less than the mean value of Hofstetter formula[17].

The accommodative facility was assessed using the ±2.00 D flipper method at 40 cm, with a target of 20/20[18]. Each student was asked to clear the near target by placing the +2.00, then the +2.00 D lens was removed and the -2.00 D was placed and he/she was again asked to announce whenever the target became clear. These two steps were considered a cycle. This process was repeated for one minute and the number of cycles in one minute is recorded [cycles per minutes (CPM)].

The gradient method was applied to calculate the amount of accommodative convergence for each 1 D of accommodation[19]. Refractive errors in the present study defines as myopia =spherical equivalent (sphere+cylinder/2) ≤-0.50 D, hyperopia =spherical equivalent ≥+0.50 D and emmetropia=-0.50< spherical equivalent <+0.50 D[20].

In the next stage, all subjects completed the Persian version of the College of Optometrists in Vision Development-Quality of Life Questionnaire (COVD-QOL). The COVD-QOL is a 30-item questionnaire formatted on a 5-point Likert scale (never=0, seldom=1, occasionally=2, frequently=3, and always=4). The maximum score for the questionnaire is 120, with lower scores indicating less discomfort and better quality of life. The questionnaire covers four domains[21].

The first domain pertains to somatic symptoms (questions 1-7, 9, and 29) and evaluates symptoms such as blurred vision, diplopia, headache, nausea/vomiting during near activities, words running together while reading, falling asleep while reading, itchy/watery/burning eyes, worsening vision at the end of the day, and car or motion sickness. The total score for this section is 36.

The second domain pertains to occupational-physical items (questions 8, 10-16, 18, and 23-25). This section assesses reading problems (such as skipping or repeating lines while reading, omitting small words, tilting the head or closing one eye to read, holding reading materials too close, difficulty copying from the blackboard, avoiding reading or near activities, and writing uphill or downhill), challenges with using handheld devices like calculators, difficulty judging distances accurately, and problems with everyday activities or self-care. The total score for this section is 48.

The third domain pertains to social interactions (questions 17, 20, 22, 26, and 27). This section evaluates issues related to sports activities, avoidance of sports and group activities, poor time management, and difficulties in completing tasks on time, all of which affect social interaction. The total score for this section is 20. The last domain addresses psychological factors (questions 19, 21, 28, and 30). These questions focus on issues such as poor attention and forgetfulness or poor memory. The total score for this section is 16.

Statistical Analysis The statistical software IBM SPSS Statistics for Windows version 22 was used for data analysis. Categorical variables were described using frequency (percentage), while numeric variables were expressed as mean±standard deviation (SD). The results of the Kolmogorov-Smirnov test confirmed the normal distribution of numeric variables. *T*-tests and ANOVA were employed to compare the average quality of life scores among different study groups. Chi-square and Fisher's exact tests were utilized to assess the correlation between quality-of-life scores and the measured ocular parameters in the study population. Linear logistic regression was applied to evaluate the effect of measured ocular parameters on the full 30-item COVD-QOL, using the enter approach adjusted for confounders, including age and sex. A 95% confidence interval and a significance level of 0.05 were considered for comparing the results.

RESULTS

Of the 726 students who participated in the study, 51.5% were women. The mean age of the participants was 21.35±1.88y (18-25y). The prevalence of myopia and hyperopia was 41.8% and 2.7%, respectively, while 45.3% of the participants had astigmatism. Totally 421 students had heterophoria, which was categorized into four groups: far exophoria, near exophoria, far esophoria, near esophoria. Besides, 15 students had tropia which were in 4 mentioned types. The number of students having any types of refractive errors, phoria, and tropia were presented in Table 1.

Table 2 presented the quality-of-life status in male and female students. Vision-related quality of life was significantly higher in men compared to women across all 30 items and in the domains of somatic symptoms, occupational-physical items, and social interactions (all $P<0.05$). The mean scores for quality of life in the domains of somatic symptoms and occupational-physical items differed significantly between age groups ($P=0.014$ and 0.027, respectively). Quality of life in these domains was significantly higher in the 18-19 age group compared to other age groups.

Tables 3 and 4 displayed the mean scores for quality of life across different groups of refractive errors, phoria, and tropia.

Our findings indicated that the quality of life of the students, in the overall and the domains of somatic symptoms and occupational-physical items, differed significantly among students with emmetropia, myopia, and hyperopia, with myopic students reporting significantly higher scores ($P<0.001$). In astigmatic students, the mean score for quality of life was significantly higher (across all 30 items, $P=0.024$) and in the domains of somatic symptoms ($P=0.015$) and occupational-physical items ($P=0.001$).

Far esophoria causes significant decrease in the quality of life in all 30 questions ($P=0.025$), as well as in the domains of somatic symptoms ($P=0.020$) and occupational-physical items ($P=0.005$). Near esophoria reduced quality of life in all 30 questions ($P=0.007$) and in the domains of somatic symptoms ($P=0.018$), occupational-physical items ($P=0.003$). Additionally, students with esotropia had a significantly lower quality of life in all 30 questions ($P=0.012$) and the domains of somatic symptoms ($P=0.002$), and psychological factors ($P=0.023$).

We found no significant difference in quality-of-life scores between students with convergence insufficiency and those

Table 1 Distribution of refractive errors, phoria, and tropia according by age and gender in university students *n*

Parameters	Number	Gender		Age (y)			
		Male	Female	18-19	20-21	22-23	24-25
Refractive errors							
Myopia	304	151	154	54	108	98	44
Hyperopia	20	11	9	5	10	3	2
Astigmatism	329	173	156	54	128	98	49
Deviation							
Far exophoria	84	32	52	17	22	32	13
Far esophoria	1	1	0	0	0	1	0
Near exophoria	328	162	166	55	125	102	46
Near esophoria	8	1	7	0	3	4	1
Far exotropia	9	1	8	4	1	2	2
Far esotropia	2	0	2	0	0	1	1
Near exotropia	2	0	2	1	0	0	1
Near esotropia	2	0	2	0	0	1	1

Table 2 Comparison of average score of quality of life and its scales divided by gender and age group in university students Mean±SD

Parameters	All	Gender			Age (y)				
		Male	Female	P^a	18-19	20-21	22-23	24-25	P^b
All	23.42±15.84	21.01±15.48	25.68±15.86	<0.001	21±14.8	22.96±14.67	24.42±17	25.56±17.51	0.126
Somatic symptoms	7.42±5.21	6.54±5	8.26±5.28	<0.001	6.20±4.82	7.32±4.88	7.93±5.70	8.13±5.35	0.014
Occupational-physical	8.24±6.75	7.63±6.62	8.80±6.82	0.019	7.47±6.13	7.66±6.01	8.88±7.34	9.50±7.89	0.027
Social communication	3.78±3.55	3.08±3.24	4.43±3.70	<0.001	3.53±3.36	3.94±3.59	3.60±3.48	3.95±3.81	0.576
Psychological factors	3.97±3.12	3.75±3.17	4.17±3.07	0.070	3.80±3.23	4.02±3.04	4±3.21	3.97±3.08	0.925

[a]The *P* was calculated by *t*-test; [b]The *P* was calculated by ANOVA.

Table 3 Comparison of average score of quality of life and its scales divided by refractive error in university students Mean±SD

Parameters	Quality of life score						
	Emmetropia	Myopia	Hyperopia	P^b	No-astigmatism	Astigmatism	P^b
All	21.46±9.42	26.67±17.53	13.5±9.42	<0.001	22.21±15.04	24.88±16.66	0.024
Somatic symptoms	6.81±3.51	8.41±5.73	4.95±3.51	<0.001	7.00±4.93	7.94±5.49	0.015
Occupational-physical	7.10±4.09	9.97±7.44	4.7±4.09	<0.001	7.49±6.34	9.13±7.11	0.001
Social communication	3.69±1.94	4.03±3.74	1.70±1.94	0.013	3.81±3.64	3.73±3.44	0.754
Psychological factors	3.85±2.32	4.25±3.4	2.15±2.32	0.007	3.89±2.96	4.06±3.97	0.473

[a]The *P* was calculated by ANOVA; [b]The *P* was calculated by *t*-test.

without this disorder ($P<0.05$). However, students without accommodation insufficiency reported significantly better quality of life in all domains ($P<0.05$), except for psychological factors ($P=0.07$).

Table 5 presented the correlation between the measured parameters and the quality of life in students. NPC and near point of accommodation (NPA) had significant inverse correlation with the quality of life (both $P<0.05$). Accommodative facility had a significant direct correlation with the quality of life ($P<0.05$ in all domains) except for social interactions item ($P=0.087$).

A regression model was employed to assess the predictive power of the measured parameters for vision-related quality of life (all 30 questions; Table 6). The results revealed a significant negative relationship between the NPC and NPA with quality of life (standardized regression coefficients: 0.102 and 0.142, respectively). Accommodation facility was directly associated with quality of life (β=-0.147).

DISCUSSION

The present study was conducted to assess the vision-related quality of life in a population of students using the COVD-QOL questionnaire. The results of the present study indicated the effect of refractive errors and binocular vision anomalies on lowering the quality of life of the university students.

The results of the present study showed no significant difference in vision-related quality of life across different age groups, particularly in the domains of social interactions and psychological factors. Although, the literature indicated

Table 4 Comparison of average score of quality of life and its scales divided by binocular disorder in university students Mean±SD

Parameters	Quality of life scores				
	All	Somatic symptoms	Occupational-physical	Social communication	Psychological factors
Far exophoria					
No	23.05±15.68	7.30±5.14	8.10±6.70	3.69±3.50	3.95±3.13
Yes	26.22±16.84	8.33±5.65	9.29±7.05	4.45±3.84	4.13±3.08
P^a	0.082	0.086	0.125	0.062	0.604
Far Esophoria					
No	23.57±15.78	7.40±5.19	8.20±6.71	3.77±3.55	3.97±3.13
Yes	48.50±26.16	16.00±7.07	21.50±10.60	5.50±4.94	5.50±3.53
P^a	0.025	0.020	0.005	0.494	0.490
Near exophoria					
No	23.55±15.98	7.42±5.30	8.33±6.82	3.77±3.51	4.02±3.17
Yes	23.27±15.69	7.43±5.11	8.13±6.66	3.78±3.60	3.92±3.06
P^a	0.818	0.965	0.691	0.969	0.670
Near esophoria					
No	23.26±15.61	7.38±5.15	8.16±6.63	3.75±3.54	3.95±3.11
Yes	38.37±28.07	11.75±8.74	15.25±12.53	5.75±4.43	5.62±3.77
P^a	0.007	0.018	0.003	0.115	0.134
Exotropia					
No	23.33±15.72	7.40±5.19	8.21±6.72	3.75±3.51	3.95±3.11
Yes	31.11±23.77	9.44±6.74	10.44±8.94	6.00±5.67	5.22±4.32
P^a	0.143	0.244	0.325	0.059	0.229
Esotropia					
No	23.34±15.79	7.39±5.18	8.21±6.74	3.77±3.55	3.96±3.11
Yes	51.50±10.60	19.00±5.65	16.50±3.53	7.00±2.82	9.00±5.65
P^a	0.012	0.002	0.083	0.200	0.023
Convergence insufficiency					
No	23.59±15.92	7.48±5.23	8.29±6.79	3.82±3.56	3.99±3.14
Yes	19.03±13.45	5.92±4.74	6.89±5.71	2.67±3.23	3.53±2.86
P^a	0.130	0.121	0.281	0.096	0.449
Accommodation insufficiency					
No	22.31±14.63	7.04±4.81	7.75±6.21	3.63±3.47	3.87±3.07
Yes	28.62±19.85	9.22±6.49	10.50±8.51	4.46±3.84	4.42±3.35
P^a	<0.001	<0.001	<0.001	0.017	0.070

The *P* was calculated by independent sample *t*-test.

Table 5 Correlation between quality of life and ocular parameters in university students *r* (*P*)

Quality of life scores	Accommodative convergence/ accommodation	Accommodation facility	Near point of convergence	Near point of accommodation
All	-0.019 (0.615)	-0.142 (<0.001)	0.160 (<0.001)	0.205 (<0.001)
Somatic symptoms	-0.047 (0.206)	-0.121 (<0.001)	0.180 (<0.001)	0.200 (<0.001)
Occupational-physical	0.010 (0.778)	-0.165 (<0.001)	0.154 (<0.001)	0.209 (<0.001)
Social communication	-0.030 (0.413)	-0.064 (0.087)	0.078 (0.035)	0.131 (<0.001)
Psychological factors	-0.004 (0.908)	-0.088 (0.017)	0.089 (0.017)	0.106 (0.004)

r: Pearson correlation coefficient.

that visual impairment associated with the aging process significantly affected psychosocial functioning, leading to substantial impacts on quality of life, disability, and overall health[22]. This issue can also be influenced by socioeconomic factors[23]. This difference may be attributed to the narrow age range of the participants in the present study who were between 18 and 25 years old and the study population who were university students only.

The present study showed that male students had a significantly higher quality of life in all domains, except for

Table 6 Effect of measured ocular parameters on quality of life of university students according to linear regression models using enter approach adjusted for confounders (age and sex)

Model parameters	Unstandardized coefficients		Standardized coefficients	*P*
	Beta	Std. Error	Beta	
Near point of convergence	0.354	0.128	0.102	0.006
Near point of accommodation	0.684	0.182	0.142	<0.001
Accommodative convergence/accommodation	0.229	0.407	0.020	0.574
Accommodation facility	-1.236	0.304	-0.147	<0.001
Sex	-4.008	1.153	-0.126	0.001
Age	0.696	0.301	0.083	0.021

psychological factors. Regarding vision-related quality of life between the two genders, female students were found to be at a higher risk of common visual problems than male students in a study by Shantakumari *et al*[24]. Pourla *et al*[25] also indicated a lower health-related quality of life in women. Although, Hogewind and Ciggaar[26] found no difference in the quality of life between the sexes in participants with anterior uveitis one year after the diagnosis of the disease. The observed difference may be related to the type of study populations and age groups, as the number of individuals seeking eye examinations varies between genders across different age groups[23].

The results of the present study showed a significantly lower quality of life in subjects with refractive errors. This is consistent with the findings of Shams *et al*[27], who indicated that emmetropic individuals had a significantly better quality of life compared to those with uncorrected refractive errors or glasses (due to limitations in daily activities), and individuals with a history of refractive surgery (due to surgical complications). According to our findings, myopic students had a worse quality of life in all domains compared to hyperopic students, indicating greater visual discomfort among myopic individuals. Similarly, other studies have shown that individuals with uncorrected myopia experience more blurred vision than those with other types of refractive errors, such as hyperopia and astigmatism[28], which has serious negative impacts on daily activities and quality of life. Rajabpour *et al*[9] reported that vision-related quality of life was low in myopic subjects, with very low myopes having a significantly lower QOL than other groups. Osuagwu *et al*[29] also found that patients with high myopia had a moderate quality of life. In another study, individuals with uncorrected myopia reported a low quality of life and experienced difficulties with activities requiring distance vision, such as reading street signs, recognizing friends, and watching television[28]. Similarly, in our study, the lowest quality of life of students was observed in the occupational-physical domain, which included questions related to distance vision, such as copying from the blackboard. This finding is supported by the study conducted by Chua and Foster[30].

The results of our study showed that hyperopic students had a better quality of life compared to those with other types of refractive errors. Since our study population was young and had sufficient accommodative ability, hyperopic individuals in this age group maintained good vision and did not experience significant blurred vision. Similarly, Hsieh and Lin[31] reported no significant association between hyperopia and difficulties with distance or near vision in high school students. Since previous studies have shown an inverse relationship between accommodation and asthenopic symptoms in hyperopic patients[32], the degree of hyperopia and the accommodation amplitude of the participants in the present study may have influenced the results obtained. The effect of accommodation is evident in the results of the present study, which indicated that accommodative insufficiency was significantly associated with a lower quality of life. Similarly, Shin *et al*[33] found a negative impact of accommodative insufficiency on quality of life. We also found that the score for somatic symptoms was worse than that of other domains in hyperopic students, particularly concerning complaints such as words running together and falling asleep while reading. Ionescu *et al*[34] indicated that somatic symptoms were related to depression and anxiety disorders, while Du *et al*[35] reported that hyperopia increased the risk of clinically significant depression. It is noteworthy to say that these results may be affected due to small number of participants with hyperopia, we recommend to evaluate this issue in more details in upcoming studies.

The results of the present study also indicated that the overall quality of life, specifically in the domains of somatic symptoms and occupational-physical items, was lower in astigmatic students compared to those without astigmatism. Uncorrected astigmatism may lead to visual disturbances, decreased quality of life, and decreased well-being[36]. Hashemi *et al*[37] found a relationship between astigmatism and somatic symptoms in university students. Al-Dairi *et al*[38] also found that the prevalence of depression was high in patients with keratoconus. Astigmatism has been reported to be associated with reduced academic readiness in preschool children[39]. However, in the present study, the mean score of quality of life

in the domains of social interaction and psychological factors showed no significant difference between astigmatic students and others. This finding could be due to the age range of the participants in the present study and the amount and the type of astigmatism.

The comparison of the mean quality of life scores among different groups with binocular vision disorders revealed that students with esophoria had a significantly lower quality of life. Both near phoria and distance phoria decreased the quality of life of the university students. Regarding phoria, few studies have evaluated its association with quality of life. For instance, a study by Lee *et al*[40] found that students with near exophoria faced numerous challenges due to their involvement in near activities, such as reading and working on computers, which contradicts our results, the results of the present study did not found any reduction in quality of life due to exophoria. It is noteworthy to say that the number of the esophoric participants in the present study is very limited and this might affect the obtained results. It is recommended to evaluate this matter in more detail in other studies. The results of the present study also indicated that convergence insufficiency had no significant effect on the quality of life. Xiong *et al*[10] reported that the Convergence Insufficiency Symptom Survey (CISS) and the COVD-QOL demonstrated low sensitivity in diagnosing convergence insufficiency. They recommended using these questionnaires in conjunction with other tests for a more comprehensive assessment. Horwood *et al*[41] also showed that the CISS score should not be used in young adults. However, exophoric patients frequently complain about problems like skipping lines reading, eye strain, headache, and occasional blurred vision, which can affect the quality of life[42]. In fact, it appears that the questionnaires used do not adequately capture the symptoms and changes in quality of life associated with phoria and convergence insufficiency. Besides, the present study showed that exophoria did not reduce the quality of life, so the lack of effect of convergence insufficiency on quality of life seems logical. Further studies and the incorporation of additional assessment tools could provide a more comprehensive evaluation of this issue.

We also observed the quality of life of students with esotropia was reduced in somatic symptoms and psychological factors, which primarily arise from impaired stereoacuity and diplopia[43]. Although, we did not observe any relationship between exotropia and quality of life. Lee *et al*[44] found that the presence of strabismus was associated with increased rates of anxiety, depression, and various other psychological issues. Many studies have examined the effect of exotropia on the quality of life of patients[45] and even their parents[46]. Liebermann *et al*[47] also assessed the effect of childhood esotropia on the quality of life. However, many patients with strabismus may not report bothersome symptoms due to sensory adaptations, such as suppression. Therefore, it can be concluded that the lack of effect of strabismus on quality of life, may be influenced by sensory adaptations in the evaluated participants and the limited sample size of individuals with strabismus in this study. Besides, in the present study, we analyzed the far and near cases with tropia with each other due to small sample size which can affect the obtained results.

We evaluated the correlation between the NPC, NPA, accommodative facility, and quality of life for the first time, and the results showed a significant relationship. NPC and NPA had a significant direct relationship with the score of quality of life; in other words, a decrease in these parameters was associated with a reduction in the score of quality of life, indicating a higher quality of life. The increase in the NPC can be a characteristic of the presence of convergence insufficiency, which can influence quality of life[48]. Although we did not observe any correlation between convergence insufficiency and quality of life which has discussed in the previous sections of the present study. Changes in the NPA also indicate the amount of accommodation available to the visual system, which, in proportion to the type of refractive error and other binocular vision anomalies[49], can affect the performance of the visual system and an individual's quality of life, especially in university students with specific visual needs. Accommodative facility also had a significant inverse correlation with the quality-of-life score; that is, an increase in accommodative facility increases quality of life. An increased accommodative facility may improve the speed of focus adjustment from near to far and vice versa[18], resulting in a better and faster performance in social interactions. Moreover, individuals with increased accommodative facility experience fewer symptoms; therefore, enhanced accommodative facility may improve their quality of life.

The present study indicated that refractive errors and binocular vision disorders negatively impact students' quality of life. Implementing screening programs to correct refractive errors and binocular vision anomalies may significantly affect students' academic achievements and their occupational-physical well-being. This study had some limitations. The status of refractive error correction was not considered, even though it has a significant effect on quality of life. Second, it was unclear whether the students' low quality of life was related to visual disorders or other factors. To obtain more accurate results, interventional and cohort studies should be conducted to evaluate the effect of treating visual disorders on quality-of-life improvement. Additionally, students' vision-related quality of life may differ among various majors, but this difference was not considered in our study.

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