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High prevalence of myopia in university students: A concern for the future

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HIGHLIGHTS

The prevalence of myopia is markedly high in university students. The prevalence of astigmatism was significantly higher in male students.

ABSTRACT

Purpose: To determine the prevalence of refractive errors in university students.
Methods: This cross-sectional study was conducted in 2017. The samples were selected through multi-stage cluster sampling. After selecting the participants and obtaining informed consent from them, examinations including the measurement of uncorrected and corrected visual acuity, autorefractometry and retinoscopy in non-cycloplegic conditions, and subjective refraction.
Results: Of 854 selected students, 726 participated in the study, of whom 51.7% (n = 375) were female. Myopia, hyperopia, and astigmatism was seen in 41.87% (38.28–45.47%), 2.75% (1.56–3.95%), and 45.32% (41.69–48.95%) of the students, respectively. Myopia with a spherical equivalent of more than 6 D was detected in 1.5% of the students (n = 11). Age and sex did not have a significant correlation with myopia and hyperopia in this age group. The prevalence of astigmatism was significantly higher in male students (OR = 1.36; 1.02–1.83).

The prevalence of WTR, ATR, and oblique astigmatism was 23.4%, 18.5%, and 3.4%, respectively. In total, 60.33% (56.76–63.90%) of the students were ametropic.

Conclusion: The prevalence of refractive errors, especially myopia, is markedly high in university students. Considering near-work activities in this population, refractive errors, especially myopia, should be corrected in students.

Key words: myopia, hyperopis, astigmatism, prevalence, young population

INTRODUCTION

Uncorrected refractive errors are the main cause of visual impairment and the second leading cause of preventable blindness in the world [1]. A meta-analysis from 2000–2020 of the prevalence of blindness and visual impairment secondary to uncorrected refractive error in 2024 found 3.7 million blind and 157 million visually impaired people due to uncorrected refractive error, a 21.8% increase in blindness and 72.0% increase in visual impairment since 2000, and an increasing trend is still expected [2].

Several studies have investigated the prevalence of refractive errors in the world. Based on the results of this study, it is already known that at least 6.7% of the children and 35% of the adults suffer from refractive errors [3, 4]. Most of these studies found that myopia was common in children [3, 5]. Some other studies investigated the prevalence of refractive errors in older people and those above 40 years and concluded that this population was at risk for blindness due to changes in ocular and ophthalmic conditions caused by ageing [6–9].

Hyperopia has also been reported to be prevalent in older people, which is related to a continuous reduction in lens power and structural changes of the crystalline lens [10, 11]. However, our knowledge of refractive errors in young and middle-aged populations is limited since most of the available studies have addressed children and adults above 40 years and few studies have evaluated young adults.

The study on the prevalence of refractive errors in the elderly shows the difference in prevalence in different parts of a country with racial variety [12]. Also studies shows that there is a difference in prevalence of refractive error in different age groups. In Germany, Schiefer and his group reported that the prevalence of refractive error in the elderly was 70%, indicating the epidemiological importance of this issue [13]. But it should also be noted that the prevalence of refractive errors has been variable in different age groups in different countries [14–16]. Racial and age differences have shown both variable results in previous studies [17–20]. Mohammadi et al. reported refractive error prevalence carries an inherent "age-related" feature and the prevalence rate increased in older ages [21]. Cheng and his group stated that two thirds of the study population were myopic, while as mentioned before, the result of some studies, such as the study of Khalaj et al., found that the prevalence of hyperopia was higher in the elderly; so the prevalence of refractive error in people over 40 years of age is such that further investigations should be performed to clarify the role of environmental factors that affect the results [11, 22]. These discrepancies in the results in the elderly indicate that it is important to study the prevalence of refractive errors not only in the elderly but also in children who are discussing the development of myopia at this age.

Lack of diagnosis and correction of refractive errors affect personal and social skills like educational achievements in young people. Visual impairment resulting from uncorrected refractive errors is associated with rapid and/or long-term effects on young people, including losing educational, occupational, financial, social, and family opportunities, adopting inappropriate lifestyles and lower quality of life [23–27]. Therefore, studies aiming at identifying common refractive errors in young populations across the world help to choose appropriate correction methods, decrease visual impairments and blindness resulting from uncorrected refractive errors, and improve the lifestyle of affected patients. Due to the importance of refractive errors in young people, this study was conducted to determine the prevalence of refractive errors in a population of university students.

METHODS

This cross-sectional study was conducted in 2017. The target population of the present cross-sectional study that was carried out in 2017 was the students of Shahrekord Azad University, central Iran [28]. First, the sample size was calculated at 785 subjects using the binomial test with a prevalence of 2%, difference of 0.1%, and type one error of 0.05. Considering a loss to follow-up of 5%, 826 subjects were finally included in the study using the following formula: Final sample size = 785 / (1–5%) = 826. Then, multi-stage cluster sampling was applied to select the students. Each academic major was defined as a stratum. In each major, the samples were randomly selected from the student rosters proportional to the total number of students. In the next step, after explaining the objective of the study, they were requested to be present at a predetermined place on a predetermined day. Informed consent was obtained from all subjects prior to participation in the study. Then, face-to-face interviews were conducted to collect demographic data and history of ocular surgery. Finally, all students underwent optometric and ophthalmic examinations.

Optometric examinations included visual acuity measurement, refraction, and cover test. First, uncorrected visual acuity was measured using a Snellen chart at 6 m under standard illumination conditions. Then, refraction was measured with an auto refractometer and the results were refined with retinoscopy. Subjective refraction was done after measuring objective refraction. Finally, best corrected visual acuity was determined for all participants and the best corrected visual acuity was recorded. In the next step, all students underwent binocular visual examination and slit-lamp biomicroscopy. Students with corrected visual acuity worse than 20/25 in each eye, any ocular or systemic disease affecting the refractive status, a history of intraocular surgery including refractive surgery, and a history of ocular trauma were excluded from the study.

Definitions: In this study, spherical equivalent based on non-cycloplegic refraction results was used to determine refractive errors. Similar to previous studies, myopia was defined as an spherical equivalent of less than -0.5 D and hyperopia was defined as an spherical equivalent of more than 0.5 D. Astigmatism was defined as a cylinder power of worse than 0.5 D. With-the-rule (WTR) astigmatism was defined as cylinder axes from 0–30° and from 150–180° and against-the-rule (ATR) astigmatism as axes from 60–120°. Other axes were considered as oblique (OBL) astigmatism. Similar to other studies, a spherical equivalent of less than -6 D, -3.1 D to -6 D, and -0.51 D to -3 D was considered as severe, moderate, and mild myopia, respectively. Moreover, a spherical equivalent of more than 4 D, 2.1 D to 4 D, and 0.51 D to 2 D was considered as severe, moderate, and mild hyperopia, respectively.

Statistical analysis: The prevalence of myopia, hyperopia, and astigmatism is presented as percentage and 95% confidence. Multiple logistic regression analysis was applied to investigate statistical correlations.

Ethical issues: The Ethics Committee of Iran University of Medical Sciences approved the study protocol, which was conducted in accord with the tenets of the Helsinki Declaration. All participants signed a written informed consent. (Ethics code: IR.IUMS.REC.1395.449).

RESULTS

Of 854 selected students, 726 participated in this study of whom 375 (51.7%) were female. The mean age of the subjects was 21.35 (±1.88) years (range: 18–25 years).

The mean spherical equivalent of the participants was -0.80 D (95% CI: -0.70 D to -0.91 D). There was no significant difference in spherical equivalent between the male: -0.83 (±1.60) D, and female: -0.78 (±1.3) D students (p = 0.611). Spherical equivalent changes with age were not significant in this age group either (P = 0.198).

According to the results, 41.87% (95% CI: 38.28–45.47%) of the students had myopia. Table 1 presents the prevalence of myopia and other refractive errors according to age and sex. Table 2 shows the results of the simple and multiple, logistic regression models. Multiple logistic regression analysis showed no significant correlation between myopia and age (P = 0.353) and sex (P = 0.544). 11 students (1.5%) had myopia with a spherical equivalent of more than -6 D. Hyperopia was found in 2.75% (1.56–3.95%) of the students. According to the results of multiple logistic regression, there was no significant correlation between hyperopia and age (P = 0.152) and sex (P = 0.558). Astigmatism was detected in 45.32% (41.69–48.95%) of the students. Multiple logistic regression analysis revealed no significant correlation between astigmatism changes and age (P = 0.513); however, the prevalence of astigmatism was significantly higher in male students (OR = 1.36; 1.02–1.83). The prevalence of WTR, ATR, and oblique astigmatism was 23.4%, 18.5%, and 3.4%, respectively. The changes of astigmatism axis had no significant correlation with sex (P = 0.118) and age (P = 0.908). In total, 60.33% (56.76–63.90%) of the students were ametropic. There was no significant inter-gender difference in the prevalence of ametropia.

DISCUSSION

This study was conducted to investigate the prevalence of refractive errors in a young population. Ametropia was detected in more than 60% of the study population in this study, indicating that more than half of the subjects had at least one type of refractive error. Table 3 shows the results of similar studies in similar age groups.

The prevalence of myopia was 41.9% in our study population. The prevalence of myopia was reported to be 41.7% in a study by Alqudah et al. in a smaller sample size among medical students in Jordan [29] and 48.7% in another study in Saudi Arabia [30]. About 36.2% of the subjects were myopic in a similar study in the US in a young population [31]. Some studies found that the prevalence of myopia was higher in Asia versus European and American countries [31–36]. About 70.6% of the people aged 19–25 years had myopia in a study conducted in South Korea [34]. The prevalence of myopia is reported to be above 50% in some other Asian countries. A study in rural areas of Iran found that myopia was more prevalent especially in the elderly [37]. As shown in table 3, the prevalence of myopia in teenagers and young adults ranges from 13.0% to 92.52%. However, it should be

TABLE 1

The prevalence of myopia, hyperopia, astigmatism and ammetropia in university students.

		n	Astigmatism (95% CI)	Ammetropia (95% CI)	Myopia (95% CI)	Hyperopia (95% CI)
Age (years)	18	28	39.29% (20.00–58.57%)	57.14% (37.60–76.68%)	35.71% (16.79–54.64%)	3.57% (0.09–19.9%)*
	19	92	46.74% (36.35–57.13%)	60.87% (50.71–71.03%)	47.83% (37.42–58.23%)	4.35% (0.10–8.59%)
	20	150	46.67% (38.59–54.74%)	59.33% (51.38–67.29%)	37.33% (29.50–45.16%)	3.33% (0.43–6.24%)
	21	145	40.00% (31.93–48.07%)	55.17% (46.98–63.36%)	35.86% (27.96–43.76%)	3.45% (0.44–6.45%)
	22	123	45.53% (36.60–54.45%)	64.23% (55.64–72.82%)	46.34% (37.40–55.28%)	1.63% (0.20–5.87%)*
	23	87	48.28% (37.56–58.99%)	64.37% (54.10–74.63%)	47.13% (36.43–57.83%)	1.15% (0.03–6.40%)*
	24	28	53.57% (33.88–73.26%)	67.86% (49.42–86.30%)	39.29% (20.00–58.57%)	3.57% (0.09–19.90%)*
	25	73	46.58% (34.86–58.29%)	58.90% (47.35–70.46%)	45.21% (33.51–56.90%)	1.37% (0.03–7.63%)*
Gender	female	375	41.60% (36.59–46.61%)	57.87% (52.85–62.89%)	40.80% (35.80–45.80%)	2.40% (0.84–3.96%)
	male	351	49.29% (44.03–54.54%)	62.96% (57.89–68.04%)	43.02% (37.82–48.22%)	3.13% (1.30–4.97%)
Total		726	45.32% (41.69–48.95%)	60.33% (56.76–63.90%)	41.87% (38.28–45.47%)	2.75% (1.56–3.95%)

* The 95% confidence interval was calculated using binominal distribution.

TABLE 2

The association between refractive errors with age and sex in simple and multiple logistic regressions.

		Simple		Multiple	
		OR (95% CI)	p-value	OR (95% CI)	p-value
Myopia	Sex (male/female)	1.10 (0.82–1.47)	0.545	1.10 (0.82–1.47)	0.544
	Age (year)	1.04 (0.96–1.12)	0.353	1.04 (0.96–1.12)	0.353
Hyperopia	Sex (male/female)	1.32 (0.54–3.21)	0.547	1.31 (0.53–3.20)	0.558
	Age (year)	0.83 (0.64–1.07)	0.150	0.83 (0.64–1.07)	0.152
Astigmatism	Sex (male/female)	1.36 (1.02–1.83)	0.038	1.36 (1.02–1.83)	0.038
	Age (year)	1.03 (0.95–1.11)	0.515	1.03 (0.95–1.11)	0.513

OR – odds ratio; CI – confidence interval.

TABLE 3

Summary of studies on the prevalence of refractive errors in different populations.

First author	Year	Sample size	Age (years)	Place	Myopia	Hyperopia	Astigmatism
Munoli [38]	2024	425	18–25	India	18.6%	9.6%	9.6%
Alqudah [29]	2023	700	18–25	Jordan	41.7%	4.9%	8.4%
Shneor [39]	2022	807	17–30	Israel	66.0%	4.0%	49.0%
Teran [40]	2021	3468	15–18	Mexico	36.11%	1.49%	29.17%
Bahakim [41]	2021	420	18–30	Saudi Arabia	26.9%	2.6%	52.6%
Aboallut [42]	2020	447	18–27	Saudi Arabia	33.8%	10.5%	10.5%
Almudhaiyan [30]	2020	660	20–40	Saudi Arabia	48.7%	25.2%	66.3%
Hashemi [43]	2020	1462	22.81 (±3.18) (18–48)	Iran	42.71%	3.75%	29.46
Parrey [44]	2019	966	16–39	Saudi Arabia	24.4%	11.9%	9.5%
Alsaif [45]	2019	338	18	Saudi Arabia	47.9%	6.5%	–
Wei [46]	2018	7732	1.4 (±20.2)	China	83.2%	7.3%	28.8%
Al–Rashidi [47]	2018	162	19–27	Saudi Arabia	53.7%	3.7%	1.2%
Hagen [48]	2018	393	16–19	Norway	13%	57%	9%
Shi [49]	2018	3504	18.83 (±0.92)	China	92.52%	1.26%	64.16%
Alsaqr [50]	2018	1007	12–20	Saudi Arabia	53.3%	2.2%	15%
Jobke [35]	2008	138	18–35	Germany	41.3%	2.9%	–
Koh [36]	2014	1508 young males	16–25	Singapore	79.2%	0.8%	41.4%
Onal [51]	2007	207	18–26	Turkey	32.9%	16.9%	–
Midelfart [52]	2004	1248	20–25	Norway	35%	13.2%	–

noted that our study population was 18–25 years old and it is possible that some of them will develop myopia in the future.

Myopia was found in a relatively large percentage of our subjects, affecting about half of them. The reason for the high prevalence of myopia in young people is that this population is engaged in a lot of indoor activity. It is well established that long-term near work and indoor activity is among environmental factors associated with myopia development, especially in people who are genetically susceptible [53–55]. Mirshahi et al. found a direct correlation between the prevalence of myopia and education level [56]. According to some studies, because myopic subjects do not have any problems with and tend to undertake near-work activities, they read more, resulting in more spasm in the ciliary muscles and causing pseudomyopia and consequently true myopia [57].

Therefore, a higher prevalence of myopia is expected in educated people. On the other hand, another theory regarding the relationship between near-work activity and myopia progression is that accommodative lag theory. According to this theory, the presence of an accommodative response error in the form of a high accommodative lag during near-work activity may result in a hypeopic defocus to correct which, during a biofeedback reaction, the axial length increases, consequently leading to myopia development and progression [58].

The prevalence of hyperopia was 2.8% in our study population, which was relatively low. Monsálvez-Romín et al. found higher prevalence of hyperopia in the children and elderly compared to young people, which is mainly due to a smaller axial length and anatomic conditions of the crystalline lens [59]. The prevalence of hyperopia vary in different studies as has been reported to be 25.2% in Saudi Arabia [30] to 1.49% in Mexico [40]. This disparity in finding can be attributed to different definitions of hyperopia (>0.50 D in first study vs. >2.00 D in the second one). Therefore, the prevalence of hyperopia was lower compared to study conducted in Saudi Arabia. The prevalence of hyperopia without cyclorefraction was 2.1% in South Korea [34] and 2.1%in the rural areas of Iran [60], and the prevalence of hyperopia with cyclorefraction was 12.5% in Tehran, capital of Iran [61]. Accordingly, the prevalence of hyperopia with cyclorefraction was higher than the prevalence without cyclorefraction in the above studies. In general, the results of different studies suggest that the prevalence of hyperopia relative to myopia in markedly lower in this age group [30, 40].

Very limited studies have investigated the prevalence of astigmatism in young populations compared to the prevalence of myopia and hyperopia. In our study, the highest prevalence of refractive errors was for astigmatism (54.7%). Munoli et al. reported a prevalence of 9.6% for astigmatism in the India [38] while its prevalence was 52.6% in Saudi Arabia [41]; so more than half of the population suffering from refractive errors had astigmatism, which was similar to our results.

As mentioned earlier, near-work activities are very common, especially in young people. A study conducted in 2015 proposed different hypothesis for the effect of near-work activity on astigmatism [62]. One of these hypotheses pointed to eyelid pressure during such activities. The possibility of developing astigmatism due to incyclotorsion was another hypothesis. On the other hand, Koh et al. found that the prevalence of astigmatism in some population-based studies was comparable to the prevalence of myopia, suggesting that the prevalence of myopia and astigmatism may affect one another [36]. The authors attributed this relationship to the effect of astigmatism on the accommodative system and the effect of ocular growth on ocular components and recommended further research in this regard. Moreover, uncorrected myopia can cause astigmatism due to squinting. As reported earlier, the prevalence of myopia was also high in our study. Several studies have investigated the relationship between education level and astigmatism prevalence and reported contradictory results. Meiktila eye study reported a reverse correlation between education level and prevalence of astigmatism [63] while Sumatra [64] reported no correlation. Therefore, education level cannot explain the differences in the results. The prevalence of astigmatism is reported to be higher in some studies conducted in South Asian countries with regards to their genetic condition and narrower palpebral aperture [36, 65] and the same result was seen in the present study. The higher prevalence of astigmatism demands that some points be taken into consideration regarding diagnosis and follow-up of refractive errors because high astigmatism in some conditions like keratoconus is more common in young people, requiring periodic follow-ups and examinations.

Another finding of the present study was lack of any significant difference in the prevalence of refractive errors, except astigmatism, between male and female students. Some previous studies found higher prevalence of myopia in men compared to women and attributed this finding to the longer axial axis in men [66, 67]. It should be considered that besides parameters like axial length, some acquired parameters and anatomical factors like corneal curvature are also effective in determining the final refractive error. Wajuihian et al. found a significant correlation between the prevalence of refractive errors and sex [68]. Vitale et al. reported the prevalence of myopia and hyperopia was higher in women aged 20–39 years and above 60 years compared to their male counterparts, respectively [31]. In our study, the prevalence of astigmatism was 49.3% in men and 41.6% in women. Touzeau et al. found no significant correlation between sex and the prevalence of different refractive errors [69]. Marasini et al. exclusively studied the relationship between the amount of astigmatism and sex in subjects with a mean age of 28.58 years and found no significant difference [70]. Another study in 2013 found that genetic factors affected inter-differences in astigmatism [71]. Some studies such as Attebo et al. study have reported that the effect of sex on the prevalence of refractive errors in not clear and needs further research [66]. However, most of these studies were done in children or subjects above 40 years. Attention should be paid to anatomical differences and longer axial length in men. Fulton et al. reported that ocular growth, due to stretching zonule fibers and ciliary muscle, can cause myopia and lenticular astigmatism [72]. The reason for the higher prevalence of astigmatism in men may be their longer axial length and more ocular growth compared to women. However, more studies are required in this regard.

Some studies found that the process of emmetropization does not exclusively occur during childhood and is seen throughout life. A major part of this developmental process occurs in childhood, and the structural changes of the eyes and the emmetropization process are more stable in young people [73, 74]. Therefore, people live with the refractive error they develop during adolescence for a long time. As a result, detection of refractive errors in this age group is of great importance.

CONCLUSIONS

The results of the present study add to our knowledge of common refractive errors in young populations as one of the most important groups and play an important role in clinical decision-making about correction of refractive errors using available methods. This study is one of the most important studies of refractive errors in young people due to the scarcity of such studies. The results of this study showed that about half of the study population had refractive errors. However, it should be noted that cyclorefraction was not done because of the composition of the study population that mostly comprised young people and the results of dry refraction were used. Among different refractive errors, astigmatism followed by myopia had the highest prevalence. The results showed a significant inter-gender difference in the prevalence of astigmatism, too. Knowledge of common refractive errors in young people improves the prognosis and helps to choose the best corrective method. More studies are required in this age range with the use of to cyclorefraction to prevent overdiagnosis of refractive errors in myopic subjects and underdiagnosis in hyperopic subjects.

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The Ethics Committee of Iran University of Medical Sciences approved the study protocol, which was conducted in accord with the tenets of the Helsinki Declaration. All participants signed a written informed consent. (Ethics code: IR.IUMS.REC.1395.449).

