Clinical and Experimental Optometry

ISSN: (Print) (Online) Journal homepage: www.tandfonline.com/journals/tceo20

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To cite this article: Parya Abdolalizadeh, Ramin Mehrdad, Bahar Saberzadeh-Ardestani, Hamidreza Pouragha, Fateme Alipour & Mehrdad Esmaili (2023) Prevalence of uncorrected distance refractive errors and associated risk factors in employees of an academic centre, Clinical and Experimental Optometry, 106:8, 869-875, DOI: 10.1080/08164622.2022.2133988

To link to this article: https://doi.org/10.1080/08164622.2022.2133988

CLINICAL AND EXPERIMENTAL OPTOMETRY
2023, VOL. 106, NO. 8, 869–875
https://doi.org/10.1080/08164622.2022.2133988

RESEARCH

Prevalence of uncorrected distance refractive errors and associated risk factors in employees of an academic centre

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ABSTRACT

Background: Uncorrected refractive error (RE) may affect the work performance of adults in the workplace. The aim of current study was to determine the prevalence of corrected and uncorrected RE, and the determinants of uncorrected RE in adult employees of a university.

Methods: This was a cross-sectional study of Tehran University Medical Sciences' staff. Besides demographic and some specific questionnaires, ophthalmic examinations including the measurement of uncorrected visual acuity (UCVA), best spectacles corrected visual acuity (BCVA), and presenting visual acuity were performed for all participants. The need for spectacles was defined as UCVA worse than 6/12 in the better eye that could be corrected to better than 6/12 with spectacles based on subjective refraction.

Results: In total, 4460 individuals with mean age of 42.32 ± 8.80 were included in the study. The VA of the better eye was 0.01 ± 0.05 logMAR for BCVA, 0.13 ± 0.26 for UCVA, and 0.05 ± 0.12 for presenting VA. Prevalence of RE was 15.7%, including uncorrected RE of 5% and spectacles coverage (corrected RE) of 10.7%. The proportion of individuals with elementary education and poor-fair status of general health were 1.62 times higher in the uncorrected group. In the univariate analysis, type of occupation (office versus non-office workers), socioeconomic status, and insurance of employees were not related to uncorrected RE (all $P > 0.4$). Myopia was the only factor associated with uncorrected RE in logistic regression analysis (odds ratio = 2.73, 95%CI = 1.02–7.31, $P = 0.04$).

Conclusion: The prevalence of uncorrected RE and spectacle coverage were 5% and 10.7%, respectively. Myopia was almost three times more likely to be associated among employees with uncorrected RE.

ARTICLE HISTORY
Received 3 August 2021
Revised 3 March 2022
Accepted 14 March 2022

KEYWORDS
Uncorrected refractive errors

Introduction

Refractive disorders are the leading cause of blindness and vision impairment, worldwide.[1] According to global burden of disease 2019, refractive disorders were considered to be responsible for vision impairment in approximately 157 million persons, of whom approximately 59 million are young adults aged 20–54 years old.[1] The burden of refractive disorders, defined as person-years affected by visual impairment, is comparable with cataract. [1] Although the majority of people with uncorrected refractive disorders live in low- to middle-income countries, refractive disorders are regarded as serious problems even in high-income countries.[1]

Uncorrected refractive errors (RE) can lead to serious disabilities. They can affect social interactions, quality of life, and educational prospects.[2,3] Moreover, uncorrected RE impair economic activities, and job opportunities.[2] This puts families and societies in a vicious cycle, worsening the economic status. Based on the World Health Organization report, uncorrected RE resulted in 269 International Dollars of total global productivity loss.[4]

Many population-based studies have been performed to determine the prevalence of RE, the percentage of uncorrected RE, and spectacles usage in different parts of the world.[5–11] They have addressed the determinants of uncorrected RE.[5–11] Although some studies have found an association between educational level and income with uncorrected RE, no study has focused on office employees with a higher degree of education in whom visual acuity is important for better performance.[5–8] Moreover, the effect of longitudinal changes of socioeconomic factors on uncorrected RE and spectacles usage has not been assessed. Therefore, the current study aimed to investigate the spectacles coverage, uncorrected RE and its sociodemographic determinants in employees of an academic centre. Understanding the vision status of the employees will be useful for developing appropriate university health policies and maintaining good eye health status of employees as well as helpful for improving their work performance by addressing their eye health issues.

Methods

This cross-sectional study was conducted from January 2018 to December 2019 as a measure of enrolment data in the phase one of Tehran University of Medical Sciences' Cohort (TEC) Study.[12] In this study, part of the data collected in the TEC cohort enrolment phase was used. In TEC, the association between different variables such as socioeconomic status (SES), occupation type, and various health outcomes have been evaluated.[12] Furthermore, the trends in these variables

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and the incidence of health outcomes were investigated.[12] Visual and refractive measures are one of the health outcomes of this cohort.[12] In the first phase of the cohort, the aim was to assess what were the descriptive data of visual and refractive measures and whether the socioeconomic status, health status and quality of life impact the refractive status and spectacles coverage. In the next phases of the Cohort, every 5 years, we will try to assess the association between changes of socioeconomic factors (without any intervention) and various health-related conditions including visual and refractive outcomes.[12]

Tehran University of Medical Sciences is the first established and the largest institute of medical sciences in Iran with approximately 19,000 employees.[13] The sample size that was given in the main study protocol article was calculated 5500 by considering a power of 90%, type 1 error of 5%, 25% difference between two groups, 20% estimated prevalence, and 10% loss to follow-up.[12] Inclusion criterion in this study was employment relationship with Tehran University of Medical Sciences. Official invitations were made via phone, short message service, the study's website, through the focal points, and in person. All staff were allowed to enter the study voluntarily. Also, there were no exclusion criteria. All participants voluntarily signed the informed consent form at the study centre. Participants in the study included a variety of departments including: office workers, clinical workers, laboratory staff, services workers, and security guard staff. The occupation types were classified as office workers (who spent work-time reading, writing and working with computers) and non-office workers (who had extra manual and physical tasks).

All examinations and data collection were performed in one working day at the designated centre (a temporary location to examine only study participants during study period) by trained personnel and according to the approved protocol of the study. All data collection steps were supervised by independent quality control and assurance team. The participants were asked to answer the World Health Organization Quality of Life questionnaire (WHOQOL-Bref) to evaluate general, social, environmental, and mental aspects of their quality of life.[14] Participants also rated their own general health through the health domain of the Copenhagen Psychosocial Questionnaire (COPSOQ) short version.[15] It is a questionnaire with 5-point Likert scale including 0 (poor), 1 (fair), 2 (good), 3 (very good) and 4 (excellent). We re-categorised the scores into two classes: poor-fair and good-to-excellent. The smartphone addiction status was assessed with the smartphone addiction scale that consisted of 6 factors and 33 items with a 6-point Likert scale based on self-reporting.[12] The socioeconomic status was measured with asset-based socioeconomic indicator (wealth index). The categorical principal component analysis was applied to the net assets of each participant and the wealth index will be created.[12,16]

All participants underwent ophthalmic examinations including measurement of uncorrected visual acuity (UCVA), best corrected visual acuity (BCVA), presenting visual acuity (VA), VA with current glasses, lensometry (to determine the power of the current glasses); objective (non-cycloplegic auto-refraction) with an auto refractor device (Topcon 8800), and subjective refraction tests. Autorefraction results were checked through retinoscopy (Heine Beta 200 Retinoscope, HEINE Optotechnik, Germany). Visual acuities were measured for the right eye followed by the left eye with a consistently illuminated Snellen chart with tumbling E within a light box placed 6 metres away from the participant by a trained optometrist. If the subject was unable to read the largest letter at 6 m with objective refraction, testing was repeated at 1 m. If the subject was unable to read the largest letter at 1 m, the VA was recorded as count fingers, hand movements, light perception or no light perception. Examinations were performed in rooms with standard lighting. Eye motility assessment, slit-lamp examination, and posterior segment examination were not done in study centre and any subjects with BCVA <6/6 was referred to Farabi eye hospital for more ocular evaluation by ophthalmologists. However, evaluation of detailed ocular disease was not the purpose of this cohort study which focused only on the vision impairment related to refractive disorders. The data of the better eye was used in this study.

Definitions

Presenting VA was defined as the visual acuity with the current glasses if the patient wore them and UCVA if the patient did not have any glasses. The spherical equivalent (SE) was calculated as the spherical error plus half of the cylindrical error. Subjective refraction was used to classify refractive status. Myopia was defined as a spherical equivalent subjective refraction < −0.5 dioptre (D). A spherical equivalent refraction >0.5D was defined as hyperopia, and values within the range of −0.5 ≤ spherical equivalent ≤ +0.5D were considered emmetropia. A cylinder refraction equal to or greater than 1.5 D was taken for high astigmatism. With the rule astigmatism was considered when the axis of the cylinder was located between 0 and 10 or 170 to 180. Eyes with cylindrical axis between 80 and 100 were categorised as against the rule astigmatism. Other cylindrical axis was classified as oblique astigmatism. The need for distance vision spectacles was defined as a UCVA worse than 6/12 in the better eye that could be corrected to better than 6/12 with suitable spectacles. It consisted of corrected RE and uncorrected RE. *Corrected RE* was calculated as the percentage of subjects who had visual acuity worse than 6/12 in the better eye without correction (UCVA < 6/12), but wore own spectacles and achieved 6/12 or better with their present spectacles (BCVA ≥ 6/12 and presenting VA ≥ 6/12).[10] *Uncorrected RE* was defined as the percentage of participant with UCVA <6/12 in the better eye without correction which could achieve 6/12 or better in the better eye with correction (BCVA ≥ 6/12), but either went without spectacles or did not achieve such correction with their present spectacles (presenting VA < 6/12).[10] If the participant had spectacles but did not use it routinely, he or she were considered a person without spectacles. If the person forgot the spectacles only at the day of examination, the examination was performed in another day with the spectacles.

Spectacle coverage (%) was calculated as:

$$\text{Corrected RE}/\text{Total RE}(\text{Corrected RE} + \text{Uncorrected RE})$$

Vision impairment was classified as mild (presenting VA of better eye worse than 6/12 to 6/18), moderate (presenting VA of better eye worse than 6/18 to 6/60), severe (presenting VA of better eye worse than 6/60 to 3/60) and, blindness (presenting VA of better eye worse than 3/60) according to World Health Organization definitions.[17]

Statistical analysis

Statistical analyses were performed with SPSS for Windows software version 24.0 (SPSS Inc., Chicago IL, USA). The data of the better eye was used for statistical analysis. The VAs were converted to the logarithm of the minimum angle of resolution (logMAR) for statistical analysis. Quantitative data were described with means (standard deviation (SD)) and percentage in continuous and numerical data, respectively. Independent student *t*-tests and chi-square tests were performed for continuous and numerical data, respectively, to compare the variables between corrected and uncorrected groups. Variables with *p*-value <0.1 in univariate analysis (educational level, refractive status, type of astigmatism and COPSOQ general health condition) were used as covariates in logistic regression to find indicators of uncorrected RE. P values less than 0.05 were considered statistically significant.

Results

Demographic and socioeconomic features

In total, 4460 subjects with mean age of 42.32 ± 8.80 (ranged from 20 to 75) years old were included. More than 60% of subjects (60.7%) were female (Table 1). Tables 1 and 2 illustrate the baseline demographic and socioeconomic features. More than 70% (73.2%) of subjects had academic educational degrees while 26.8% had elementary educations (Table 1). Majority of patients (79.1%) were married. The coverage of basic and supplementary insurance was 87.9% and 51.9%, respectively. More than 60% of subjects (62.3%) had intermediate or less socioeconomic status. Nearly 90% of subjects (88.2%) had good to excellent general health based on COPSOQ classification. The mean score of QoL was 14.59 ± 2.75 in general domain, 15.92 ± 2.15 in physical domain, 14.96 ± 2.58 in mental domain, 14.87 ± 2.69 in social domain and 13.75 ± 2.17 in environmental domain. Participants have smoked 0.84 ± 4.11 pack-year. Their smart phone addiction score was 23.46 ± 10.10.

Visual and refractive measures of the better eye

In total, 99.4% (4434/4460) of subjects had no vision impairment (BCVA >6/12 in the better eye). The prevalence of mild and moderate vision impairment were 2.7% (122/4460) and 2.7% (121/4460), respectively. No subject had severe vision impairment or blindness. Tables 1 and 2 illustrate the various visual and refractive measures in the better eye. The VA in the better eye was 0.01 ± 0.05 logMAR for BCVA, 0.13 ± 0.26 for UCVA, and 0.05 ± 0.12 for presenting VA. Moreover, 16.3% (728/4460) and 5.4% (243/4460) of the subjects had UCVA <6/12 and presenting VA < 6/12 in the better eye, respectively. The mean of presenting VA was significantly worse than mean BCVA (P < 0.001), while the mean of presenting VA was significantly better than mean UCVA (P < 0.001). Two-thirds of eyes (66.0%) were emmetropic followed by myopia (27.1%), and hyperopia (6.8%). The subjective refraction (SE) was 0.10 ± 0.58 dioptre more myopic than current spectacles (SE) (P < 0.001). Nearly 7% of eyes had significant astigmatism (≥1.5 Dioptre). The most common type of astigmatism was with-the-rule accounting for 68.6% of astigmatic eyes followed by oblique astigmatism (22.8%) and against the rule astigmatism (8.6%).

Uncorrected refractive error

In total, 15.7% (95%CI = 14.6%–16.8%) of subjects need spectacles to achieve better visual acuity. The prevalence of subjects with uncorrected RE was 5.0% (95%CI = 4.4%–5.7%) among total

Table 1. Demographic, visual and refractive characteristics (categorical parameters) of 4460 participants included in Tehran University of Medical Sciences' Employees Cohort (TEC) Study.

Parameter		Total *number (%)*	Need for spectacles *number (%)*	Uncorrected refractive error *number (%)*	Met need *number (%)*	*p-Value* †
No. of participants		4460	699	222	477	-
Gender (male)		1753 (39.3)	290 (41.5)	83 (37.4)	207 (43.4)	0.13
Age	≤40 years	2006 (45.0)	290 (41.5)	90 (40.5)	200 (41.9)	0.73
	>40 years	2454 (55.0)	409 (58.5)	132 (59.5)	277 (58.1)	
Diabetes		173 (3.9)	35 (5.0)	14 (6.3)	21 (4.4)	0.28
Underlying Cancer		19 (0.4)	2 (0.3)	1 (0.5)	1 (0.2)	0.53
Underlying Rheumatologic Disease		114 (2.6)	17 (2.4)	3 (1.4)	14 (2.9)	0.21
Other internal underlying diseases		703 (15.8)	99 (14.2)	32 (14.4)	67 (14.0)	0.89
Smoking		693 (15.5)	112 (16.0)	29 (13.1)	83 (17.4)	0.15
Education	Elementary	1194 (26.8)	181 (25.9)	72 (32.4)	109 (22.9)	**0.007**
levels	Academic	3262 (73.2)	518 (74.1)	150 (67.6)	368 (77.1)	
Marital status	Single	930 (20.9)	142 (20.3)	51 (23.0)	91 (19.1)	0.23
	Married	3526 (79.1)	557 (79.7)	171 (77.0)	386 (80.9)	
Basic Insurance Coverage		3920 (87.9)	607 (86.8)	191 (86.0)	416 (87.2)	0.67
Supplementary Insurance Coverage		2315 (51.9)	363 (59.8)	111 (58.1)	252 (60.6)	0.57
Occupation (Office worker)		1617 (41.2)	239 (39.4)	71 (37.2)	168 (40.4)	0.45
Socioeconomic status	Poorest	828 (18.6)	129 (18.5)	37 (16.7)	92 (19.3)	0.63
	Poor	946 (21.2)	138 (19.7)	50 (22.5)	88 (18.4)	
	Intermediate	1002 (22.5)	165 (23.6)	54 (24.3)	111 (23.3)	
	Rich	839 (18.8)	137 (19.6)	44 (19.8)	93 (19.5)	
	Richest	845 (18.9)	130 (18.6)	37 (16.7)	93 (19.5)	
COPSOQ	Poor to fair	477 (11.8)	86 (13.6)	35 (17.7)	51 (11.7)	**0.04**
general health	Good to excellent	3571 (88.2)	547 (86.4)	163 (82.3)	384 (88.3)	
Refractive status‡	Emmetropia	2396 (66.0)	18 (2.9)	10 (5.2)	8 (1.9)	**0.01**
	Myopia	985 (27.1)	539 (87.9)	159 (82.4)	380 (90.5)	
	Hyperopia	247 (6.8)	56 (9.1)	24 (12.4)	32 (7.6)	
High astigmatism (≥1.5 D) ‡		266 (7.3)	150 (24.5)	53 (27.5)	97 (23.1)	0.24
Type of astigmatism ‡	With the rule	2487 (68.6)	271 (44.2)	69 (35.8)	202 (48.1)	**0.01**
	Against the rule	313 (8.6)	85 (13.9)	34 (17.6)	51 (12.1)	
	Oblique	828 (22.8)	257 (41.9)	90 (46.6)	167 (39.8)	

†: Chi-square test; ‡: based on the better eye; D: dioptre; COPSOQ: Copenhagen Psychosocial Questionnaire.
Bold values in table mean statistically significant p-values.

Table 2. Demographic, visual and refractive characteristics (continuous parameters) of 4460 participants included in Tehran University of Medical Sciences' Employees Cohort (TEC) Study.

Parameter			Total *Mean ± SD*	Need for spectacles *Mean ± SD*	Uncorrected refractive error *Mean ± SD*	Corrected refractive error *Mean ± SD*	*p-value* †
Smart-phone addiction score			23.46 ± 10.10	23.72 ± 10.82	22.99 ± 10.78	24.05 ± 10.83	0.27
Pack-year smoking			0.84 ± 4.11	0.72 ± 3.63	0.93 ± 5.17	0.63 ± 2.63	0.30
Quality of life		General	14.59 ± 2.75	14.39 ± 2.99	14.19 ± 2.81	14.49 ± 3.07	0.21
		Physical	15.92 ± 2.15	15.90 ± 2.15	15.79 ± 2.21	15.95 ± 2.12	0.35
		Mental	14.96 ± 2.58	14.82 ± 2.71	14.57 ± 2.67	14.93 ± 2.72	0.10
		Social	14.87 ± 2.69	14.91 ± 2.78	14.83 ± 2.62	14.94 ± 2.85	0.64
		Environmental	13.75 ± 2.17	13.68 ± 2.14	13.56 ± 2.25	13.73 ± 2.09	0.32
VA (LogMAR) [b]		UCVA	0.13 ± 0.26	0.72 ± 0.30	0.81 ± 0.26	0.71 ± 0.27	**<0.001**
		CSVA	0.04 ± 0.11	0.06 ± 0.10	0.38 ± 0.06	0.04 ± 0.07	**<0.001**
		PresentingVA	0.05 ± 0.12	0.06 ± 0.10	0.42 ± 0.06	0.04 ± 0.07	**<0.001**
		BCVA	0.01 ± 0.05	0.02 ± 0.07	0.18 ± 0.15	0.02 ± 0.06	**<0.001**
Distance Refraction (D) [b]	Auto-refraction	SE	−0.57 ± 1.27	−1.92 ± 2.07	−1.33 ± 2.10	−2.20 ± 2.00	**<0.001**
	Subjective refraction	Sphere	−0.28 ± 1.21	−1.39 ± 2.06	−0.76 ± 2.02	−1.69 ± 2.01	**<0.001**
		Cylinder	−0.58 ± 0.67	−1.06 ± 0.99	−1.15 ± 0.99	−1.01 ± 0.98	0.09
	Current spectacles Prescribed spectacles SE	SE	−0.44 ± 1.21	−1.84 ± 1.99	−1.25 ± 2.07	−2.11 ± 1.89	0.09
		Sphere	−0.22 ± 1.11	−1.35 ± 1.95	−1.11 ± 0.93	−1.66 ± 1.87	**<0.001**
		Cylinder	−0.44 ± 0.66	−0.70 ± 1.97	−1.28 ± 3.72	−0.91 ± 0.88	**<0.001**
		SE	−1.39 ± 1.99	−0.97 ± 0.90	−0.71 ± 3.54	−1.99 ± 1.91	**0.01**
		Sphere	−1.01 ± 1.95	−1.93 ± 2.11	−1.13 ± 1.12	−1.61 ± 1.90	**0.04**
		Cylinder	−0.74 ± 0.87	−1.54 ± 2.09	−1.63 ± 2.68	−0.76 ± 0.90	**0.009**
		Sphere	−0.94 ± 1.69	−0.79 ± 0.92	−1.06 ± 2.56	−2.06 ± 2.20	**0.01**
		Cylinder	−0.55 ± 1.64	−1.92 ± 2.36	−1.14 ± 1.08	−1.59 ± 2.26	0.30
			−0.77 ± 0.82	−1.42 ± 2.37		−0.94 ± 1.12	0.20
				−1.01 ± 1.11			0.29

†: independent *t*-test; b: based on the better eye; SD: standard deviation; D: dioptre; BCVA: best corrected visual acuity; UCVA: uncorrected visual acuity; VA: visual acuity; CSVA: current spectacles visual acuity; SE: spherical equivalent.
Bold values in table mean statistically significant p-values.

population and 31.8% (95%CI = 28.3%–35.4%) among people who needed spectacles, whose UCVA and BCVA were <6/12 and ≥6/12. This means 10.7% (95%CI = 9.8%–11.6%) of all subjects wore spectacles for distance vision impairment. The spectacles coverage (met need) was 68.2% (95%CI = 64.6%–71.7%). Table 3 illustrates the prevalence of spectacles need, corrected and uncorrected RE in various sub-groups. The corrected and uncorrected groups did not differ in terms of baseline demographic features except for educational level (P = 0.007) and COPSOQ general health (P = 0.04). The proportion of individuals with elementary education and poor-fair status of general health were 1.62 (95%CI = 1.14–2.31) and 1.62 (95%CI = 1.01–2.58) times higher in uncorrected group, respectively (Table 1). Moreover, the scores of QoL in general, mental, physical, social and environmental domains were not different between corrected and uncorrected groups (all Ps > 0.05) (Table 2). Two groups had similar cell-phone addiction scores (P = 0.27) and smoking status (P = 0.3) (Table 2).

The BCVA and presenting VA were worse in patients with uncorrected RE while their UCVA was better than subjects with corrected RE (Table 2). Although myopia was the most common RE in both groups, the percentage was lower in uncorrected compared to corrected group (P = 0.01) (Table 1). The sphere and spherical equivalent of refraction in uncorrected group was less myopic than corrected group (P < 0.001) while uncorrected group had more cylinder (P = 0.01). The percentage of against-the-rule and oblique astigmatism was higher in individuals with uncorrected RE (P = 0.01).

None of the significant variables in univariate analysis remained significant in logistic regression analysis except myopia (Odds ratio = 2.73, 95%CI = 1.02–7.31, P = 0.04) (Table 4).

Discussion

The present study was a cross-sectional study investigating the vision status of the employees of an academic institution by reporting the corrected and uncorrected RE as well as spectacles coverage. The prevalence of need for distance vision spectacles and uncorrected RE in our study was 15.7% and 5.0%, respectively. This means that 10.7% of the total population wore appropriate spectacles to correct distance vision.

Different surveys on populations with different socio-demographic backgrounds have shown differing substantial prevalence rates of uncorrected RE in many countries. The uncorrected RE was reported to be higher: India 11%,[7] the USA 9%,[9] Bangladesh 7%,[10] Pakistan 9%,[11] Nigeria 9%,[18] Taiwan 9%,[19] China 13%,[20] Brazil 6%,[21] and 10% in Australia.[22] In Iran, uncorrected RE has a similar frequency which was reported around 10%.[6,8,23] Inter-study differences may be related to factors such as the target population, study design, inclusion criteria, examiner accuracy, age of the participants, sampling methods, and definitions. Most studies of this topic have used the definition of unmet need (uncorrected RE) used by Bourne et al.[10] According to this definition, an unmet need is present when the presenting vision of the person is worse than 6/12 but becomes more than 6/12 after correction.[10] However, this definition overlooks the role of spectacles in improving vision of people with UCVA better than 6/12. In other words, people with UCVA better than 6/12 but less than 6/6 also have suboptimal vision and can improve their BCVA with spectacles. The prevalence of uncorrected RE in current study, which is almost half of the reported national levels and other global reports (5.0%), is noticeable and could be attributed to factors related to the workplace, leading to a sample with significantly different baseline characteristics, providing better health awareness or care accessibility. Although uncorrected RE was lower in this population, the study findings highlight the need for awareness of the refractive error problem and its correction methods among the university staff. However,

Table 3. The prevalence of need for spectacles, uncorrected and corrected refractive errors by different subgroups in Tehran University of Medical Sciences' Employees Cohort (TEC) Study.

Parameter		Need for spectacles *Prevalence% (95%CI)*	Uncorrected refractive error *Prevalence% (95%CI)*	Corrected refractive error *Prevalence% (95%CI)*
Gender	Male	16.5 (14.8–18.4)	4.7 (3.8–5.8)	11.8 (10.3–13.4)
	Female	15.1 (13.8–16.5)	5.1 (4.3–6.0)	10.0 (8.9–11.2)
Age	≤40 years	14.5 (12.9–16.1)	4.5 (3.6–5.5)	10.0 (8.7–11.4)
	>40 years	16.7 (15.2–18.2)	5.4 (4.5–6.3)	11.3 (10.1–12.6)
Diabetes	Yes	20.2 (14.5–27.0)	8.1 (4.5–13.2)	12.1 (7.7–18.0)
	No	15.5 (14.4–16.6)	4.9 (4.2–5.5)	10.7 (9.8–11.6)
Underlying Cancer	Yes	10.5 (1.3–33.1)	5.3 (0.1–26.0)	5.3 (0.1–26.0)
	No	15.7 (14.6–16.8)	5.0 (4.4–5.7)	10.7 (9.8–11.7)
Underlying Rheumatologic Disease	Yes	14.9 (8.9–22.8)	2.6 (0.5–7.5)	12.3 (6.9–19.7)
	No	15.7 (14.6–16.8)	5.0 (4.4–5.7)	10.7 (9.8–11.6)
Other internal underlying diseases	Yes	14.1 (11.6–16.9)	4.6 (3.1–6.4)	9.5 (7.5–11.9)
	No	16.0 (14.8–17.2)	5.1 (4.4–5.8)	10.9 (9.9–12.0)
Smoking	Yes	16.2 (13.5–19.1)	4.2 (2.8–6.0)	12.0 (9.7–14.6)
	No	15.6 (14.4–16.8)	5.1 (4.4–5.9)	10.5 (9.5–11.5)
Education levels	Elementary	15.2 (13.2–17.3)	6.0 (4.7–7.5)	9.1 (7.6–10.9)
	Academic	15.9 (14.6–17.2)	4.6 (3.9–5.4)	11.3 (10.2–12.4)
Marital status	Single	15.3 (13.0–17.7)	5.5 (4.1–7.1)	9.8 (8.0–11.9)
	Married	15.8 (14.6–17.0)	4.8 (4.2–5.6)	10.9 (9.9–12.0)
Basic Insurance Coverage	Yes	15.5 (14.4–16.7)	4.9 (4.2–5.6)	10.6 (9.7–11.6)
	No	17.0 (14.0–20.5)	5.7 (3.9–8.0)	11.3 (8.8–14.3)
Supplementary Insurance Coverage	Yes	15.7 (14.2–17.2)	4.8 (4.0–5.7)	10.9 (9.6–12.2)
	No	15.2 (13.5–17.1)	5.0 (4.0–6.2)	10.2 (8.8–11.8)
Occupation (Office worker)	Yes	14.8 (13.1–16.6)	4.4 (3.4–5.5)	10.4 (8.9–12.0)
	No	16.0 (14.5–17.5)	5.2 (4.3–6.2)	10.8 (9.5–12.1)
Socioeconomic status	Poorest	15.6 (13.2–18.2)	4.5 (3.2–6.1)	11.1 (9.1–13.5)
	Poor	14.6 (12.4–17.0)	5.3 (3.9–6.9)	9.3 (7.5–11.3)
	Intermediate	16.5 (14.2–18.9)	5.4 (4.1–7.0)	11.1 (9.2–13.2)
	Rich	16.3 (13.9–19.0)	5.2 (3.8–7.0)	11.1 (9.0–13.4)
	Richest	15.4 (13.0–18.0)	4.4 (3.1–6.0)	11.0 (9.0–13.3)
COPSOQ general health	Poor to fair	18.0 (14.7–21.8)	7.3 (5.2–10.1)	10.7 (8.1–13.8)
	Good to excellent	15.3 (14.2–16.5)	4.6 (3.9–5.3)	10.8 (9.8–11.8)
Refractive status	Emmetropia	0.8 (0.4–1.2)	0.4 (0.2–0.8)	0.3 (0.1–0.7)
	Myopia	54.7 (51.6–57.9)	16.1 (13.9–18.6)	38.6 (35.5–41.7)
	Hyperopia	22.7 (17.6–28.4)	9.7 (6.3–14.1)	13.0 (9.0–17.8)
High astigmatism (≥1.5 D)	Yes	56.4 (50.2–62.4)	19.9 (15.3–25.2)	36.5 (30.7–42.6)
	No	13.8 (12.6–15.0)	4.2 (3.5–4.9)	9.6 (8.6–10.7)
Type of astigmatism	With the rule	10.9 (9.7–12.2)	2.8 (2.2–3.5)	8.1 (7.1–9.3)
	Against the rule	27.2 (22.3–32.4)	10.9 (7.6–14.8)	16.3 (12.4–20.9)
	Oblique	31.0 (27.9–34.3)	10.9 (8.8–13.2)	20.2 (17.5–23.1)

CI: confidence interval, D: dioptre.

Table 4. Logistic regressions of uncorrected refractive error in Tehran University of Medical Sciences' Employees Cohort (TEC) Study.

Parameter		Odds Ratio (95% CI)	*p-value*
Education level	Elementary	1	-
	Academic	1.44 (0.93–2.21)	0.10
COPSOQ general health	Poor to fair	1	-
	Good to excellent	1.25 (0.73–2.14)	0.41
Refractive status	Emmetropia	1	-
	Myopia	2.73 (1.02–7.31)	0.04
	Hyperopia	1.57 (0.51–4.88)	0.43
Type of astigmatism	With the rule	1	-
	Against the rule	0.58 (0.33–1.01)	0.05
	Oblique	0.72 (0.48–1.07)	0.10

CI: confidence interval.

comparison of this study with previous population-based studies, especially from other countries, may be unconvincing because comparison is better suited to similar characteristics study sample population. Therefore, not many comparable studies have been published. There is a need for more studies that look at the uncorrected RE and refractive error services in various specific populations.

Correction of the RE through wearing spectacles is one of the most cost-effective interventions in ocular care and plays a major role in quality of life and economic development.[24] However, the uncorrected RE has remained a big challenge worldwide. The spectacles coverage reported in a study from America was 21%,[9] Bangladesh 25%,[10] Pakistan 15%,[11] Nigeria 3%,[18] China 44%,[20] Tanzania 17.6%,[25] Eritrea 22%,[26] and India 28.0–38.0%.[27] The spectacles coverage (met need) in current study was 68.2% (95%CI = 64.6–71.7%), equalling 10.7% (95%CI = 9.8%–11.6%) of total participants. However, different population-based studies should be compared cautiously because of different populations with different characteristics.

Several factors might affect the prevalence of uncorrected RE and use of spectacles, including age, gender, type of RE, location, economic problems, level of education, lack of knowledge, lack of feeling the need, lack of health insurance, lack of access to services, and inadequacy of services.[5,6,9,11,19] In future studies, the way in which changes of these determinants impact the spectacles coverage, should be evaluated.

The costs of services are among the barriers to accessing eye-health services and inability to afford the costs is an important reason for lack of proper spectacles coverage.[28–31] Raznahan et al.[32] measured Horizontal Inequity Index of unmet need in Iran and found that the uncorrected RE were unequally distributed among people with different economic status and concentrated on individuals with lower economic status. Similar reports also indicated that uncorrected RE were more prevalent in people with a lower economic status.[5,10,22,33] Yekta et al.[8] showed that after adjusting for education, age, sex, living place, and type of RE, the higher prevalence of

uncorrected RE in the poor group was due to the direct effect of economic status, and claimed that, if the economic condition of the poor people improved, more than two-thirds of the inequality between the poor and the rich would be removed. High spectacles coverage in current study could be attributed to the fact that all participants were employees and might be able to afford the costs of eye health services. Moreover, we found that the socioeconomic status and occupation type did not affect the uncorrected RE among employees. However, more studies are needed to assess the spectacles coverage of employees considering the service costs of eye care.

Low level of education is another important determinant of the uncorrected RE.[5–8,23] Current study also showed that the uncorrected RE was 1.6 times more common in people with elementary level of education comparing to academic levels. Emamian et al.[5] suggested that half of the gap in the prevalence of the uncorrected RE between high and low economic status was due to the disparity in the level of education. Apart from the economic effect, education level per se, has a marked effect on the people's attention to their refractive status and health-seeking behaviour.[32,33] Indeed, there is a gap between the professionally determined refractive need and the perceived need of the people. This gap might be less in educated individuals due to more awareness and knowledge about the need for eye care, as they have a greater need for good vision to do their jobs. Intensive behavioural changes are required in illiterate people to generate sufficient demand. On the other hand, lower education is an independent risk factor for visual impairments.[34] Low educated people usually do physical jobs that may be associated with more danger to the eye. An association has been reported between occupation and the prevalence of refractive errors.[25] Mashayo et al.[25] found significantly higher prevalence of uncorrected RE in the unemployed and farmers as compared to professionals while teachers and professionals had similar prevalence. In the current study, the prevalence of uncorrected RE of non-office workers (5.2%) was higher than office workers (4.4%) although it was not statistically significant. Raznahan et al.[32] concluded that one of the most important steps to reduce health inequality of uncorrected RE is to regulate policies aimed at increasing literacy in people with low economic status.

Both RE and uncorrected RE were more likely to be observed among the elderly.[6,8,9,11,19,21] Moreover, Kuang et al.[19] believed that the idea that "*nothing can change the situation*" causes lack of utilisation of ophthalmic care by elderly. Older people with lower education levels have an even worse situation.[19] Absence of older people in our study might be a cause of low uncorrected RE and high spectacles coverage comparing to previous studies of Iran.[6,8,23]

In line with previous studies, we determined a higher prevalence of uncorrected RE versus corrected RE in myopic subjects compared to hyperopic people.[6,8,19,23] It seems that near vision is preserved in myopic individuals while their distance vision may be compromised. Therefore, there is less interest in myopia correction, especially in poor people, leading to increased prevalence of myopia in this group.[8]

Our results were in line with previous studies reporting similar prevalence of uncorrected RE between males and females.[6] Gender seems to have no significant and determining effect on uncorrected RE although some studies showed a higher prevalence of RE in men.[6,9,25,27] Conversely, some studies found that women had more severe uncorrected RE, compared to men, in spite of the same need for correcting RE.[32] Raznahan et al.[32] believed that the lower mean of years of education and lower economic status among women, compared to men were the possible reasons of this finding.[32] The effect of cultural norms and social stigma are regarded as other factors, which can be contributed to the gender difference for correcting the RE.[33,35] Although these factors might have a small effect in educated societies, our population was not affected.

Quality of life (QoL) is a multidimensional construct that can be measured with patient-reported outcome measures (PROMs). Generic PROMs cover broad aspects of QoL and health status, and are intended to be used in a wide range of disease conditions although they may not be sensitive enough to capture the QoL issues specific to RE.[36,37] On the other hand, the majority of refractive specific PROMs have items predominantly for activity limitation, vision and symptoms domains only and do not cover other aspects of QoL.[36,37] Therefore, we chose a generic tool (WHOQOL-Bref) to evaluate the QoL. We did not detect statistically significant difference between corrected and uncorrected groups. It is in contrast with previous studies which observed significant improvement of QoL following refractive correction.[36,38–40] However, none of these studies used WHOQOL-Bref.[36] Moreover, these studies assessed children,[38] elderly people[39] or subjects with high RE.[40] Therefore, age (young to middle-aged) and refractive status (low to moderate) of our participants might be the reason for the discrepancy with previous literature.

This study has some limitations. First, we did not report visual acuity and refractive measures of near vision which is also important in employees, especially office workers performing near tasks. Second, absence of random sampling might have made a selection bias which affected the results. Moreover, including only those participants willing to go for examination has downgraded the validity of prevalence data. Third, the number of participants did not reach the predicted sample size due to COVID-19 lockdown which might cause under- or over-rating of the prevalence results. Forth, using a generic PROM (WHOQOL-Bref) instead of condition-specific tool might not be sensitive enough to detect the differences of QoL as one would expect worse status in those with uncorrected RE.

In conclusion, the current study showed that the prevalence of need for spectacles, uncorrected RE and spectacles coverage among adult employees were 15.7%, 5.0% and 10.7%. The employees with myopia had more chance of uncorrected RE while hyperopia did not. Therefore, the employees should be examined to address uncorrected RE especially in subjects with myopia who may have less performance at workplace due to decreased visual acuity.

Disclosure statement

No potential conflict of interest was reported by the authors.

Funding

This study was supported and was carried out by the cooperation of Tehran University of Medical Sciences employee's cohort (TEC) study.

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