Refractive errors in medical students in Singapore

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ABSTRACT

Introduction: Refractive errors are becoming more of a problem in many societies, with prevalence rates of myopia in many Asian urban countries reaching epidemic proportions. This study aims to determine the prevalence rates of various refractive errors in Singapore medical students.

Methods: 157 second year medical students (aged 19-23 years) in Singapore were examined. Refractive error measurements were determined using a stand-alone autorefractor. Additional demographical data was obtained via questionnaires filled in by the students.

Results: The prevalence rate of myopia in Singapore medical students was 89.8 percent (Spherical equivalence (SE) at least -0.50D). Hyperopia was present in 1.3 percent (SE more than +0.50D) of the participants and the overall astigmatism prevalence rate was 82.2 percent (Cylinder at least 0.50D).

Conclusion: Prevalence rates of myopia and astigmatism in second year Singapore medical students are one of the highest in the world.

Keywords: astigmatism, epidemiology, myopia, prevalence rates

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INTRODUCTION

The prevalence rates of myopia in many Asian countries, such as Singapore and Taiwan, have reached epidemic proportions. While refractive errors may be corrected using spectacles and contact lenses, refractive errors present a reasonably large economic burden[1]. An earlier study of myopia in 128 Singapore medical students reported that the prevalence rate of myopia in Singapore medical students was 82%, while that of astigmatism was more than 70%[2]. Another study of 345 medical students in Taiwan showed that more than 90% of Taiwanese medical students were myopic[3]. In contrast, similar studies on medical students in Denmark and Norway yielded relatively- low prevalence rates of 50% and 50.3%, respectively[4,5]. This study was designed to determine the prevalence rates of refractive errors in Singapore medical students.

METHODS

One hundred and ninety-nine second year medical students from the National University of Singapore (NUS), aged 19-23 years, were invited to participate in this study. NUS is the only university in Singapore with a medical school. The medical students were examined over a five day period in September 2000. The participation rate was 89% (157 students; 104 males, 53 females). Twenty two students were excluded from the study. Twenty one were wearing contact lenses and their autorefractometry results had to be excluded. One student suffered from glaucoma and was not eligible for the study.

Written consent was obtained via a consent form that stated the purpose of the study, procedures, risks, benefits, and the assurance of confidentiality of the results. Demographic data such as age, gender and parental history of myopia (asking whether the parents wore corrective lenses for short-sightedness) and housing type were obtained from a self-administered questionnaire. Housing type was considered assessed in four categories: one to three-room government apartments, four to five-room apartments, private apartments, and other types of private housing.

Autorefraction was performed on both eyes for 157 medical students using the Canon RK5 autorefractometer (Canon Inc Ltd, Tokyo, Japan). The average of three readings for each eye was recorded. The readings were taken by an experienced optometrist and trained medical students. Cycloplegia was not used.

Spherical equivalent was calculated as sphere plus half negative cylinder. Myopia was defined as spherical error (SE) of at least -0.50 dioptres (D), SE of at least -0.75D and SE of at least -1.00D. High

Table I: Prevalence rates of myopia and high myopia.

	N	Myopia			High myopia
		SE < -0.50D	SE < -0.75D	SE < -1.00D	SE at least -6.00D
		% (95% CI)	% (95% CI)	% (95% CI)	% (95% CI)
Total	157	89.8 (85.0, 94.5)	86.0 (80.6, 91.4)	85.4 (79.9, 90.9)	28.7 (21.6, 35.8)
Gender					
Male	105	89.5 (83.6, 95.4)	84.8 (77.9, 91.7)	84.8 (77.9, 91.7)	33.3 (24.3, 42.3)
Female	52	90.4 (82.4, 98.4)	88.5 (79.8, 97.2)	86.5 (77.2, 95.8)	19.2 (8.5, 29.9)
Race					
Chinese	141	90.1 (85.2, 95.0)	85.8 (80.0, 91.6)	85.1 (79.2, 91.0)	29.8 (22.3, 37.3)
Non-Chinese	16	87.5 (71.3, 100)	87.5 (71.3, 100)	87.5 (71.3, 100)	18.8 (0, 37.9)
Housing					
Government	68	88.2 (80.5, 95.9)	85.3 (76.9, 93.7)	85.3 (76.9, 93.7)	33.8 (22.6, 45.0)
Private	89	91.0 (85.1, 96.9)	86.5 (79.4, 93.6)	85.4 (78.1, 92.7)	24.7 (15.7, 33.7)

CI: confidence interval; D: dioptres; N: number; SE: spherical equivalence

Table II: Prevalence rates of hyperopia.

	N	Hyperopia		
		SE > +0.50D	SE > +0.75D	SE > +1.00D
		% (95% CI)	% (95% CI)	% (95% CI)
Total	157	1.3 (0, 3.1)	1.3 (0, 3.1)	1.3 (0, 3.1)
Gender				
Male	105	1.0 (0, 2.9)	1.0 (0, 2.9)	1.0 (0, 2.9)
Female	52	1.9 (0, 5.6)	1.9 (0, 5.6)	1.9 (0, 5.6)
Housing				
Government	68	1.5 (0, 4.4)	1.5 (0, 4.4)	1.5 (0, 4.4)
Private	89	1.1 (0, 3.3)	1.1 (0, 3.3)	1.1 (0, 3.3)

CI: confidence interval; D: dioptres; N: number; SE: spherical equivalence

Table III: Prevalence rates of astigmatism.

	N	Astigmatism		
		Cylinder >0.5D	Cylinder >0.75D	Cylinder >1.00D
		% (95% CI)	% (95% CI)	% (95% CI)
Total	157	82.2 (76.2, 88.2)	58.6 (80.1, 91.1)	45.9 (38.1, 53.7)
Gender				
Male	105	85.7 (79.0, 92.4)	63.8 (54.6, 73.0)	50.5 (40.9, 60.1)
Female	52	75.0 (63.2, 86.8)	48.1 (34.5, 61.7)	36.5 (23.4, 49.6)
Race				
Chinese	141	82.3 (76.0, 88.6)	58.2 (50.1, 66.3)	45.4 (37.2, 53.6)
Non-Chinese	16	81.3 (62.2, 1.00)	62.5 (38.8, 86.2)	50.0 (25.5, 74.5)
Housing				
Government	68	80.9 (71.6, 90.2)	60.3 (48.7, 71.9)	48.5 (33.6, 60.4)
Private	89	83.1 (75.3, 90.9)	57.3 (47.0, 67.6)	43.8 (33.5, 54.1)

CI: confidence interval; D: dioptres; N: number; SE: spherical equivalence

myopia was defined as SE of at least -6.00D. Hyperopia was defined as SE of at least +0.50D, SE of at least +0.75D and SE of at least +1.00D. Astigmatism was defined as cylinder of at least 0.50D, cylinder of at least 0.75D and cylinder of at least 1.00D.

Descriptive and univariate analyses were performed using Statistical Package for Social Sciences (SPSS) version 11.0. Analysis was conducted using right eye data, as the results from the right and left eye were similar (Pearson's correlation coefficient 0.84). The prevalence rates and 95% confidence intervals (CI) for each refractive error were calculated. Proportions were compared using the chi-square test.

RESULTS

A total of 157 subjects were examined. The median age was 20 (19-23) years. 105 (66.9%) were males and 52 (33.1%) were females. There were 141 (89.8%) Chinese and 16 (10.2%) non-Chinese students. 85 (54.1%) lived in private housing and 72 (45.9%) lived in Government housing. The prevalence rates and 95% CI of myopia for students with different gender and race were calculated using the different definitions (Table I).

The overall prevalence rates of myopia were 89.8% (95% CI = 85.0, 94.5) (SE OF at least -0.50D), 86.0% (95% CI = 80.6, 91.4) (SE OF at least -0.75D), 85.4% (95% CI = 79.9, 90.9) (SE OF at least -1.00D) and 28.7% (95% CI = 21.6, 35.8) for high myopia (SE OF at least -6.00D). The prevalence rates of myopia in female students were observed to be no different from males. There were no significant differences between the Chinese and non-Chinese students using all 3 definitions of myopia. The prevalence rates of high myopia (SE OF at least -6.00D) appeared higher in males compared with females. However, this difference was found to be only of borderline significance (p=0.07).

The prevalence rates of hyperopia (Table II) were 1.3% (95% CI =0, 3.1) for all definitions. There were no statistically significant differences in the rates of hyperopia (SE more than +0.50D, SE more than +0.75D, SE more than +1.00D) for different gender, race and housing groups. The relationship between hyperopia and race was not examined, as there were no hyperopic non-Chinese students in the study population.

The prevalence rates of astigmatism are shown in Table III. The overall prevalence rates of astigmatism were 82.2% (95% CI = 76.2, 88.2) (cylinder OF at least 0.50D), 58.6% (95% CI = 50.8, 66.3) (cylinder OF at least 0.75D) and 45.9% (95% CI = 38.1, 53.7) (cylinder of at least 1.00D). The prevalence rate of astigmatism (cylinder of at least 0.75D) was slightly higher in males as compared to females. This difference was however, of borderline significance (p=0.06). There were no significant differences in the prevalence rates of astigmatism between for different races and type of housing. Students with at least one myopic parent were found to have an odds ratio (OR) of myopia of 2.26 (95% CI = 0.71, 7.19). This association was, however, not statistically significant (p=0.16).

DISCUSSION

The overall prevalence rate of myopia in medical students in Singapore is 89.8% (SE of at least -0.50D). The prevalence rate of hyperopia (SE more than +0.50D) was found to be 1.3% while that of astigmatism (cylinder of at least 0.50D) was 82.2%. Earlier studies in young Singaporean men (aged 15-25 years) have suggested that the prevalence rates of myopia in Singapore may have increased in the past decade[6,7]. A study of 128 third year medical students in Singapore (using the definition of myopia as SE of at least -0.50D) had reported a rate of 83% while that observed in this study was 89.8%[2]. However, there are limitations in comparing these two studies, as participation rates are different and criteria for entry into medical school may have changed. The results obtained from this study were also similar to the study of medical students in Taiwan in 1996, where 92.8% of medical students were reported to be myopic[3].

The myopia rates in Asia are higher as compared to those in Europe. A Danish study of 147 medical students (median age 26 years) in 2000 reported figures of 50% while the Norwegian study on 140 medical students (median age 24.9 years) in 1992 reported a prevalence rate of 50.3%[4,5]. However, the methodology, non-participation rates and refraction techniques differ and there are limitations in making comparisons. Fledelius used refractive values based mainly on information given by the students while the refractive values obtained in this study were obtained from autorefraction[4].

It has been reported that the severity of myopia is associated with the level of educational attainment[7,8]. A study in Israel also found a strong association of myopia with both intelligence and years of school attendance. The prevalence rate of myopia was found to be significantly higher in the more intelligent and better educated groups[9]. A study conducted among men drafted for military service in Denmark also revealed that factors associated with intelligence and education were seen to be important in triggering the onset of myopia. Myopes in general

achieve higher intelligence test scores and higher educational levels than non-myopes. The overall difference in intelligence test scores corresponded to approximately 7 IQ points[10]. Medical students are a select population with a high level of education as well as above average intelligence. This perhaps might explain the high prevalence rates of myopia among medical students.

The long and intensive study regimen of medical school involves extensive nearwork such as reading and writing[2,11]. It has been suggested that the amount of nearwork could cause myopia as well as its progression in adulthood[12-15]. It is possible that medical school may be a surrogate factor for intensive nearwork activity. It has been hypothesised that an underlying genetic predisposition may alter eye growth[16,17]. However, it is now generally agreed that both heredity and the environment have important roles to play[15,18]. It is possible that differences in myopia prevalence rates in medical students across different countries may be attributable to ethnic variations and different genetic predispositions. However, this study did not demonstrate any statistically significant correlations between myopia and the number of parents with myopia, and myopia rates were not different among races.

An earlier study of 1738 Greek high school students (aged 15-18 years) reported that the prevalence rate of myopia was higher in female students as compared to their male counterparts ($p<0.001$)[19]. This trend was also observed in another study in Finnish school children[20]. In our present study, there was a higher rate of high myopia (SE of at least -6.00D) in males (33.3%) compared to females (19.2%), though this relationship was only found to be of borderline significance. In this study, the overall prevalence rate of hyperopia among medical students was 1.3%. A Norwegian study on 224 engineering students (mean age 20.6 years) had reported a higher figure of hyperopia of 30%[21]. However, the non-participation rate (5%) in the Norwegian study differed from this study and it may be inappropriate to draw comparisons. Cycloplegia was used in that study whereas it was not used here.

The overall prevalence rate of astigmatism in this study was 82.2% (cylinder of at least 0.50D). 85.7% of male medical students and 75.0% of female medical students were found to have astigmatism (cylinder of at least 0.50D). Chow et al reported overall astigmatism rates of 72% in Singapore medical students using the same definition. Another study on astigmatism among 1738 Greek students (aged 15-18 years) reported prevalence rates of 10.2%[22]. The rate of astigmatism was higher in female students compared with males. Our study found that there was a higher prevalence rate of astigmatism in males compared with females but this was only of borderline significance ($p=0.06$). However, there are limitations comparing the two studies as the refraction readings from the Greek study were from questionnaires while this study used autorefraction.

This study benefited from the fact that there was a high participation rate (89%). Although the sample size was relatively small (199), all second year medical students from the only medical school (NUS) in the country were invited to participate in this study. Cycloplegia was not used in our study and this may have lead to falsely- high refractive readings due to excessive accommodation. However, the use of non-cyclopleged autorefraction had been validated in an earlier study in male military conscripts aged 16 to 25 years. Wu et al performed non-cycloplegic autorefraction in their study population, using a randomised stratified sample of 670 subjects (mean age 19.5 years) with SE between +2.0 and -16.0D. Their subjects then received one drop of 1% cyclopentolate (Cyclogyl) with one drop of 1% tropicamide (Mydracil) three times at five minute intervals. Autorefraction was then repeated after 20 minutes. The intraclass correlation coefficient (ICC) was shown to be 0.99, 0.94 and 0.99 for spherical power, cylinder power and spherical equivalent, respectively. Hence, Wu et al established that non-cycloplegic autorefraction was a valid tool for measuring refractive errors[23].

Six medical students performed the refraction readings, and all of them were intensively trained and supervised by the same optometrist, thus reducing variability in the measurements obtained. In conclusion, the prevalence rate of myopia (SE of at least -0.50D) in Singapore medical students is 89.8%, rate of hyperopia is 1.3% (SE of at least +0.50D), and rate of astigmatism is 82.2% (cylinder of at least 0.50D).

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