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ORIGINAL ARTICLE

Prevalence and risk factors of refractive errors among preparatory school students in Beni-Suef, Egypt

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Abstract

Background Studying the epidemiology of refractive errors (REs) among school students is important for developing national strategies that can prevent visual impairment. The purpose of this study was to detect the prevalence and risk factors of RE among preparatory school students in Beni-Suef, Egypt.

Methods In this cross-sectional study, a total of 469 school students aged 12~14 years received visual acuity (VA) assessments using Snellen's chart, and students who failed the test (visual acuity worse than 6/9 in either eye) were subjected to refractive evaluation using an autorefractor.

Results The overall prevalence of RE among the sampled students was 22.8% (71% myope and 29% hyperope). There was a statistically significant association between RE and family factors. Students whose parents both wore glasses were more likely to have RE ($P < 0.001$, OR = 3.24) and students with two or more siblings wearing glasses showed higher rates of RE ($P < 0.001$, OR = 4.5). Students with RE reported more hours/day watching TV ($P < 0.001$, OR = 3.59).

Conclusion The prevalence of RE in preparatory school students in Beni-Suef was detected. Family history and indoor activities are determining risk factors for RE. Nearly half of our school students with RE were newly detected in this study.

Keywords Refractive errors · School students · Risk factors · Prevalence

Background

Refractive errors (REs) affect a large proportion of the population worldwide (Resnikoff et al. 2008). Pascolini and Mariotti (2012) conducted a systematic review using surveys from 39 countries in 2010 and estimated that 285 million were visually impaired, 9 million were blind, and 246 million had low vision.

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Blindness due to RE usually manifests at an early age, and the number of blind-person years due to RE in developing countries is approximately twice as high as cataract-related blindness (Holden et al. 2000).

Uncorrected refractive errors (UREs) are a particularly significant problem in school children (Negrel et al. 2000). On the educational level, children with reduced vision have a higher probability of dropping out of school and underachieving on examinations (Gomes-Neto et al. 1997). Socially, they are more prone to school bullying and other social problems associated with school drop-outs (Fulk and Goss. 2001).

In Egypt, Saad and El-Bayoumy (2007) estimated the prevalence of RE among schoolchildren in Cairo as 22.1%, and the results coming from other Egyptian cities ranged from 11.9% in El-Minya (Hassanien et al. 2001) to 17.5% in Menofiya (El Sayed et al. 1993) and reached 36.8% in Giza (Abou Elel et al. 1992). Worldwide, the prevalence rates vary significantly: 9.4% in Ethiopia (Yared et al. 2012), 6% in Brazil (Salomao et al. 2008), 25.6% in Ghana (Ovenseri-Ogbomo and Omuemu 2010), 37% in Greece (Mavracanas et al. 2000), and 75% in Mexico (Castanon Holguin et al. 2006).

RE was the cause of visual impairment in 83% of children in urban India (Murthy et al. 2002), 70% in rural India (Dandona et al. 2002), 93% in China (Zhao et al. 2000), 55.1% in Nepal (Pokharel et al. 2000), 55% in Chile (Maul et al. 2000), and 63.6% in South Africa (Naidoo et al. 2003). Of those children, 86% in rural India presented without RE correction, 92% in Nepal, 58% in China, 46% in Chile, and 71% in South Africa.

The variation in the prevalence rates could be attributed to many factors. There is no universal agreement on the definition of RE (Luo et al. 2006). Also, environmental conditions, such as indoor and outdoor activities, the socioeconomic standard, and urbanization, can have a profound impact on the prevalence and progression of RE (Ip et al. 2008). Further, genetic, parental, and ethnic factors play pivotal roles in the incidence and progression of RE, especially myopia (Norlaila et al. 2002; Hawthorne and Young. 2013; Carter et al. 2013).

The aim of our study was to detect the prevalence of RE and URE among school children in Beni-Suef, Egypt, in addition to investigating the relation between RE and some socio-demographic, parental, and environmental risk factors.

Subjects and methods

This cross-sectional study was conducted on a cohort of preparatory school students in Beni-Suef during the beginning of the second semester of the year 2014/2015 in the period between February and April 2015. The study locale, Beni-Suef City, is the capital of Beni-Suef governorate and situated 110 km south to Cairo.

Study team

The examination team consisted of an ophthalmologist, two optometrists, and researchers from the Public Health Department, Beni-Suef University, in addition to the nursing school.

Methodology

The sample size was calculated using Epi-Info version 7 Stat Calc, [Centers for Disease Control (CDC), WHO], based on the following criteria: RE rate of 20%, confidence level of 95%, and margin of error of 5%.

Then, the educational administration of Beni-Suef City was stratified geographically and out of each geographic area; two public schools were selected (1 for boys and 1 for girls) by card withdrawal. The distribution of the schools was as follows: three schools for boys and three schools for girls, four schools in urban areas, and two schools in rural areas. To begin the field work, every second student recorded in the class checklist was chosen for screening, and personal details of each subject were recorded in standard format. Then, VA was measured unaided in well-lit classrooms using Snellen's chart. Students who failed the test were subjected to refractive evaluation by an autorefractor (Japanese NIDEK ARK-310 standard autorefractor with vertical alignment and auto acquisition). All examinations were done unaided.

The students were asked to fill in a one-page questionnaire including some personal details and questions to investigate whether the students suffered from any refractive error symptoms or if there were parental or environmental risk factors or systemic disorders relevant to their vision.

School students enrolled for evening classes and those who were absent during screening days were excluded from the study.

Pilot study

We began with 40 randomly selected students from two classes for boys and girls as a pilot study. Then, the questionnaire was revised for simplicity and clearness. Cronbach's alpha for the reliability of the questionnaire was 0.76, while content validity was judged by a professor of public health.

Definitions

Subnormal vision was defined as VA of <6/9 in either eye. High myopia was considered VA ≤ −6 D, high hyperopia VA ≥ 5 D, and high astigmatism ≤ −4 D. Only children with VA < 6/9 in either eye underwent evaluation by the autorefractor.

Statistical analysis

Data were analyzed using the Statistical Package for Social Science software (SPSS Inc.,2009; PASW Statistics for Windows, version 18.0, SPSS Inc., Chicago, IL, USA). Frequency distribution with its percentage and descriptive statistics with mean and standard deviation was calculated. Chi-square and t-test correlations were made whenever needed. $P < 0.05$ was considered significant.

Results

A total of 500 students attending 6 governmental preparatory schools in Beni-Suef were recruited for the study, of which 472 students were examined. This gave a participation rate of 94.4%. Of the 472 students examined, the results of three students were excluded from the analysis because their examination forms were not completed, giving a total of 469, 45% females and 55% males. The mean age of the screened students was 12.8 + 0.67 years.

Of the 469 surveyed students, 14.7% reported having had a previous eye examination and were wearing their glasses; 22.8% were diagnosed with RE of 71% myope and 29% hyperope and 11.3% with URE. All students with RE were found to have a degree of astigmatism. Although statistically insignificant, the prevalence of RE was relatively higher among females ($P = 0.17$) and residents of urban areas ($P = 0.15$).

According to Snellen's chart readings, children with 6/6 VA constituted the biggest portion of those surveyed: 211(45%) for right eyes and 190 (40.5%) for left eyes, followed by 6/9 with 169 (36%) for the right eyes and 193 (41.2%) for left eyes, with no statistically significant differences between right and left eyes ($P > 0.05$) (Table 1). Based on the autorefractor findings for students with RE, only two (0.4%) had high myopia (VA ≤ − 6 D), one (0.2%) high hyperopia (VA ≥ 5 D), and eight (1.7%) high astigmatism (VA ≤ − 4 D) (Table 2). In terms of eyes, only 3% of the right and 2.6% of the left eyes were categorized as high myopic. No high hyperopia was recorded in the right eyes, and only one left eye was highly hyperopic. Furthermore, 6% of the right eyes with astigmatism were found to have high astigmatism compared with 5% of the left eyes (Table 2).

Parental impact was clear in our study since 45.8% of the students with RE had fathers with glasses [$P < 0.001$; OR = 1.82, 95% CI (1.40, 2.40)], and 43% of the students with RE had mothers with glasses [$P < 0.001$, OR = 2.43, 95% CI (1.78, 3.32)]. Students with parents wearing glasses had higher rates of RE compared with students whose parents did not wear glasses at all [$P < 0.001$, OR = 3.24, 95% CI (2.12, 4.95)], and students with one parent with glasses showed higher rates of RE compared with students whose parents did not wear glasses at all [$P < 0.001$, OR = 1.97, 95% CI (1.49, 2.61)] (Table 3).

By comparing the number of siblings wearing glasses with the development of RE, we detected that students with one sibling with glasses were more likely to have RE compared with students whose siblings did not wear glasses [$P < 0.001$, OR = 2.43, 95% CI (1.70, 3.46)] and students with two or more siblings with glasses were more likely to have RE compared with students whose siblings did not wear glasses [$P < 0.001$, OR = 4.32, 95% CI (2.10, 8.92)] (Table 3).

Furthermore, the prevalence of RE among younger siblings was significantly higher than in the older ones ($P < 0.001$). For instance, we found that the third and younger siblings were more prone to having RE compared with their older siblings [$P < 0.001$, OR = 1.72, 95% CI (1.17, 2.52)] (Table 3).

Students who watched TV and played computer games > 2 h/day had significantly higher rates of RE compared with students who carried out the same activities < 2 h/day [$P < 0.001$, OR = 3.59, 95% CI (2.59, 4.97)] (Table 3).

Multivariate regression analysis for the factors that contributed to RE showed that watching TV, parents wearing glasses and order of siblings were potential determinants of RE ($P < 0.05$).

In addition, 40.5% of the students with RE reported hazy borders compared with only 5.4% of students with no RE, [$P < 0.001$, OR = 7.45, 95% CI (5.10, 10.94)] and 48.6% suffered from headaches or eye pain when reading compared with only 2.2% of students with no RE [$P < 0.001$, OR = 22, 95% CI (10.79, 44.83)].

Table 1 Distribution of Snellen's chart readings in right and left eyes of the examined students

VA	OD *n* = 469, (%)	OS n = 469, (%)
6/6	211 (45.0)	190 (40.5)
6/9	169 (36.1)	193 (41.2)
6/12	52 (11.1)	52 (11.1)
6/18	21 (4.5)	16 (3.4)
6/24	11 (2.3)	14 (3.0)
6/36	2 (0.4)	3 (0.6)
6/60	3 (0.6)	1 (0.2)

Table 2 Distribution of refractive errors according to severity among the studied students using an autorefractor

Grades of RE	Frequency by students (%)	Frequency in OD (%)	Frequency in OS (%)
Low to moderate			
Myopia (> − 6 D)	74 (97.4)	64 (97.0)	74 (97.4)
High Myopia (≤ − 6 D)	2 (2.6)	2 (3.0)	2 (2.6)
Total	76	66	76
Low to moderate			
Hyperopia (< 5 D)	30 (96.8)	31 (100.0)	30 (96.8)
High hyperopia (≥ 5 D)	1 (3.2)	0 (0.0)	1 (3.2)
Total	31	31	31
Low to moderate			
Astigmatism (> − 4 D)	97 (90.7)	91 (93.8)	95 (95.0)
High astigmatism (≤ − 4 D)	10 (9.3)	6 (6.2)	5 (5.0)
Total	107	97	100

OD means right eye, *OS* means left eye

Discussion

The prevalence of RE in our study was 22.8%, consistent with many national and international studies (Mavracanas et al. 2000; Castanon Holguin et al. 2006; Saad and El-Bayoumy. 2007; Ovenseri-Ogbomo and Omuemu. 2010; Yared et al. 2012). However, the wide variations in methodologies and definitions of RE in these studies should be considered.

We also noticed that the prevalence of RE was relatively higher among females and residents of urban areas, but these

Table 3 Effect of socio-demographics and family factors on the prevalence of RE

Risk factor		RE ($n = 107$) (%)	No RE ($n = 362$) (%)	P value
Sex	Male	54 (50.1)	204 (56.4)	0.167
	Female	53 (49.9)	158 (43.6)	
Residence	Urban	93 (86.9)	297 (82.0)	0.150
	Rural	14 (13.1)	65 (18.0)	
Watching TV/PC (2 h/day)	More	52 (48.6)	49 (13.5)	< 0.001*
	Less	55 (51.4)	313 (86.5)	
Order among siblings	First	43 (40.2)	99 (27.3)	< 0.001*
	Second	34 (31.9)	204 (56.4)	
	Third	15 (13.9)	46 (12.7)	
	Fourth	10 (9.4)	13 (3.6)	
	Fifth	5 (4.6)	0 (0.0)	
Father wears glasses	Yes	49 (45.4)	91 (25.1)	< 0.001*
	No	58 (54.6)	271 (74.9)	
Mother wears glasses	Yes	46 (43.4)	64 (17.7)	<0.001*
	No	61 (56.6)	298 (82.3)	
No. of siblings wear glasses**	Zero	48 (49.5)	264 (79.5)	< 0.001*
	One	36 (37.1)	55 (16.6)	
	Two	10 (10.3)	12 (3.6)	
	Three	3 (3.1)	1 (0.3)	

*$P < 0.05$ considered significant

**Total RE = 97, total no RE = 332 after exclusion of single children

differences were statistically insignificant. A study by Carter et al. (2013) found no association between RE and either gender or residence. However; many previous studies supported this association (Norlaila et al. 2002; Dandona et al. 2002; Saad and El-Bayoumy. 2007). It has been suggested that different preferences between genders regarding their daily activities might influence the result more than gender itself; specifically, female children might prefer more indoor activities and tasks that require near vision than male children (Norlaila et al. 2002). Also, it was suggested that children in rural areas practice fewer near activities, so they are less prone to developing RE (Norlaila et al. 2002). However, in our study, female and male students and children residing urban and rural suburbs did not show recognizable differences regarding hours of watching TV ($P > 0.05$).

Furthermore, we confirmed the parental effect on the prevalence of RE in many ways such as mothers wearing glasses, fathers wearing glasses, siblings wearing glasses, and the order among siblings ($P < 0.05$). Mutti et al. (2002) investigated the parental role and reached almost the same conclusion. However, the authors did not find that children inherit a myopigenic environment or a susceptibility to the effects of near work from their parents. Unlike Mutti et al. (2002), we detected a significant association between parental RE and hours of near activities spent by their children, which refers to a possibility that parents wearing glasses have children who do more near work ($P < 0.05$).

Interestingly, when examining the effect of having siblings with glasses and the order among siblings on the prevalence of RE, we found that both variables were significantly associated with students' RE. The current study is the first to report that having siblings with glasses and late order among siblings are significant determinants of RE. The high prevalence of RE among younger siblings can be explained by the lifestyle of the younger generations who prefer videogames and sedentary activities, known to be risk factors for RE, rather than outdoor activities (Mutti et al. 2002).

Consistent with a previous study by Mutti et al. (2002), watching TV and playing computer games were found to be determining risk factors for RE, and students who spent > 2 h daily practicing near activities were more likely to have RE compared with other students.

It is also worth pointing out that only 14.7% of the students had been previously screened for RE, and less than half of the students with RE had visited ophthalmologists before.

Furthermore, most children who reported hazy borders or headaches were diagnosed with RE, which turns attention to the fact that many parents and teachers think that the students pretend to have visual problems and ignore or underestimate their children's complaints.

Based on our fieldwork, the currently implemented national screening program for RE, which includes screening of all students in the first grade of primary, preparatory, and secondary schools using charts, has many obvious defects. First, most of the school nurses have no experience with visual screening, indicating a lack of training and absence of institutional supervision. Second, the children stated that they had never been screened for vision impairment at school before. Third, the nurses had no lists

for students referred for refractive assessment in the Health Insurance Organization clinics. Fourth, there are few health facilities in rural schools.

Therefore, we suggest that screening should initially be conducted annually throughout the schooling period to prevent undetected visual impairment among students and to offer them an opportunity to receive early treatment. Further, a national strategy for ocular health should be more concerned with both vision loss prevention programs and the improvement of eye care facilities. Medical and nursing students could play a role in any future programs.

Compliance with ethical standards

The study was conducted in full accordance with the guidelines for Good Clinical Practice and the Declaration of Helsinki. The protocol was approved by the Research Ethics Committee at the Faculty of Medicine, Beni-Suef University. The heads of the selected schools were briefed on the purpose of the study and signed an informed consent form on behalf of the school children. Verbal assent of the students was sought before they were examined.

Conflict of interests The authors declare no conflict of interests.

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