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ORIGINAL ARTICLE

Prevalence of Visual Impairment and Refractive Errors in Children of South Sinai, Egypt

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ABSTRACT

Purpose: To assess the prevalence and causes of visual impairment in children of South Sinai, and to evaluate outcomes of rehabilitation programs.

Methods: Population-based, cross-sectional analysis of 2070 healthy school children screened for visual impairment from 2009 through 2010 in cities of South Sinai and their surrounding Bedouin settlements. Visual acuity (VA) was tested using Snellen charts followed by cycloplegic autorefractometry for cases with presenting VA $\leq$ 6/9. Appropriate eyeglasses were prescribed and VA re-evaluated.

Results: This study included 1047 boys and 1023 girls, mean age 10.7 ± 3.1 years. Visual impairment (uncorrected VA $\leq$ 6/9) was detected in 29.4% of children, while 2.0% had moderate–severe visual impairment (uncorrected VA $\leq$ 6/24). There were statistically significant differences in prevalence of visual impairment between the studied cities ($p < 0.05$), with the highest prevalence in Abu Redis. Prevalence of visual impairment was significantly higher among girls ($p < 0.05$) and those with positive consanguinity ($p < 0.05$). Bedouin children showed significantly lower prevalences of visual impairment. Only age was a reliable predictor of visual impairment (odds ratio 0.94, $p < 0.0001$). Ophthalmic examination revealed other disorders, e.g. dry eye (4.74%), squint (2.37%), exophthalmos (1.58%) and ptosis (0.79%). VA significantly improved in children who received spectacles ($p < 0.001$).

Conclusion: A total of 29.4% of South Sinai children had some form of visual impairment, 90.32% of which comprised refractive errors (mainly astigmatism) which were significantly corrected with eyeglasses. VA screening and correction of refractive errors are of the utmost importance for ensuring better visual outcomes and improved school performance.

Keywords: Children, prevalence, refraction error, school, visual impairment

INTRODUCTION

School children frequently have visual problems that go undetected at the time of school entry. Suboptimal vision often leads to poor school performance with consequent lack of interest and frequent drop-out from school. Underlying visual problem often manifest as behavioral problems, e.g. learning disabilities, dyslexia and attention deficit disorder.[1] Thus, early detection of visual defects provides the best opportunity for effective treatment while failure to detect such problems early can have permanent, deleterious effects on long-term visual outcomes, educational achievement, and self-esteem.[2]

In the World Health Organization (WHO) Vision 2020 global initiative for elimination of avoidable blindness, the worldwide prevalence of refractive errors and various other ocular disorders, e.g. cataract

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and trachoma are highlighted.[3] One of the missions of the WHO is to eliminate avoidable blindness by the year 2020, by bringing government and non-governmental agencies together.[4]

The South Sinai governorate, which occupies the southern portion of the Sinai Peninsula in north-eastern Egypt, is located 375 km from Cairo and is well known for its tourist attractions. The governorate comprises six major cities, all of which are surrounded by sprawling Bedouin settlements. The area is one of environmental, social and ethnic specifications that differ markedly from those in other regions in the Nile valley. South Sinai is a desert region with mountain chains and poor water supply; it is the least populated governorate in Egypt. South Sinai is an exceedingly underserved area with no ophthalmic screening facilities. Consequently, the extent of visual impairment among children in this area is uncertain. This is compounded by poor educational levels and lack of awareness of visual problems among parents.[5]

The present study was designed to assess the causes and prevalence of visual impairment among children of South Sinai and evaluate the outcome of visual rehabilitation programs.

MATERIALS AND METHODS

The study was approved by the National Research Center of Cairo. Data collection conformed to all local laws. The study conformed to the principles of the Declaration of Helsinki.

Study Population

This study was a population-based, cross-sectional descriptive survey using a multi-stage (stratified) sampling technique. All schools within each city and neighboring settlements were first identified, after which several schools were randomly selected for the study, which was carried out from 2009 through 2010. The study population comprised school children from the six cities of the South Sinai governorate and their surrounding Bedouin settlements. The South Sinai Bedouins, a desert-inhabiting population with unique habits and distinctive traditions, originated from ancient tribes that depended on animal breeding and limited farming for their subsistence.

Of the 98,000 persons living in the entire governorate, there were 27,000 children within the selected age group. The representative sample size was calculated using the following formula:

$$\text{Sample size} = \frac{Z^2 \times P(1-P)}{C^2}$$

where; Z takes the standard value 1.96 for a 95% confidence level, P = percentage selecting a choice (expressed as 0.5 sample size needed), C = confidence interval (expressed as 2.1 in this study). The calculated sample size was 2015 children. Data regarding the population of children in each city and surrounding settlements were available in health directories.

The number of children needed from each age group per locality was then calculated followed by a random selection of school children who represented the social, environmental and ethnic variations in South Sinai. The study was conducted in 27 schools (primary, preparatory and secondary), randomly selected from a total of 112 identified schools. One or more classes of different grade levels from each school were randomly selected and students from these classes were screened. The study included 2070 healthy school children representing ≈7.7% of all similar aged children (based on the calculated sample), representing the six South Sinai cities (El-Tur, Abu Redis, Abu Zenima, Saint Katherine, Nuweibaa and Ras Sidre). The purpose of the research and nature of the study were explained to parents. Data were submitted to the Education Department of the governorate and written permission from school authorities obtained.

The study included 2070 children aged 5.5–17.0 years (mean 10.7 ± 3.1 years). There were 1047 boys (50.6%) and 1023 girls (49.4%). Children were classified as Bedouin or urban, based on their ethnicity. There were 1039 students (50.1%) from urban areas and 1031 (49.9%) from Bedouin areas. Students of urban origin were found mainly in schools of the main cities, and settlement schools had higher percentages of students of Bedouin origin. Positive consanguinity was detected in 1102 children (53.2%), while negative consanguinity represented 755 (36.5%); 213 students (10.3%) were of unknown consanguinity.

The work was conducted in three stages:

Stage 1

Children were screened for visual impairment by a team comprising an ophthalmologist, a pediatrician, an ophthalmic technician and a nurse. Personal data regarding age, sex, ethnicity, consanguinity and residence were obtained. Children were given a general physical examination including height and weight measurements. Visual acuity (VA) was measured using a Snellen chart placed 6 m from the student in a well-lit room. Uncorrected VA was recorded in both eyes for all children. Visual impairment was defined as VA < 6/9 in the better-seeing eye. Impairment was classified as mild (VA 6/9–6/18), moderate (VA 6/24–6/60) or severe (VA < 6/60–3/60). However, moderate and severe impairment groups were combined as moderate–severe. VA was then converted to the decimal system to allow calculation of correction effects. Blindness was defined according to WHO guidelines, i.e. vision less than counting fingers at a distance of 3 m in the better eye.

Stage 2

Children with visual impairment in either eye were referred for a detailed slit lamp ophthalmic evaluation. Ocular alignment was evaluated using the Hirschberg, cover-uncover and alternate cover tests after testing ocular motility in the six cardinal directions. Cycloplegic refraction was assessed by autorefractometer. Refraction ≤ -0.5 diopters (D) was considered myopic, while >+1.5D was considered hypermetropic. Astigmatism was defined as cylinder power ≥ 0.75D. Errors were then corrected and appropriate eyeglasses prescribed. Post-correction readings were recorded and compared to pre-correction values.

Stage 3

Prescription eyeglasses were prepared and delivered to children with VA < 6/12 in one or both eyes. Due to funding limitations, children with better VA yet still in need of glasses were advised to get access to school medical insurance clinics and their data sheets were handed to their parents. Children with severe visual impairment who did not improve with correction, as well as children with documented squint, cataract or other detected pathology, were referred to specialized centers for appropriate intervention.

All examinations, medications and glasses were provided free of charge. Parents were educated regarding their children's health and eye care.

Statistical Analysis

Collected data and clinical results were computerized, coded and analyzed using SPSS software version 18.0 (SPSS Inc, Chicago, IL, USA). Quantitative data were expressed as mean values ± standard deviation (SD). Ranges and frequency of distributions were estimated for quantitative variables. The mean of quantitative variables of 2-paired matched comparable groups was compared using the paired samples t-test. The significance of differences between proportions was tested by the χ^2 test. Differences were considered significant at p values ≤ 0.05. Correlations between individual variables were tested using Pearson's correlation coefficient (r). Values of $p \leq 0.05$ were considered statistically significant. Logistic regression analysis was performed to predict the presence or absence of outcomes based on a set of predictor values.

RESULTS

The results of VA assessments are shown in Table 1. Some form of visual impairment was found in 29.4% of the studied sample, while moderate–severe visual impairment was detected in 2.0% of those studied. Prevalence of visual impairment was significantly different between cities ($p < 0.05$). Nuweibaa had the highest recorded prevalence of normal VA (91.0%), while Abu Redis had the highest prevalence of impaired vision (54.4%).

Correlations of uncorrected VA with sex, age, origin and consanguinity are shown in Table 2. We found that prevalence of visual impairment was significantly higher among girls ($p = 0.0001$), younger-aged children ($p = 0.0001$), and children with positive consanguinity ($p = 0.001$). However, visual impairment was statistically less prevalent among Bedouin children compared to urban children ($p = 0.007$).

Logistic regression analysis was performed to assess the associations of visual impairment with age and body mass index. Age was significantly associated with visual impairment. For every year of increasing age, children were 0.94 times more likely to be visually impaired ($p < 0.0001$). There was no correlation between VA of screened children and body mass index (odds ratio 1.01, $p = 0.14$).

Further ophthalmological assessment was performed on 253 children (506 eyes) with visual impairment. Dry eye and strabismus were the most commonly detected ophthalmic disorders in the examined sample, with reported prevalences 4.74% and 2.37%, respectively, as shown in Table 3.

TABLE 1. Prevalence of visual impairment among screened children in 6 cities, South Sinai, Egypt.

	City, *n* (%)						
Visual acuity	El-Tur	Abu Redis	Abu Zenima	Ras Sidre	Saint Katherine	Nuweibaa	Total, *n* (%)
Normal (6/6)	344 (69.2)	158 (45.5)	51 (56.7)	291 (71.1)	252 (77.3)	365 (91.0)	1461 (70.6)
Mild impairment (6/9–6/18)	143 (28.8)	183 (52.7)	36 (40.0)	103 (25.2)	71 (21.8)	32 (8.0)	568 (27.4)
Moderate–severe impairment (6/24–3/60)	10 (2.0)	6 (1.7)	3 (3.3)	15 (3.7)	3 (0.9)	4 (1.0)	41 (2.0)
Total	497 (100.0)	347 (100.0)	90 (100.0)	409 (100.0)	326 (100.0)	401 (100.0)	2,070 (100.0)

TABLE 2. Severity of visual impairment among screened children according to sex, age group, origin and consanguinity, South Sinai, Egypt.

Characteristic	Visual acuity, n (%)				
	Normal ($n=1461$)	Mild impairment ($n=568$)	Moderate–severe impairment ($n=41$)	Total ($n=2070$)	χ^2, p value (df)
Sex					
Male	766 (73.2)	267 (25.5)	14 (1.3)	1,047 (100.0)	9.3, <0.0001[a] (2)
Female	695 (67.9)	301 (29.5)	27 (2.6)	1,023 (100.0)	
Age group, years					
5–9	622 (66.2)	307 (32.7)	10 (1.1)	939 (100.0)	37.0, <0.0001[a] (4)
10–14	659 (76.0)	188 (21.7)	20 (2.3)	867 (100.0)	
15+	180 (68.2)	73 (27.7)	11 (4.1)	264 (100.0)	
Consanguinity					
Yes	522 (69.1)	223 (29.5)	10 (1.3)	755 (100.0)	23.3, <0.0001[a] (4)
No	813 (73.8)	264 (24.0)	25 (2.2)	1,102 (100.0)	
Unknown	126 (59.2)	81 (38.0)	6 (2.8)	213 (100.0)	
Ethnic origin					
Bedouin	745 (72.3)	275 (26.7)	11 (1.0)	1,031 (100.0)	9.9, 0.007[a] (2)
Urban	716 (68.9)	293 (28.2)	30 (2.9)	1,039 (100.0)	

[a]$\chi^2=216$, $p<0.0001$, df $=10$.

TABLE 3. Distribution of ophthalmic disorders and refractive error among visually impaired children, South Sinai, Egypt.

Type of ophthalmic disorder	Affected, n (%)
Refractive examination (506 eyes)	
Myopia	64 (12.65)
Hypermetropia	75 (14.82)
Astigmatism	318 (62.85)
Anisometropia[a]	49 (9.68)
Ophthalmic disorders (253 children)	
Dry eye	12 (4.74)
Strabismus	6 (2.37)
Exophthalmos	4 (1.58)
Ptosis	2 (0.79)
Cataract	1 (0.40)
Retinal detachment	1 (0.40)
Amblyopia[b]	1 (0.40)

[a]Anisometropia defined as difference in spherical equivalent refraction between both eyes ≥1 diopter; [b]Amblyopia defined as decreased vision in a structurally normal eye with difference between best-corrected visual acuity ≥2 lines.

Refractive error represented 90.32% of the causes of visual impairment, with a prevalence of 11.04% among the studied population. Spherical errors were low. Astigmatism was the most frequently detected error (62.85%).

At the time of screening, 34 children (68 eyes) were already wearing eyeglasses. Correction of refractive error was performed on an additional 218 children (436 eyes) yielding a highly significant improvement in VA ($p<0.0001$; both eyes) compared with pre-correction values. Two eyes of two patients were not amenable to correction; one had cataract and the other had retinal detachment. Both patients were referred to a specialized facility for surgical intervention. VA outcomes after eyeglass prescription are summarized in Table 4.

DISCUSSION

Monitoring the extent of visual impairment is essential for the implementation of policies that aim to prevent and eliminate avoidable causes of visual impairment. The estimated number of visually impaired people in the world is 285 million, including 39 million blind and 246 million with low vision.[6] Children with undetected vision problems join school and often perform poorly, leading to leaving school and abandoning education, with social and economic consequences.

Presenting vision was defined as VA in the better eye, using currently available refractive correction, if any. According to WHO guidelines,[7] this is to be used for all population-based studies. Visual impairment was detected in 609 children (29.4%) in the current study. Mild impairment was found in 568 children (27.4%) while moderate–severe impairment was found in 41 (2.0%). This prevalence of visual impairment is relatively high when compared to regional studies that reported a prevalence of 9.4% (Gondor town in Ethiopia),[8] and only 5% (a study on 400 preschool Malaysian children), although VA < 6/9 was defined as subnormal/impaired vision.[9]

However, other studies showed higher prevalences of visual impairment. Harvey and colleagues reported impaired vision in 35% of 1327 Native American children. In their study, impaired vision was defined as VA ≤ 20/40.[10]

These differences could be due to different cutoff points for defining visual impairment, age groups, racial factors and sample sizes. Available data suggest that there is a 10-fold difference in prevalence between the wealthiest and poorest countries in the world, ranging from as low as 0.1/1000 children aged

TABLE 4. Visual outcomes in children after prescription of eyeglasses, South Sinai, Egypt.

		Post-correction visual impairment[a], *n* (%)		
Pre-correction visual impairment[a]	Without glasses, *n* (%)	Normal	Mild	Moderate–severe
Mild (568)	372 (65.49)	193 (33.98)	3 (0.53)	0
Moderate–severe (41)	7 (17.07)	30 (73.17)	2 (4.88)	2 (4.88)

[a]Mild defined as visual acuity 6/9–6/18, moderate–severe as visual acuity 6/24–3/60.

0–15 years in the wealthiest countries to 1.1/1000 children in the poorest.[11]

Visual impairment was significantly more prevalent among young (5–9 years) children ($p<0.0001$) and girls (32.1%). Yared and colleagues had similar results, although they attributed the finding to a larger proportion of girls in their sample.[8]

The different locations in this study varied significantly in prevalence of visual impairment ($p<0.0001$): Prevalence of visual impairment was 9.0% in Nuweibaa compared with 54.4% in Abu Redis. Vojniković and co-authors reported different rates of visual impairment (40%, 17% and 9%) from refractive error in the three different locations of their study in Croatia.[12]

The consanguinity rate in South Sinai was 37.5%.[13] Children confirmed to be positively consanguineous had a higher prevalence of impaired vision compared with non-consanguineous children ($p<0.0001$). The highest rate of consanguinity (52.3%) was recorded for Abu Redis and the lowest rate (24.1%) for Nuweibaa;[13] this variation may explain the distribution of visual impairment.

Bedouin children had lower rates of visual impairment than urban children ($p=0.007$). Lu and co-workers found that low vision among preschool children due to correctable refractive error was more prevalent in urban areas than in rural areas.[14] Although urban areas have better access to medical services, refractive error is more prevalent. This is perhaps attributable to a cause-effect relationship, e.g. increased access to education (cause) and myopia (effect), among other factors, e.g. ethnicity (cause) and visual impairment (effect).[15]

The prevalence of refractive error in the entire sample was 11.06%. A figure that is similar to the 11.6% reported in a study of 623 children from Kampala.[16] Chen and colleagues showed a higher prevalence rate (18.5%), however, the children in their study were 6–7 years, an age normally known for a high incidence of refractive error.[17] In contrast, Yared and co-authors reported a prevalence rate of 9% in Ethiopian children,[8] while Preslan and Novak reported a prevalence rate of 8.2% among American children.[18]

Refractive error represents one of the main causes of visual impairment with a prevalence rate ranging from 43–95%.[6,9,14,19] In the current study, refractive error was the cause of 90.32% of impaired vision. The prevalence of refractive error differs according to sample, cut-off point and age group (within which a myopic shift occurs with age).[19]

Astigmatism ($\geq$0.75D) was the most prevalent refractive error (62.85%), followed by hypermetropia (14.82%) and myopia (12.65%). In a summary of several studies, the overall prevalence of refractive error in children was 9.2% for myopia, 12.8% for hypermetropia, and 28.4% for astigmatism.[11] Some studies reported the prevalence of astigmatism to be 34%[15] while others reported it to be 52%.[16]

Kalikivayi and colleagues found hypermetropia ($\geq$+0.50D) to be the most common error (23%) among Indian children,[20] while Kawuma and Mayeku found that Japanese children had a high rate of myopia (58%).[16] Wen and co-workers found that hypermetropia (defined as spherical equivalent $\geq$+2.00D) was more prevalent in non-Hispanic white preschool children (25.65%) compared to Asian children (13.47%).[21] Carter and colleagues found Paraguayan children were remarkably hyperopic and relatively free of myopia.[22] Yared and co-workers found that myopia (≤-0.50D) was the most prevalent refractive error (31.6%) among Ethiopian children.[8] Such variations confirm that there are differences in vision and refractive error according to ethnicity, sex, age, geographical region and population patterns.

According to Freidman and co-authors, the most common eye problems of children of preschool- and early school-age are amblyopia, strabismus and refractive error.[23] Strabismus was found in 2.37% of children in our study compared to 2.5% in a Turkish study,[24] and 1.2% in an Iranian study.[25] Children already known to have strabismus as well as those presenting with manifest squint during our examination were recorded. None of the children were occluded in search for intermittent exotropia, hence, we believe the reported rate of strabismus in the current study was underestimated.

Cataract, retinal detachment and amblyopia had low rates among examined children in our study (0.4%; one case of each). Other studies have reported the prevalence of amblyopia to be between 1.7% and 3.95%.[14,19,25]

Dry eye was detected in 4.74% of children in our study, who all presented with signs of vitamin A deficiency. Diagnosis was confirmed by slit lamp examination as well as history of artificial tears use. The prevalence of dry eye is perhaps underestimated in the current study, as it was only evaluated in those who underwent slit lamp examination; some children did not undergo slit lamp evaluation as they were absent on examination day. Other detected problems included exophthalmos (1.58%) and ptosis (0.79%). The high rate of exophthalmos noted in this study could be due to the high incidence of goiter secondary to iodine deficiency reported in South Sinai.[26]

Significant improvement in visual impairment prevalence ($p < 0.0001$) occurred when eyeglasses were prescribed, prepared and delivered to any child having one or both eyes with VA < 6/12. WHO guidelines state that most individuals with presenting VA < 6/18 and $\geq$3/60 require spectacles, surgery (e.g. cataract surgery) and/or other sight restoring treatment.[7]

Inability to examine all children with visual impairment by slit lamp due to absence on the scheduled day is one study limitation. This could affect the reported prevalence of different detected problems. Providing glasses for all children who needed them was not feasible due to limited resources, which is also considered a limitation.

In conclusion, 29.4% of South Sinai children had visual impairment due to refractive error, especially astigmatism. Correction of these errors proved to be very effective. The different ethnic groups studied have distinct genetic backgrounds, differing nutritional habits and dissimilar social living behaviors, all of which impact on vision.

Assessment of visual impairment and refractive error in children is very important particularly for those living in remote areas. Visual problems in young children are often undetected, thus rendering correction of errors and other causes of visual impairment indispensable in their positive impact on education and quality of life.

Increasing community awareness and provision of health services are of the utmost importance. However, the unavailability of testing services, and the inability to make use of such services due to socioeconomic factors and cultural deterrents still present obstacles and are a cause of lack of compliance.

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DECLARATION OF INTEREST

The authors report no conflicts of interest. The authors alone are responsible for the content and writing of the paper.

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REFERENCES

1. Hong CL, Press LJ. Visual factors in childhood behavioral disorders. *California Optometry* 2009;13:46–54.
2. American Academy of Pediatrics. Eye examination in infants, children, and young adults by pediatricians. *Pediatrics* 1996;13:153.
3. Human Development Report 2000. New York: Oxford University Press; 2000. United Nations Development Programme.
4. Global Initiative for the Elimination of Avoidable Blindness. Geneva: WHO program for the prevention of blindness; 1997. December, World Health Organization, Geneva. WHO/PBL/9761.
5. South Sinai Environmental and Developmental Profile. Ministry of State for Environmental Affairs and South Sinai Governorate, 2003.
6. Stevens GA, White RA, Flaxman SR, et al; Vision Loss Expert Group. Global prevalence of vision impairment and blindness: magnitude and temporal trends, 1990–2010. *Ophthalmology* 2013;120:2377–2384.
7. Gilbert CE, Ellwein LB; Refractive Error Study in Children Study Group. Prevalence and causes of functional low vision in school-age children: results from standardized population surveys in Asia, Africa, and Latin America. *Invest Ophthalmol Vis Sci* 2008;49:877–881.
8. Yared AW, Belaynew WT, Destaye S, et al. Prevalence of refractive errors among school children in Gondar town, northwest Ethiopia. *Middle East Afr J Ophthalmol* 2012;19: 372–376.
9. Premsenthil M, Manju R, Thanaraj A, et al. The screening of visual impairment among preschool children in an urban population in Malaysia; the Kuching pediatric eye study: a cross sectional study. *BMC Ophthalmol* 2013;19: 13–16. doi:10.1186/1471-2415-13-16.
10. Harvey EM, Dobson V, Miller JM. Prevalence of high astigmatism, eyeglass wear, and poor visual acuity among Native American grade school children. *Optom Vis Sci* 2006;83:206–212.
11. Gilbert CE, Anderton L, Dandona L, et al. Prevalence of visual impairment in children: a review of available data. *Ophthalmic Epidemiol* 1999;6:73–82.
12. Vojniković B, Mićović V, Stefanac-Nadarević V, et al. Refractive errors in children of Primorsko-Goranska County – epidemiological study. *Coll Antropol* 2013; 37(Suppl. 1):37–39.
13. Yamamah G, Abdel-Raouf E, Talaat A, et al. Prevalence of consanguineous marriage in South Sinai, Egypt. *J Biosoc Sci* 2013;45:31–39.
14. Lu Q, Zheng Y, Sun B, et al. A population-based study of visual impairment among pre-school children in Beijing: the Beijing study of visual impairment in children. *Am J Ophthalmol* 2009;147:1075–1081.
15. Resnikoff S, Pascolini D, Mariotti SP, et al. Global magnitude of visual impairment caused by uncorrected refractive errors in 2004. *Bull World Health Organ* 2008;86: 63–70.
16. Kawuma M, Mayeku R. A survey of the prevalence of refractive errors among children in lower primary schools in Kampala district. *Afr Health Sci* 2002;2:69–72.
17. Chen PC, Chang RJ, Lee DA, et al. Prevalence of ocular disorders among 6 and 7 year olds in Santa Monica, California. *J Am Optom Assoc* 1996;67:358–365.
18. Preslan MW, Novak A. The Baltimore Vision Screening Project. *Ophthalmology* 1996;103:105–109.
19. Polling JR, Loudon SE, Klaver CC. Prevalence of amblyopia and refractive errors in an unscreened population of children. *Optom Vis Sci* 2012;89:e44–49.

20. Kalikivayi V, Naduvilath TJ, Bansal AK, et al. Visual impairment in school children in southern india. *Indian J Ophthalmol* 1997;45:129–134.
21. Wen G, Tarczy-Hornoch K, McKean-Cowdin R, et al; Multi-Ethnic Pediatric Eye Disease Study Group. Prevalence of myopia, hyperopia, and astigmatism in non-Hispanic, White and Asian children: Multi-Ethnic Pediatric Eye Disease Study. *Ophthalmology* 2013;120:2109–2116.
22. Carter MJ, Lansingh VC, Schacht G, et al. Visual acuity and refraction by age for children of three different ethnic groups in Paraguay. *Arq Bras Oftalmol* 2013;76:94–97.
23. Friedman DS, Repka MX, Katz J, et al. Prevalence of decreased visual acuity among preschool-aged children in an American urban population: the Baltimore pediatric eye disease study, methods, and results. *Ophthalmology* 2008;13:1786–1795.
24. Gursoy H, Basmak H, Yaz Y, et al. Vision screening in children entering school: Eskisehir, Turkey. *Ophthalmic Epidemiol* 2013;20:232–238.
25. Jamali P, Fotouhi A, Hashemi H, et al. Refractive errors and amblyopia in children entering school: Shahrood, Iran. *Optom Vis Sci* 2009;86:364–369.
26. Yamamah G, Kamel A, Abd-El Dayem S, et al. Thyroid volumes and iodine status in Egyptian South Sinai schoolchildren. *Arch Med Sci* 2013;9:548–554.