Original Article

A clinic-based study of refractive errors, strabismus, and amblyopia in pediatric age-group

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ABSTRACT

Purpose: The purpose of this cross-sectional observational study was to determine the distribution and patterns of refractive errors, strabismus, and amblyopia in children seen at a pediatric eye care. **Materials and Methods:** The study was conducted in a Private Hospital in Dammam, Kingdom of Saudi Arabia, from March to July 2013. During this period, a total of 1350 children, aged 1–15 years were seen at this Center's Pediatric Ophthalmology Unit. All the children underwent complete ophthalmic examination with cycloplegic refraction. **Results:** Refractive errors accounted for 44.4% of the cases, the predominant refractive error being hypermetropia which represented 83%. Strabismus and amblyopia were present in 38% and 9.1% of children, respectively. **Conclusions:** In this clinic-based study, the focus was on the frequency of refractive errors, strabismus, and amblyopia which were considerably high. Hypermetropia was the predominant refractive error in contrast to other studies in which myopia was more common. This could be attributed to the criteria for sample selection since it was clinic-based rather than a population-based study. However, it is important to promote public education on the significance of early detection of refractive errors, and have periodic screening in schools.

Key words: Amblyopia, children, refractive errors, strabismus

INTRODUCTION

A large number of people living in different parts of the world suffer from visual impairment. An estimated 285 million people around the world are visually impaired. Of this number, 19 million are children below the age of 14 years. About 43% of this population is visually impaired as a result of refractive errors, which is the principal cause of visual impairment in children.[1]

Refractive error is a condition of the eye in which the eye fails to focus the image on the retina resulting in blurred vision.[2] Sharp vision is obtained by prescribing appropriate spectacles to focus the image on the retina. This treatment is one of the simplest and effective forms of eye care.

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Visual impairment from uncorrected refractive errors can have immediate and long-term consequences in children such as poor performance at school and lost employment opportunities. This can further result in the impaired quality of life and low economic gain for individuals, families, and societies.

A total of 153 million people in the world are visually impaired owing to uncorrected refractive errors. Of this number, 12.8 million are children from 5 to 15 years, making a global prevalence of 0.96% of this condition.[3]

The literature indicates that refractive errors have been reported as the leading cause of visual impairment in

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school children in the Kingdom of Saudi Arabia (KSA).[4,5] A recent study in KSA has shown that overall prevalence of refractive errors in primary school children was 13.7% in the Al Hassa region.[6] Other studies in KSA have reported the prevalence of refractive errors in school children as 10.7–23%.[7,8]

A number of factors are responsible for uncorrected refractive errors. They are the lack of awareness of the problem, inability to recognize the problem at personal and family level, nonavailability and/or nonaffordability of the pediatric eye care services, and the cultural disincentives to compliance.[3]

Uncorrected refractive error can result in amblyopia and or strabismus. The risk of developing amblyopia increases as a hypermetropic refractive error, and the levels of anisometropia increases. Unfortunately, there is no set level of refractive error above which amblyopia is certain, or below which the development of amblyopia is impossible. What complicates the situation is that the level of refractive error (hypermetropia, anisometropia, astigmatism) that is thought to be of concern is controversial and varies from study to study.

The purpose of this study was to estimate the frequency and pattern of refractive errors, and analyze associations between refractive error and different types of strabismus in children seen at a private medical complex providing secondary level eye care. This was to highlight the magnitude of pediatric refractive related eye problems and help gather information necessary for the planning of eye care services in our region.

MATERIALS AND METHODS

This clinic based cross-sectional study was conducted at a private ophthalmic clinic that provides secondary level eye care. The center is located in the city of Dammam and receives patients from Dammam City and its environs. The study was carried out from March to July 2013. During this period, all children under the age of 15 years who visited the clinic were included in the study. Informed consent was taken from the children's parents or guardians. All patients underwent a complete ophthalmic examination including a detailed history of ophthalmic problems, refraction, uncorrected visual acuity (VA), and best corrected visual acuity (BCVA) using logMAR ETDRS chart. Keeping in view that accommodation may affect the result, cycloplegic refractions were conducted using 1% cyclopentolate. During the ophthalmic examination of these children, the presence or absence of amblyopia and strabismus was also recorded. All the details were entered in a computerized proforma. Normal VA for the purpose of this study was defined as an uncorrected VA equal to or better than 0.3 logMAR in the better eye. Amblyopia was defined as initial BCVA of 0.20 logMAR or worse, and at least two line logMAR differences between the amblyopic and fellow eye, without ocular pathology in either eye. Diagnosis of strabismus was defined as an intermittent or constant horizontal deviation of 10 or more prism diopters (DS), a vertical deviation of 3 or more prism DS, or other eye movement disorders.

The children were grouped as follows: Myopia with a refractive error of more than −0.50 DS and hypermetropia with a refractive error of more than +0.50 DS. Hypermetropia and myopia were further subdivided into three subgroups based on the spherocylinder power of the refraction, namely: Mild if ≤3.00 DS, moderate from 3.00 to 6.00 DS, and high if >6.00 DS. Refractive error was classified as simple hypermetropia or simple myopia if not associated with astigmatism. Compound astigmatism was divided into two groups: Compound myopic astigmatism or compound hyperopic astigmatism and each was classified as follows: Mild if compound astigmatism was between 0.50 and 1.00 DS, moderate if compound astigmatism was between 1.25 and 2.50 DS, high if compound astigmatism was more than 2.50 DS.

RESULTS

From March 2013 to July 2013, a total of 1350 children presented at the center. The mean age of the children was 7.6 years (±3.64 years) with an age range of 1–15 years. Of the 1350 children, a total of 600 (44.4%) were found to have refractive errors of which 51% were males.

Of the total 600 patients with refractive errors, 83% (498) were hypermetropes, 13.3% (80) were myopes, and 3.6% (22) had astigmatism. Hypermetropia was present in 30.5% (183), 33% (198), and 19.5% (117); and myopia in 4.6% (28), 5.6% (34), and 3% (18) corresponding to mild, moderate, and high subgroups, respectively. Table 1 shows the distribution of refractive error subtypes.

Strabismus was seen in 38% (228) of the children. Figure 1 shows the distribution of strabismus in the myopic group with 77.5% (62) children who had no strabismus. Two (2.5%) children had esotropia and 16 (20%) had exotropia. Exotropia was the predominant type of strabismus in children with myopia, with no obvious relation between the extent of compound myopic astigmatism and the frequency of strabismus. Regarding the presence of strabismus in hypermetropes, about 59% (293) of the children with hypermetropia had no strabismus. About 32% (193) children had esotropia and 2.4% (12) had exotropia. Esotropia was substantially more frequent in children with

mild-moderate compound hyperopic astigmatism than in children with myopia (P = 0.0001). Figure 2 shows the distribution of strabismus in hypermetropic subtypes. There was no obvious relation between the extent of compound hyperopic astigmatism and the frequency of strabismus. The refractive errors were equally distributed between esotropic and nonstrabismus children.

In the mixed astigmatism group, 17 (77%) of the children had no strabismus, whereas 1 (4.5%) had esotropia and 4 (18%) had exotropia.

A total of 57 (9.5%) children had amblyopia. None of the children with myopia had amblyopia. However, 27 (47%) amblyopes were hypermetropic with no strabismus, 26 (45%) amblyopes were hypermetropic with esotropia, and 1 (1.7%) was hypermetropic with exotropia. In the group of children with astigmatism, one child without strabismus had amblyopia and two children with exotropia had amblyopia. Figure 3 shows the distribution of refractive errors among amblyopic children in relation to the presence and type of associated strabismus. There was no statistically significant difference in the distribution of amblyopia among the children who had esotropia and children without strabismus. The majority of amblyopic children had mild to moderate compound hypermetropic astigmatism, while 19.2% had high astigmatism. Furthermore, 18 (32%) children had amblyopia in both eyes, 13 (23%) had it in the right eye and 26 (46%) had amblyopia in the left eye.

Table 1: Distribution of RE subtypes

	Number of patients (%)	Sub-groups of RE (DS)	Number of patients (%)
Hypermetropia	498 (83)	<3.00	183 (30.5)
		3.00-6.00	198 (33)
		>6.00	117 (19.5)
Myopia	80 (13.3)	<3.00	28 (4.6)
		3.00-6.00	34 (5.6)
		>6.00	18 (3)
Mixed astigmatism	22 (3.6)		
Total	600		

DS: Diopters; RE: Refractive errors

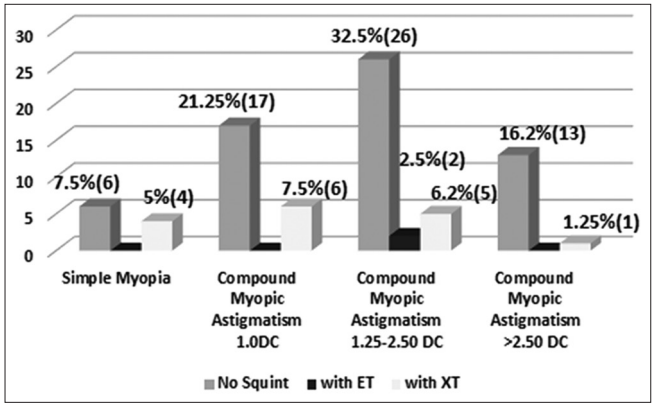

Figure 1: Distribution of strabismus types among myopic children in relation to subtypes of refractive error

DISCUSSION

Refractive errors are common visual problems of childhood. Uncorrected refractive errors cause immediate and long-term problems such as poor educational performance, missed employment opportunities, and impaired quality of life.[3] Vision 2020 (Global initiative of World Health Organization for the prevention of avoidable blindness) has identified uncorrected refractive errors in children as a major area which needs immediate action.[9] Early screening of school-age children is an important measure to discover the magnitude of refractive error and take immediate corrective action.[6]

The purpose of our study was to assess the distribution and patterns of refractive errors in children for the proper planning of pediatric eye services at the center. In this study, the refractive errors were almost equally distributed amongst the male and female children. This is in contrast to previous studies in Al Hassa and Riyadh, KSA, where the errors were more prevalent in females than males.[6,8]

In this study, refractive error was found in 44.4% of the children. This frequency is higher than other studies conducted in KSA.[6-9] Since this was a clinic-based study rather than population-based one, any comparison with earlier studies of the prevalence of refractive errors would be inaccurate. The reported prevalence of refractive error in different parts of the world showed a variation from 3.8% to 19.8% as shown in Table 2.

However, the distribution of subtypes of refractive error among children shows that hypermetropia was more common than myopia. This is in contrast to other studies

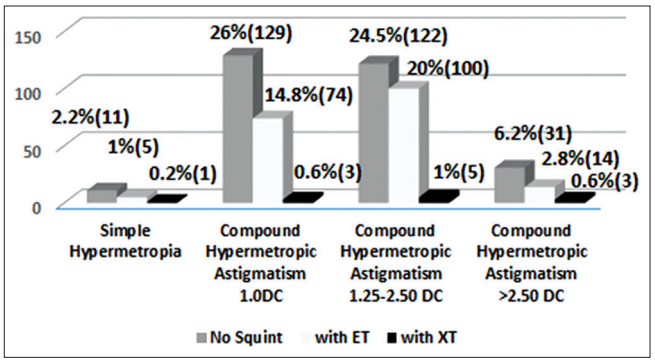

Figure 2: Distribution of strabismus types among hypermetropic children in relation to subtypes of refractive error

in which myopia was the predominant type of refractive error.[6,10-16] The predominance of hypermetropia in this study could be attributed to the sample selection criteria, and to the high number of patients with esotropia and amblyopia, who were seeking medical care since simple myopic cases are usually dealt with by optometrists.

In our study, the prevalence of astigmatism was 3.6%, which was much lower than a study done in Jordan which had a prevalence of 20.4%.[14] The reason for this may be that only mixed astigmatism was included in our study. Other types were either grouped as myopia or hypermetropia based on their spherical equivalent.

The study also took into account ocular deviation associated with refractive errors. The prevalence of strabismus in our study was 38% (228). This is higher than what has been reported in most previous studies.[17] The reason for this high prevalence could be the nature of the study, being clinic-based rather than population based. Around 22.5% of the children with myopia had some sort of ocular deviation, and around 90% (16 out of 18) had exotropia.[18]

However, around 41% (205) of the children with hypermetropia had strabismus and 94% (193) of this number had esotropia. The explanation for this increased association of esotropia with hypermetropia more than myopia can be physiological phenomena: That is, the accommodation the hyperopic child has to make to focus an image on the retina stimulates convergence. Esotropia develops when fusional divergence is insufficient to compensate for this. Esotropia tends to occur more frequently in children with hypermetropia than emmetropia.[19] Each diopter of increasing hypermetropia markedly raises the risk of esotropia.[20] Esotropia can be seen in 24% of cases of hypermetropia ≥+5.00 D, which would make the odds of having esotropia 122 times greater than in children with 0 to <+1.00 D of hypermetropia.[20]

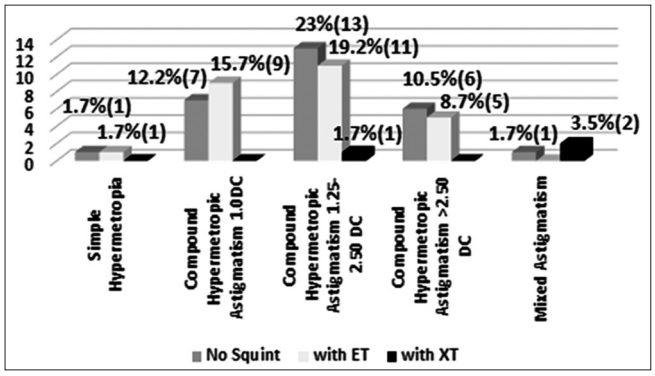

Figure 3: Distribution of refractive error among amblyopic children in relation to presence and type of associated strabismus

The prevalence of amblyopia in this clinic-based study was 9.5% while its prevalence in population-based studies is estimated around 1.6–3.6%.[18] In the current study, 68.5% of amblyopic children were unilateral and 31.5% bilateral. This is in line with the reported ratio in which the unilateral amblyopia is twice as common as binocular amblyopia.[18] The majority of amblyopic children had mild to moderate compound hypermetropic astigmatism, with no statistical significant difference in the frequency of amblyopia in esotropia and nonsquinting subgroups. These findings are consistent with findings from other studies that described a strong association of moderate hyperopic refraction with strabismus[21] and amblyopia.[17,22,23] In fact, the relationship between strabismus, hypermetropia, and amblyopia is complex. A significant bilateral hypermetropia or ocular misalignment presenting during the critical period of visual development (from birth to the age of seven) will lead to development of amblyopia.[24]

The findings of present study validates the implementation of fundamental guidelines including recommendation that the parents of children with refractive errors, strabismus and amblyopia should have all of their children screened; promoting parent education and the distribution of brochures on amblyopia and strabismus at our medical center. Periodic awareness campaigns on pediatric visual problems and the importance of early detection and management including screening examination when feasible, should be carried out at different places, including schools, shopping malls, and in the social media.

Table 2: Distribution of RE subtypes among school-age children in different studies

Country	Year	Age group	Sample size	Prevalence of RE (%)	Myopia (%)	Hypermetropia (%)
Abu-Shagra *et al*.[4]	1991	6-19	1188	10	50	15
Ali *et al*.[10]	2007	10-16	540	19.8	43	21.5
Hashim *et al*.[11]	2008		840	7.0	77.5	14.3
AL-Nuaimi *et al*.[12]	2010	6-13	670	19.7	73	17
Al Rowaily and Alanizi[8]	2010	12-13	1536	9.8	57.6	15.2
Al Wadaani *et al*.[6]	2013	6-14	2002	13.7	65.7	12.4
Current study	2013	5-15	1350	44.4	13.3	83

RE: Refractive errors

CONCLUSIONS

In this clinic-based study, the frequency of refractive errors, strabismus and amblyopia have been highlighted since prevalence was considerably high. Hypermetropia was the predominant refractive error in contrast to other studies in which myopia was more common. This may be attributed to the criteria for sample selection as the study was clinic-based study rather than population-based. However, there should be an emphasis on public education on the significance of early detection of refractive errors, and periodic screening in schools. This will help in the early detection and treatment of refractive errors, strabismus and amblyopia and thereby reduce the prevalence of strabismus and amblyopia in children, and consequently improve educational opportunities and their quality of life.

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Conflicts of interest
There are no conflicts of interest.

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