ORIGINAL ARTICLE

Refractive errors in children: analysis among preschool and school children in Tuzla city, Bosnia and Herzegovina

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ABSTRACT

Aim To establish the prevalence of refractive errors in preschool and school children between 4 and 15 years of age, living in Tuzla, Bosnia and Herzegovina.

Methods Children from all elementary schools in the city of Tuzla and as well from eight day-care centres were screened for refractive errors in the period 2015-2019. Any child, who failed to pass the screening examination, was referred to an ophthalmologist for complete ophthalmological evaluation. The obtained data were analysed using non-parametric statistics.

Results The highest number of children who were tested after the screening process was during 2015. A total of 7415 children (3790 males and 3625 females), in the age range of 4-15 were screened. In the total sample of children who were completely evaluated (n=145; 290 eyes) the most common refractive error was astigmatism, in 152 (52.4%) eyes. In the preschool children (n=18; 36 eyes), the most common refractive error was astigmatism, in 19 (52.8%) eyes, followed by hyperopia, in 9 (25%) eyes. In the school children (n=127) (254 eyes), the most common refractive error was astigmatism, in 133 (52.4%) eyes, followed by myopia, in 92 (36.2%) eyes. The overall prevalence of refractive errors was 1.95% (145 with refractive error out of 7415 screened).

Conclusion Prevalence of refractive errors is high enough to justify a school eye screening programme.

Key words: astigmatisms, hypermetropia, myopia, visual screening

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INTRODUCTION

It is well known that children with different uncorrected refractive errors may experience different kinds of problems in life, including headache and persistent ocular discomfort, particularly for near work which can impair reading efficiency and their performance in school activities. Children with uncorrected refractive errors can have poor school performance as well (1). There are three types of refractive errors: myopia, hyperopia and astigmatism. Myopia is a condition in which the eye is long and causes a reduction in visual acuity (VA) that cannot be overcome by accommodation (2,3). In addition, highly myopic eyes, of −6 dioptres (D) or more, may develop sight-threatening complications (4). Hyperopia, by contrast, is a condition in which the eye is shorter (5). Although distance VA may be unaffected, especially in mild hyperopia, it can create visual disturbances which can affect optimum functional performance of school children or cause squint (5,6). Astigmatism is another form of refractive error which is caused by differences in the refractive power of the optical system in different axes. This is caused by irregular curvature of the cornea and less commonly the crystalline lens (7). The importance of astigmatism in children lies in the fact that it is a correctable cause of visual impairment in these ages, and it can coexists with spherical error (8). In addition, astigmatism increases the incidence of amblyopia in children, and even treatment results are affected by the type of astigmatism (9,10). Anisometropia is the condition in which two eyes have unequal refractive power; its severe forms can affect binocular vision (11). During the growth of the eye, the process of emmetropization normally occurs. It is known that hyperopia, from +3.0D to +4.0D that is present at birth, usually decreases during the preschool period to +0.50D, emmetropia or even converges to small myopia (12). Minor amount of anisometropia remains undetected and does not cause any significant visual problem. However, a difference of ≥1.0D in a child can lead to amblyopia and development of squint (13). Refraction of the eye changes through life.

In Bosnia and Herzegovina most children, in our experience, are usually examined very late by the ophthalmologist and many of them are forced to live visually impaired life prior to the first examination. In our country there is small amount of information available on the incidence of refractive errors in our population, especially among preschool and school children (14). To our knowledge, a similar study only with school children was done in Brčko District (15) and only one similar study that evaluated the frequency of refractive errors in premature children in retinopathy of prematurity (ROP) screening (16) was done in the Federation of Bosnia and Herzegovina.

There was also a study in Croatia, comparing the difference between screened and unscreened population (17).

The aim of this study was to analyse and evaluate refractive errors in paediatric population in the city of Tuzla, Bosnia and Herzegovina.

PATIENTS AND METHODS

Patients and study design

All pre-school children from 7 day-care centres and school children from all 24 elementary schools in Tuzla, who failed vision screening and were referred to the Eye Clinic, University Clinical Centre (UCC), Tuzla for full eye exam, were included in this study. This study took place between November 2014 and November 2019 in Tuzla, Bosnia and Herzegovina.

An approval of the Ethics Committee Board of the University Clinic Centre Tuzla was obtained to conduct this study in accordance with the Declaration of Helsinki.

Inclusion criteria were age of 4-15 years on the examination day, failed vision screening, parents or legal guardians signed an informed consent, and no history of systemic diseases. The exclusion criteria were children who had eye injuries or eye diseases of any kind, children who were allergic to any ingredient in 1% cyclopentolate solution, children who refused to continue the examinations due to eye discomfort during cyclopentolate administration (e.g. burning, photophobia, irritation).

Methods

The vision screening process and examinations of children were performed by medical teams consisting of medical students (volunteers), residents in ophthalmology, ophthalmologist and ophthalmic nurse and optometrist.

Ophthalmologic examinations included external eye examination, visual acuity, biomicroscopic examination of the anterior segment of the eye, intraocular pressure, dilated fundus and as well as ocular motility examination. The examination process began with testing uncorrected visual acuity. To measure visual acuity Snellens charts, tumbling E or Lea charts were used. A cover-uncover test was then performed to detect if strabismus was present. The eye movements were tested in 9 cardinal directions. Anterior segment was examined with slit lamp to detect any ocular pathology of anterior segment like corneal pathology, cataract, congenital anomalies and evidence of previous eye surgery. The children underwent a full ocular examination, and any pathology involving the anterior and posterior ocular segments was documented. Detailed history about present and past ocular problems and treatment, history of any medical or surgical treatment, and family history were taken.

Refraction was performed under cycloplegia, with cyclopentolate 1% administrated three times at 5 minutes intervals. Retinoscopy was performed 45 minutes following the first instillation of drops, followed by dilated fundus exam. Subjective refraction was also performed if the child collaborated. Myopia was considered when measured objective refraction was ≥ −0.75 spherical equivalent dioptres in one or both eyes. Hyperopia was considered when the measured objective refraction was greater than +2.00 spherical equivalent dioptres in one or both eyes provided no eye was myopic. Astigmatism was considered to be visually significant if ≥1.00D. Anisometropia was defined as unequal refractive power in two eyes.

Statistical analysis

Relevant data were presented as frequencies, means, and standard deviations.

RESULTS

In the period between November 2014 and November 2015 a total of 7415 children were examined. There were 3790 (51%) male and 3625 (49%) female children. The number of children referred to the ophthalmologists for further evaluation and management was 409, of which 145 children completed full ophthalmological examination, 18 preschool children and 127 school children. The mean age of children was 9.50 ± 2.91 years (range of 4 to 15 years).

In the period 2016-2019 at UCC Tuzla there was fewer number of children who failed screening tests and were examined in our department: in 2016 30, in 2017 79, in 2018 48, and in 2019 46 children. The average visual acuity (VA) of the right eye without correction in all patients was 0.54 (SD=+/-0.27). The most frequently repeated visual acuity of the right eye without correction was 0.80. The minimum visual acuity of the right eye without correction was 0.03, while the maximum visual acuity of the right eye without correction was 0.90. The overall average visual acuity (VA) of the left eye without correction was 0.53 (SD = +/-0.29). The most frequently repeated visual acuity of the right eye without correction was 0.80. The minimum visual acuity of the right eye without correction was 0.01, while the maximum without correction was 0.90.

During 2015, 2016, 2017, 2018 and 2019 we found 36 (24.8%), 10 (33.3 %), 25 (31.64 %), 15 (31.25%), and 15 (32.60%), respectively, children with anisometropia of≥1.0D.

As the higher number of examined children was during 2014-2015 we gave a special focus on this period. The most common refractive error in the 2014-2015 period was astigmatism, in 152 (out of 290; 52.4%) of eyes. In both preschool (n=18; 36 eyes) and school children (n=127; 254 eyes), the most common refractive error was astigmatism, which was recorded in 19 (52.8%) and 133(52.4%) eyes, respectively, followed by hyperopia, 9 (25%) and myopia, 8 (22.2%) eyes in preschool children, and in school children followed by myopia, 92 (36.2%) and hyperopia, 29 (11.4%) (Table 1).

Table 1. Distribution of refractive errors among preschool and school children during 2015

Children group	No (%) of eyes			
	Astigmatism	Hyperopia	Myopia	Total
Preschool	19 (52.8)	9 (25)	8 (22.2)	36 (100)
School	133 (52.4)	29 (11.4)	92 (36.2)	254 (100)
Total	152 (52.4)	38 (13.1)	100 (34.5)	290 (100)

During 2016, among 30 children (60 eyes) 5 children were of school age, while 25 were preschoolers. The most common refractive error was hyperopia, in 25 (41.7%), followed by myopia,

20 (33.3%), and astigmatism, in 15 (25%) children. During 2017, among 79 children (158 eyes) the most common refractive error was hyperopia, 80 (50.6%), followed by astigmatism, 48 (30.4%) and myopia, 30 (19%). During 2018, among 48 children (96 eyes) the most common refractive error was astigmatism, 47 (50%), followed by myopia, 25 (26%), and hyperopia, 23 (24%). During 2019, among 46 children (92 eyes) the most common refractive error was astigmatism, 44(47.8%), followed by myopia, 33 (35.9%), and hyperopia 15 (16.3%) (Table 2).

Table 2. Distribution of refractive errors in the 2015-2019 period

Year	Total number of children/eyes	No (%) of eyes		
		Astigmatismus	Myopia	Hypermetropia
2015	145/290	152 (52.4)	100 (34.5)	38 (13.1)
2016	30/60	15 (25)	20(33.3)	25 (41.7)
2017	79/158	48 (30.4)	30(19)	80(50.6)
2018	48/96	47 (50)	25 (26)	23 (24)
2019	46/92	44(47.8)	33 (35.9)	15 (16.3)

As we gave special focus to the 2014-2015 period, we asked parents about medical history of the children. Of the total number of children (n=145) 140 were delivered without any complication, while five pregnancies were maintained by hormone therapy. All children had normal postnatal development. In the family history, we did not receive information from the parents about ocular diseases (glaucoma, cataracts or strabismus) in immediate family members. From the total number (n=145) of children, 118 (81.4%) were without refractive error (RE) in the family. In six (4.2%) children, some of the refractive errors were found in siblings, five had astigmatism while one sibling had high myopia. In four (2.8%) children, both parents wore glasses, while in seven (11.8%), one parent wore glasses or lenses.

DISCUSSION

In this study we analysed refractive errors in school and preschool children living in Tuzla city. The results showed that refractive errors were very common and undiagnosed. Detection and correction of refractive anomalies are especially important in the paediatric population, because they can be the cause of amblyopia and strabismus, if detected late (18). Our screening program relating to refractive errors was the biggest one in Bosnia and Herzegovina after the war, since there is still no population-based screening program for preschool children. In the last few years there are strong initiatives in neighbouring countries for systemic screening at the age of 4 (17). Our results showed that the prevalence of refractive errors was 1.95%; however, considering that children who previously had corrected visual acuity with appropriate glasses or contact lenses were not included, we can estimate the prevalence of refractive errors in the Tuzla city is much higher. It can be estimated that the prevalence in the city of Tuzla could be expected to be around 9.96%. The prevalence of refractive errors varies from one country to another. Several studies reported the prevalence of refractive errors between 2.9% and 18.5% (20-22). Variations within the country are also noticeable (22,23). The reason for this variation is probably because some studies were conducted in rural and other in urban areas (22, 23). In the period 2016-2019 fewer children were examined in UCC Tuzla probably because teachers had sent children to primary health centres in our region, and many children were examined by private practitioners.

In a study from Niš (Serbia) conducted on the sample of 620 children (1240 eyes), hypermetropia was the most common refractive error, 54.11%, followed by astigmatism, 42.91%, while myopia was detected in 2.98% children (12). A study in Novi Sad (Serbia), where 200 children (400 eyes) aged 3-18 were examined, showed prevalence of hyperopic astigmatism (farsighted astigmatism) of 40.8%, followed by hypermetropia, 21.3% (24). In Lithuania, in a study involving 839 (1678 eyes) children aged 2-6 years, different grade hyperopia was present in 43.26% and hypermetropic astigmatism in 23.08% (25). Also, the rate of myopia in the United States in patients aged 12-17 years increased significantly from 24.5% during 1971-1972 to 34.8% during the 1999 -2004 periods (26). In Taiwan the prevalence of myopia is 20-30% among 6-7 year olds, and as high as 84% in high school students (27). In Hong Kong, in a study of 4257 children aged 6–8 years, 25.0% were myopic (28).

Screening programs can significantly reduce amblyopia, as showed in our neighbouring countries (17). Preschool and school children are not quick in sharing their visual problems and parents are very often unaware of the children problems. Refractive errors are common in Bosnian chil-

dren and often remained undiagnosed due to low standard of living and low level of social-economic development in some areas, and there is not enough attention paid to children's vision and refraction. We also emphasize that it is necessary to implement mandatory examination of all children at the age of 4 years.

The obstacles in this study came from the fact that many examinations were performed in private practices with no legal register. Also, a high number of children was not further examined even though it was suggested after the screening.

In conclusion, our study presents evidence that a national screening program in Bosnia and Herzegovina is needed in order to include a larger number of children and to obtain even more accurate data. We strongly believe it is necessary to conduct a massive screening program in the whole country to determine the correct incidence and prevalence of refractive errors which can be easily diagnosed and corrected at a relatively small cost. Conducting preventive programs directed to preschool and school children requires participation of several sectors of the community involving physicians, educators, family members and volunteer personnel.

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TRANSPARENCY DECELERATION

Conflicts of interest: None to declare.

REFERENCES

1. Harrington SC, Stack J, Saunders K, O´Dwyer V. Refractive error and visual impairment in Ireland school children. Br J Ophthalmol 2019; 103:1112-8.
2. Goss D, Grosvenor T. Optometric Clinical Practice Guideline Care of Patient with Myopia. Reference Guide for Clinicians. St Louis, MO: American Optometric Association, 2006: 3-10.
3. Lagrèze WA, Schaeffel F. Preventing Myopia. Dtsch Arztebl Int. 2017;114:575-80.
4. Williams K, Hammond C. High myopia and its risks. Community Eye Health 2019; 32:5-6.
5. Verhoeven VJ, Wong KT, Buitendijk GH, Hofman A, Vingerling JR, Klaver CC. Visual consequences of refractive errors in the general population. Ophthalmology 2015; 122:101–9.
6. Bruce A, Fairley L, Chambers B, Wright J, Sheldon TA, Impact of visual acuity on developing literacy at age 4-5years: a cohort-nested cross-sectional study. BMJ Open 2016; 6:e010434
7. Grosvenor T. How much do we know about astigmatism? Clin Exp Optom 2007; 90:3-4.
8. Sayed, K.M. Analysis of components of total astigmatism in infants and young children. Int Ophthalmol 2017; 37:125–29.
9. Yap TP, Luu CD, Suttle C, Chia A, Boon MY. Effect of stimulus orientation on visual function in children with refractive amblyopia. Invest Ophthalmol Vis Sci 2020; 61:1-9.
10. Harvey EM. Development and treatment of astigmatism-related amblyopia. Optom Vis Sc 2009; 86:634 -9.
11. Murray SJ, Codina CJ. The role of binocularity in anisometropic amblyopia. J Binocul Vis Ocul Motil 2019;69:141-52.
12. Kostovska V, Stanković-Babić G, Smiljković-Radovanović K, Cekić S, Vujanović M, Bivolarević I. Analysis of refractive errors in children aged up to 15 years. Acta Medica Medianae 2013; 52:33–40
13. Deng L and Gwiazda JE. Anisometropia in children from infancy to 15 years. Invest Ophthalmol Vis Sc 2012; 53:3782-8
14. Vodencarevic AN, Jusufovic V, Halilbasic M, Alimanovic E, Terzić S, Čabrić E, Drljević A, Burgić M. Amblyopia in children: analysis among preschool and school children in the city of Tuzla, Bosnia and Herzegovina. Mater Sociomed 2017; 29:164-7.
15. Popovic-Beganovic A, Zvorničanin J, Vrbljanac V, Zvorničanin E. The prevalence of refractive errors and visual impairment among school children in Brčko District, Bosnia and Herzegovina. Semin Ophthalmol 2018; 33:1-11.
16. Pidro A, Alajbegović-Halimić J, Jovanović N, Pidro A. Evaluation of refractive errors in retinopathy of prematurity screening. Med Glas (Zenica) 2019; 16:204-8.
17. Busic M, Bjelos M, Petrovecki M,Kuzmanovic Elabjer B, Bosnar D, Ramic S, Miletic D, Andrijasevic L, Kondza Krstonijevic E, Jakovljevic V, Biscan Tvrdi A, Predovic J, Kokot A, Biscan F, Kovacevic Ljubic M, Motusic Aras R. Zagreb Amblyopia Preschool Screening Study: near and distance visual acuity testing increase the diagnostic accuracy of screening for amblyopia. Croat Med J 2016; 57:29-41.
18. Al-Tamimi ER, Shakeel A, Yassin SA, Ali SI, Khan UA. A clinic-based study of refractive errors, strabismus and amblyopia in pediatric age-group. J Family Community Med 2015; 22:158-62.

19. Muma MK, Kimani K, Kariuki-Wanyoike MM, Ilako DR, Njuguna MW. Prevalence of refractive errors among primary school pupils in Kilungu Division of Makueni District, Kenya. Med J Zambia 2009; 36:165-70.
20. Hashemi H, Rezvan F, Yekta AA, Hashemi M, Norouzirad R, Khabazkhoob M. The prevalence of astigmatism and its determinants in a rural population of Iran: the "Nooravaran Salamat" mobile eye clinic experience. Middle East Afr J of Ophthalmol-2014; 21:175-81.
21. Maul E, Barroso S, Munoz SR, Sperduto RD, Ellwein LB. Refractive error study in children: Results from La Florida, Chile. Am J Ophthalmol 2000; 129:445-54.
22. Shrestha GS, Sujakhu D, Joshi P. Refractive error among school children in Jhapa, Nepal. J Optom 2011; 4:49-55
23. Pokharel GP, Negrel AD, Munoz SR, Ellwein LB. Refractive error study in children: results from Mechi Zone, Nepal. Am J Ophthalmol 2000; 129:436-44.
24. Bolinovska S. Hipermetropija kod dece predškolskog i školskog uzrasta. Med Pregl 2007; 60:115-21.
25. Majauskiene O, Aukstikalniene R, Ceponiene R, Majauskaite I. The evaluation of visual disorders in preschool children. Medicina (Kaunas) 2005; 41:240-5.
26. Vitale S, Sperduto RD, Ferris FL 3rd. Increased prevalence of myopia in the United States between 1971-1972 and 1994-2004. Arch Ophthalmol 2009; 127:1632-9.
27. Wu PC, Huang HM, YU HJ, Fang PC, Chen CT. Epidemiology of myopia. J Ophthalmol 2016; 5:386-93.
28. Yam JC, Tang SM, Kam KW, Chen LJ, YU M, Law AK, Yip BH, Wang YM, Cheung CYL, NG DSC, Young AL, Tham CC, Pang CP. High prevalence of myopia in children and their parents in Hong Kong Chinese population: the Hong Kong Children Eye Study Acta Ophthalmol 2020. Online ahead of print.