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The frequency of refractive errors required to be corrected in childhood among Turkish children

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ABSTRACT

BACKGROUND: The aim of this study is to investigate the distribution of refractive errors needed to be correct in childhood.

MATERIAL AND METHODS: Children applied and received glasses prescriptions were recruited. Age, gender, spherical, cylindrical error, and spherical equivalent (SE) were noted. The refractive errors were classified as myopic, hyperopic and cylindrical errors according to the SE and prescriptions. Cylindrical errors were subdivided into myopic, hyperopic. Children were classified into 4 groups. Group 1, 2, 3 and 4 composed of children whose ages were between 0–5, 6–10, 11–15 and 16–18 years, respectively.

RESULTS: There were 846 children in group 1, 3931 in group 2, 5948 in group 3, 3896 in group 4, and a total of 14621 children. The rates of myopia and hyperopia were 72.4% and 27.6%. Myopic and hyperopic astigmatism were found in 29.1% and 11.3% of children. Myopia, myopic astigmatism increased with age ($p < 0.05$). The hyperopia rate decreased with decreasing age ($p < 0.05$). The frequency of myopia, myopic astigmatism was higher in both male and female children ($p < 0.05$). The rate of myopia was higher in females ($p < 0.05$). There was no statistically significant difference in terms of cylindrical value between genders. The statistically significant difference was found in terms of mean SE among all groups and a negative correlation was present between age and mean SE. A lower negative correlation was stated between age and cylindrical value.

CONCLUSION: Corrected myopic and myopic astigmatism errors were higher than hyperopic refractive errors. The prevalence of myopia increased by age and was higher in females. The need for glasses was highest in children whose age range was between 11 and 15 years.

KEY WORDS: refractive errors; astigmatism; myopia; hyperopia; childhood

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INTRODUCTION

The most common cause of visual impairment worldwide is uncorrected refractive errors (myopia, hyperopia, and astigmatism). Approximately 153 million people are thought to be affected [1]. Uncorrected refractive errors may lead to amblyopia in childhood and cause persistent visual impairment. Refractive status should be checked in both preschool and school-age children [2]. Studies have been previously performed on the prevalence of refractive errors in childhood in different regions [2–5]. Rajavi et al. reported in a study conducted in Iran that they had 3.5% hyperopia, 22.6% myopia and 4.9% astigmatism in children

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aged 7–12 years. They also observed an increase in myopia and decrease in hyperopia as the children aged [6]. Another study conducted in Germany also revealed an increase in myopia and decrease in hyperopia with age for patients between 2 and 35 years old [7]. The prevalence of myopia has been increasing steadily and is estimated to afflict approximately 1 billion people in the 2050 year according to a study by Holden et al. [8]. These studies reveal the refractive status of children, but not the refractive errors which need to be corrected. Mild hyperopia in children (below 3 diopters) without ocular deviation and with sufficient accommodation does not need to be corrected. Also, moderate myopia in preschool-aged children may be observed without intervention. Caca et al. investigated the refractive status of 21062 children and 22.7% needed correction of a refractive error. The age range was between 6–14 years [9]. The need for refractive error correction and the prevalence of corrected refractive errors in children is important to evaluate the real effect of refractive status on children's vision. To our knowledge, there is no study in the literature evaluating the prevalence of corrected refractive errors in children aged 0 to 18 years old.

MATERIAL AND METHODS

This study was conducted at the Departments of Ophthalmology of two major hospitals (Sakarya Training and Research Hospital, Yenikent State Hospital) in the Sakarya province in Turkey between January 2016 and December 2018. Prior approval from the Institutional Review Board (IRB number:71522473/050.01.04/19) was received and written informed consent was obtained from the parents of each participant. The study was performed in adherence to the Declaration of Helsinki.

Children between 0 to 18 years of age who were treated at the two hospitals and received a prescription for glasses after an ophthalmological examination were recruited for this study. Children with a previous history of refractive surgery were not included in this study.

All the children underwent a full ophthalmological examination including a best-corrected visual acuity measurement by Snellen chart, cycloplegic refraction, biomicroscopic examination for the anterior segment and fundus evaluation. Autorefractometers (Tonoref 3; Nıdek Co., Ltd, Gamagori, Japan, and Canon RK-F2 Full Auto Ref-Keratometer; Canon, Tokyo, Japan) in the hospitals were used for measuring refractive errors. Examination for ocular deviation and dynamic retinoscopy was also performed. According to the results of the examination, a prescription for glasses was written and registered in the hospitals' information systems. The results of a dynamic retinoscopy and improvement in the best corrected visual acuity as the primary data used to determine if glasses should be prescribed to a child.

Age, gender, spherical and cylindrical errors, and spherical equivalent (SE) were noted. The SE was calculated as the sum of the spherical and half of the cylindrical value. Records of the glasses prescriptions were taken from the information systems and investigated retrospectively. The refractive errors were classified as myopic, hyperopic, and cylindrical errors according to the SE and prescriptions, respectively. Cylindrical errors were subdivided into myopic astigmatism and hyperopic astigmatism. The study was classified into four groups based on age range. Groups 1, 2, 3 and 4 were composed of children whose ages were between 0–5, 6–10, 11–15, and 16–18 years, respectively.

STATISTICAL ANALYSIS

Statistical analyses were performed using the SPSS program version 17 (SPSS Inc, Chicago, IL, USA). Descriptive statistics were used for data analyses. The Pearson correlation analysis was used for detecting the correlation between the refractive errors of the eyes of each child. Numerical data were given as mean ± standard deviation. Distribution according to age and gender was given as a percentage. Kolmogorov-Smirnov analysis was used for testing the normality of distribution. Parametric tests (the Student t test) were used for variables with normal distribution and non-parametric tests (Mann-Whitney U test) were chosen for variables without normal distribution. A p value of < 0.05 was considered statistically significant.

RESULTS

This current study was composed of 14621 children in total, if which 5656 (38.7%) were female and 8965 (61.3%) were male. The mean ages of males and females were 11.58 ± 4.26 and 12.70 ± 3.85 years, respectively, and the overall mean age was 12.27 ± 4.05 years. A statistically significant difference was present in terms of the mean ages of male and female children ($p < 0.05$). As mentioned in the materials and methods section, the children were divided into 4 groups. There were 846 (5.8%)

Table 1. Distribution of refraction errors by age groups and gender (n, %)

	Myopia	Hyperopia	Total	Myopic astigmatism	No astigmatism	Hyperopic astigmatism	Total
Group 1 (0–5 y)	135 (16.0%)	711 (84.0%)	846 (100.0%)	138 (16.3%)	372 (44.0%)	336 (39.7%)	846 (100.0%)
Group 2 (6–10 y)	2211 (56.2%)	1720 (43.8%)	3931 (100.0%)	1034 (26.3%)	2119 (53.9%)	778 (19.8%)	3931 (100.0%)
Group 3 (11–15 y)	4817 (81.0%)	1131 (19.0%)	5948 (100.0%)	1769 (29.7%)	3788 (63.7%)	391 (6.6%)	5948 (100.0%)
Group 4 (16–18)	3426 (87.9%)	470 (12.1%)	3896 (100.0%)	1315 (33.8%)	2436 (62.5%)	145 (3.7%)	3896 (100.0%)
Total (0–18)	10589 (72.4%)	4032 (27.6%)	14621 (100.0%)	4256 (29.1%)	8715 (59.6%)	1650 (11.3%)	14621 (100.0%)
Male	3771 (66.7%)	1885 (33.3%)	5656 (100.0%)	1815 (32.1%)	3001 (53.1%)	840 (14.9%)	5656 (100.0%)
Female	6818 (76.1%)	2147 (23.9%)	8965 (100.0%)	2441 (27.2%)	5714 (63.7%)	810 (9.0%)	8965 (100.0%)

children in group 1, group 2 included 3931 (26.9%) children, Group 3 included 5948 (40.7%) children, and there were 3896 (26.6%) children in Group 4. A high positive correlation was found between the two eyes of children and the data obtained from the right eye were used in the analyzes ($r = 0.814$, $p = 0.000$).

Myopia was present in 10,589 (72.4%) children and hyperopia was present in 4032 (27.6%) children. Myopic astigmatism was found in 4256 (29.1%) children and 1650 (11.3%) children had hyperopic astigmatism. In 8715 (59.6%) children astigmatism was not present.

While the myopia rate was 16% and the myopic astigmatism rate was 16.3% in Group 1, these rates were 87.9 % and 33.8% in Group 4, respectively. It was observed that myopia and myopic astigmatism increased with age ($p < 0.05$). The rates of hyperopia and hyperopic astigmatism were 84.0% and 39.7% in Group 1 and 12.1%, and 3.7% in Group 4, respectively. The hyperopia rate decreased with age ($p < 0.05$).

The distribution of corrected refractive errors in all age groups and genders is summarized in Table 1. When the distribution of refractive errors according to gender was investigated, the frequency of myopia and myopic astigmatism was higher than hyperopia and hyperopic astigmatism in both male and female children ($p < 0.05$). In addition, the rate of myopia was higher in females ($p < 0.05$).

The mean SE was –0.65 ± 2.22 diopter (D) and ranged between –17.50 D and +18.00 D. The mean cylindrical value was –0.16 ± 0.90 D and ranged between –7.00 D and +6.25 D. A statistically significant difference was found in terms of mean SE among all groups and a negative correlation was present between age and the mean SE ($r = –0.375$, $p < 0.05$). Similarly, a lower negative correlation was stated between age and cylindrical value ($r= –0.162$, $p < 0.05$) (Fig. 1).

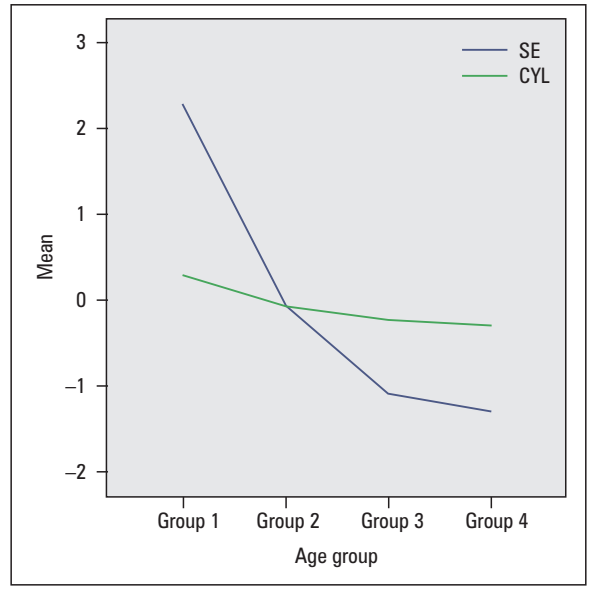

FIGURE 1. Mean values of refraction errors according to age groups in diopters (Group 1: 0–5 years, Group 2: 6–10 years, Group 3: 11–15 years and Group 4: 16–18 years). D — diopter; SE — spherical equivalent; CYL — cylinder

The mean SE and cylindrical value were –0.43 ± 2.45 D and –0.15 ± 1.03 D in males and

Table 2. Comparison of spherical equivalent (SE) and cylinder (CYL) values according to age groups						
		Group 1 (n = 846)	Group 2 (n = 3931)	Group 3 (n = 5948)	Group 4 (n = 3896)	p
Mean SE (D)		2.25 ± 2.76	–0.05 ± 2.30	–1.07 ± 1.88	–1.26 ± 1.77	< 0.05
95% CI for Mean SE	Lower	2.06	–0.12	–1.12	–1.32	
	Upper	2.44	–0.02	–1.03	–1.20	
Mean CYL (D)		0.31 ± 1.25	–0.06 ± 1.09	–0.21 ± 0.78	–0.29 ± 0.69	< 0.05
95% CI for Mean CYL	Lower	0.2312	–0.0961	–0.2369	–0.3159	
	Upper	–0.4012	–0.0278	–0.1971	–0.2721	

Group 1: 0–5 years, Group 2: 6–10 years, Group 3: 11–15 years and Group 4: 16–18 years; D — diopter; SE — standard error; CI — confidence interval

–0.80 ± 2.04 D and 0.17 ± 0.80 in females, respectively. While the frequency of myopia was higher in females, there was no statistically significant difference in terms of cylindrical value between males and females ($p < 0.05$ and $p = 0.363$, respectively). Table 2 summarizes the mean SE and cylindrical values classified according to age group.

DISCUSSION

This current study revealed the rate of corrected myopic and myopic astigmatism errors were higher than hyperopic refractive errors. Robaei et al. found the rate of 12-year-old Australian children requiring glasses was 19.0%. The rates of myopia, hyperopia, and astigmatism were 46.3%, 10.9%, and 21.8%, respectively [10]. Gaete et al. found school-aged children needed glasses at a rate of 34.4%. They did not investigate the distribution of refractive errors [11]. Robaei et al. also investigated the patterns of glasses use in 6-year-old Australian school children and found the rate of glasses use was 4.4%. Hyperopia with or without astigmatism was the most frequent reason for glasses use (40.3%) [12]. These reports supported our findings. We found a higher hyperopic corrected refractive error in children between 0 and 5 years old and this refractive error gradually decreased with age. We also observed the need for glasses was lower in children between 0 and 10 years old. This result indicated that hyperopic refractive errors were less often corrected. Huang et al. found myopia started in children at approximately 7 years old, increased with age, and had a significant association with visual acuity [13]. Gursoy et al. investigated refractive errors in 7- to 8-year-old children and the need for glasses for myopia and hyperopia were 0.8% and 1.0%, respectively. The narrow and young age range may cause this result. In this study, the need for glasses was 20.4% of all children [14].

When we investigated the rate of corrected refractive errors in children, we observed the need for glasses was highest in children whose age range was between 11 and 15 years (Group 3). The growth of children in this age range is faster than in other periods. Chen et al. found the prevalence of myopia exhibited an increased tendency with height development in children [15]. These factors may be responsible for our findings.

Glasses need for myopia was higher in girls than boys in this study. Lin et al. found a lower prevalence and lesser degree of myopia among boys. Goldschmidt et al. reported higher myopia prevalence in girls. But Alemam et al. found myopia was more prevalent in males. The behavioral differences of children in different regions may lead to these variations [16–18].

CONCLUSION

The need for glasses increased gradually by age 15 and a minimal decline was observed between 15- and 18-year-old children. The prevalence of myopia increased with age and was higher in females. This current study is unique in terms of investigating the distribution of the need for glasses in childhood according to age, gender, and classification of refractive errors.

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Conflicts of interest

The Authors declare that there is no conflict of interest.

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