ACTA MEDICA LITUANICA. 2017. Vol. 24. No. 2. P. 83–92

Refractive errors characteristic of the patients at the Children's Ophthalmology Outpatient Department of Kauno klinikos Hospital (Lithuanian University of Health Sciences) from 1 January 2012 to 31 December 2012

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Background. The purpose of our study was to assess the distribution and patterns of refractive errors in children for the proper planning of paediatric eye care at the centre.

Material and methods. The study was conducted in the hospital of the Lithuanian University of Health Sciences in Kaunas, from 1 January 2012 to 31 December 2012. During this period, a total of 11,406 children, aged 0–18 years, were evaluated at the outpatient department of paediatric ophthalmology, Kauno klinikos, the Lithuanian University of Health Sciences. All the children underwent a complete ophthalmic examination with cycloplegic refraction.

Results. Myopia increased from 1.5% (95% CI:1.2, 1.8) in the age group of 0–1 to 44.7% (95% CI:43.46, 45.94) in the age group of 14–18 ($p < 0.001$). Myopia was associated with older age, female gender (20.3%; 95% CI:19.3, 21.3; $p < 0.001$). Hypermetropia decreased from 84.6% (95% CI:83.7, 85.5) in the cohort of 0–1 to 11.4% (95% CI: 10.61, 12.19) in the 14–18 age group ($p < 0.001$). Hypermetropia was associated with younger age, male gender (43.4%; 95% CI:42.16, 44.64; $p < 0.001$), preterm birth (56.1%; 95% CI:54.86, 57.34; 43.4%; $p < 0.001$), low birth weight (61.8%; 95% CI:60.59, 63.01; $p < 0.001$), and birth by Caesarean section (57.1%; 95% CI: 55.87; 58.33) ($p < 0.001$).

The prevalence of astigmatism was 25.5% (95% CI: 24.41; 26.59) ($p < 0.001$). Astigmatism was associated with female gender (20.1%; 95%. CI: 19.1; 21.1) and too big pregnancy weight (22.1%.; 95%. CI: 21.06; 23.14) ($p < 0.001$).

Conclusions. Of the 14–18 age group, 44.7% of the patients were myopic. Of the 0–1 age group, 84.6% were hypermetropic. Astigmatism was detected in about 25.5% of children. The prevalence of refractive errors was associated with age, gender, gestation age, gestation weight, and parental refractive error.

Keywords: myopia, hypermetropia, astigmatism

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INTRODUCTION

Worldwide, more than 150 million people are estimated to be visually impaired because of uncorrected refractive error, of which 8 million are functionally blind (1). Refractive error affected 1.45 billion people, or 27% of the world's population, in 2010 (2). By the year 2020, it is estimated that 2.5 billion people, or one third of the world's population, will be affected by myopia alone (3). Childhood visual impairment due to refractive errors is one of the most common problems among school-age children, and is the second leading cause for treatable blindness (4). Refractive error occurs when there is a failure of the eye to correctly focus rays of light from an object onto the retinal plane. The resultant image perceived by the individual is blurred and refractive correction is required in order to see clearly. Refractive error can be divided into myopia ("short or near-sightedness"), hyperopia ("long or far-sightedness"), and astigmatism. In myopia, light is focussed to a point anterior to the retina as a result of excessive refraction at the cornea or the lens, or, more commonly, an increased length of the eye ('axial myopia'). In hyperopia, the reverse occurs with an image forming posterior to the retinal plane as a result of either in adequate refraction or a short axial length. In astigmatism, the refractive power of the eye is uneven across different meridians (5). Vision is important in child development because it allows children to interact with their environment (6). Vision in preschool children is uniquely important because their visual system is still developing and they are at risk of developing amblyopia from some forms of uncorrected high ametropia or anisometropia (7). Children are born with a normal distribution of refractive error. Refractive status at birth is related to gestational age (8). Preterm babies have myopia which decreases as gestational age increases and term babies are known to be hypermetropic (9). Full term neonates commonly demonstrate high levels of hyperopia and astigmatism that reduce rapidly during the first year of life (10). The refractive status of the eye can be clinically defined using SE measures and quantitated in dioptres (D) (11). In addition, refractive errors are risk factors for various ocular diseases (12). Refractive errors can lead to visual impairment and, ultimately, even blindness. Uncorrected refractive errors are a major cause of visual impairment (13), and may lead to a loss of productivity (12). Numerous studies previously examined the prevalence of myopia (14). Myopia is a complex disease, and genetic variations can increase the susceptibility to environmental factors and cause early onset and/or aggressive progression (15). Greater daily light exposure was associated with less axial eye growth (16). Many blinding diseases such as retinal detachment, pigmentary degeneration, myopic macular degeneration, glaucoma, and cataracts have a potential association with pathologic myopia (17–19). An abnormal level of hyperopia is the most frequent refractive anomaly (5–6%) found in the population at 9 months of age. It is associated with a higher risk of amblyopia and strabismus at 4 years of age (20). Astigmatism is a low order aberration, but the inherent oriented nature of the blur that it produces makes it particularly attractive for investigating the adaptive processes in the visual system (21).

We conducted this study to examine the distribution of myopia, hypermetropia and astigmatism in the hospital of Lithuanian University of Health Sciences children's outpatient department.

METHODS AND MATERIALS

Having obtained a permission (No. BEC-MF-80) from Kaunas Regional Biomedical Research Ethics Committee, the study was conducted at the Department of Ophthalmology of the Lithuanian University of Health Sciences.

Our patient material consisted of the population of children with refractive error in the year 2012, who were examined at the children's eye clinic. In total, there were 11,406 who at reception had a history of an underlying disease. For further detailed analysis the selected case histories of 6,171 patients with the diagnoses of myopia, hypermetropia, or astigmatism were selected. A questionnaire, in which all the necessary data were recorded for further analysis, was prepared. The data collected included: gender, age, city of residence, diagnosis, history of refractive error in the family, myopia, history of hypermetropia, astigmatism in the family, wearing glasses in the family, when the child began to wear glasses, history of diseases, full-term/preterm birth, birth

weight, childbirth complications, risk factors, complaints, visual acuity, refraction, portable correction.

The major eligibility criteria for the study included: medical records with myopia, hypermetropia, astigmatism, age from one month to 18 years, and medical records of children who in 2012 registered with the Outpatient Department of Paediatric Eye Diseases at Kauno klinikos Hospital of the Lithuanian University of Health Sciences.

The subject exclusion criteria were: children over 18 years of age before 1 January 2012 and there was no analysis of medical records without myopia or hypermetropia, or astigmatism diagnosis. In this research, the patients' visual acuity, the transparency of the cornea and the lens, and the fundus were examined. Biomicroscopy was performed in order to assess corneal and lenticular transparency. Non-corrected and the best-corrected visual acuity (measured in decimals from 0.1 to 1.0) was evaluated using Landolt's rings (C optotypes) by Snellen test types at a 5-metre distance away from the chart. The lens was examined using a slit-lamp, positioning the illumination source at a 45-degree angle and the light beam being set to 2 mm width. A refraction or skiascopy was performed at each examination to determine the best corrected visual acuity. The auto refractometer Accuref-K 9001 Shin Nippon was used for refraction measurement. Pupils of the subjects were dilated with tropicamide 1%. After dilation of the pupils, funduscopy was performed with an ophthalmoscope of the direct monocular type and a slit-lamp, using a double aspheric lens of +78 dioptres.

The Teller Acuity Card test was used in infants and small children without language. In older children, an optotype test, mostly the Østerberg test or the LH test, was used. In the most cooperative children the visual acuity was tested with ordinary Snellen optotypes. Due to varying degrees of cooperation, the visual acuity sometimes had to be tested binocularly rather than in each eye separately.

Statistical analysis was performed using SPSS 20.0 statistical software. All experimental data were compared using χ^2 criterion of Pearson correlation, which helped to evaluate the data dependency. In order to verify the hypotheses, the significance level of $p < 0.05$ was chosen.

RESULTS

Out of the 11,406 children who were primarily eligible, the further study eventually included 6,171 (54.1%) children. The study eventually included 2,926 (47.4%) boys and 3,245 (52.6%) girls. Children were divided into five age groups: 1st group – age 0 to 1 year, 2nd group – age 1 to 4 years, 3rd group – age 5 to 9 years, 5th group – age 10 to 13 years, and 6th group – age 14 to 18 years. In the 1st age group there were 736 (11.9%) children, in the 2nd age group 1,289 (20.9%) children, in the 3rd age group 1,641 (26.6%) children, in the 4th age group 1,337 (21.7%) children, and in the 5th age group 1,168 (18.9%) children.

The prevalence of myopia was overall 35.6% (95% CI:34.41; 36.79) in the 0–18-year-old children. The prevalence of myopia increased from 1.5% (95% CI:1.2; 1.8) in the 0–1-year-old children to 44.7% (95% CI: 43.46, 45.94) in 14–18-year-olds ($p < 0.001$). The prevalence of hypermetropia was overall 14.1% (95% CI: 13.23; 14.97) in the 0–18-year-old children. The prevalence of hypermetropia decreased from 84.6% (95% CI: 83.7; 85.5) in the 0–1-year-olds to 11.4% (95% CI: 10.61; 12.19) in the 14–18-year-olds ($p < 0.001$). Astigmatism was found in 25.5% (95% CI: 24.41; 26.59) ($p < 0.001$) (Fig. 1).

The prevalence of myopia was significantly associated with female gender (20.3%) (95% CI:19.3; 21.3) ($p < 0.001$); hypermetropia was associated with male gender 43.4% (95% CI:42.16; 44.64) ($P < 0.001$) (Fig. 2).

The presence of hypermetropia was significantly associated with a low birth weight 61.8% (95% CI: 60.59; 63.01) ($p < 0.001$) but astigmatism was associated with a higher birth weight 22.1% (95% CI:21.06; 23.14) ($p < 0.001$) (Fig. 3).

56.1% of preterm babies have hypermetropia (95% CI: 54.86; 57.34) ($p < 0.001$) (Fig. 4).

The prevalence of hypermetropia was associated with children who were born by cesarean section 57.1% (95% CI: 55.87; 58.33) ($p < 0.001$) (Fig. 5).

In families in which both parents have myopia, 47.9% of their children also have myopia (95% CI:46.65, 49.15) ($p < 0.001$). Parents with astigmatism had 100% of their children with hypermetropia ($p < 0.001$) and 61.2% of their children with astigmatism ($p < 0.001$) (Fig. 6).

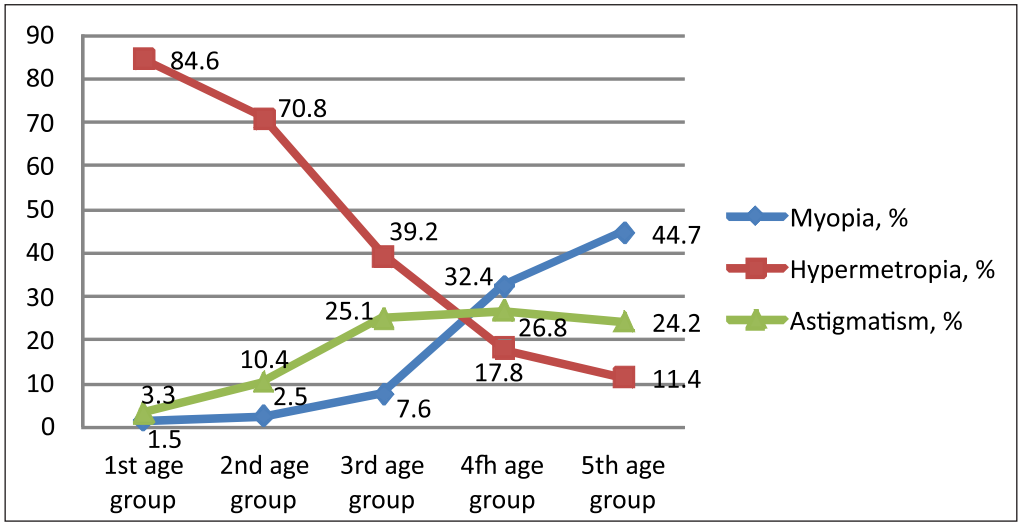

Fig. 1. Age and refractive error

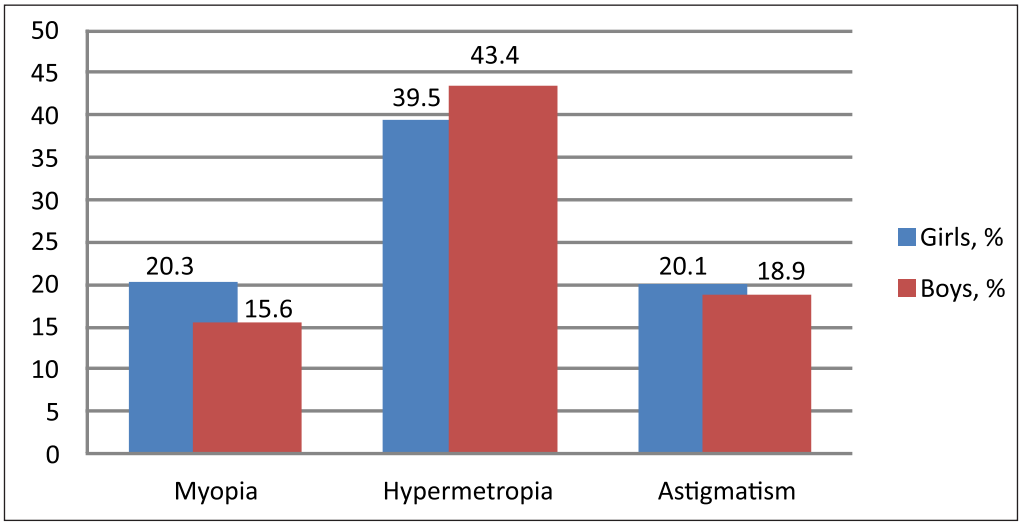

Fig. 2. Gender and refractive error

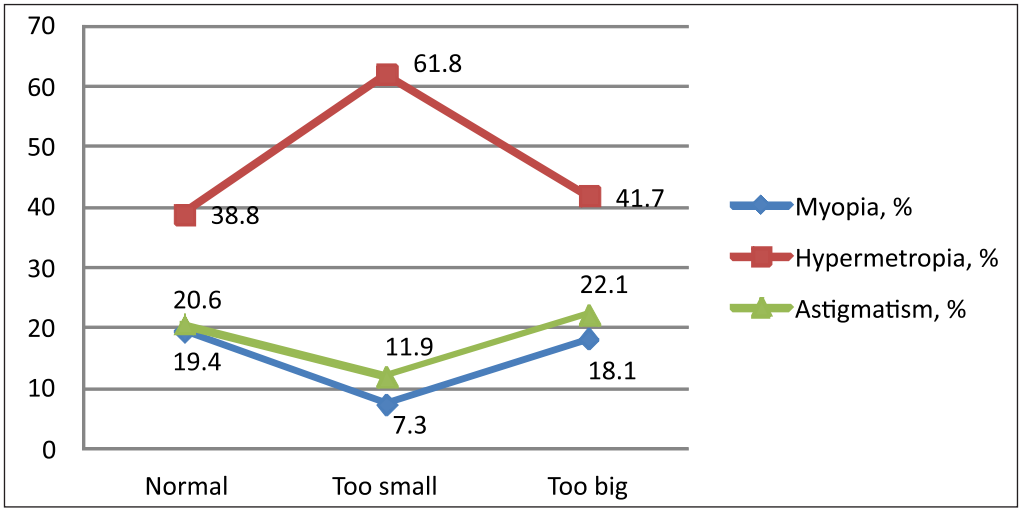

Fig. 3. Low birth weight and refractive error

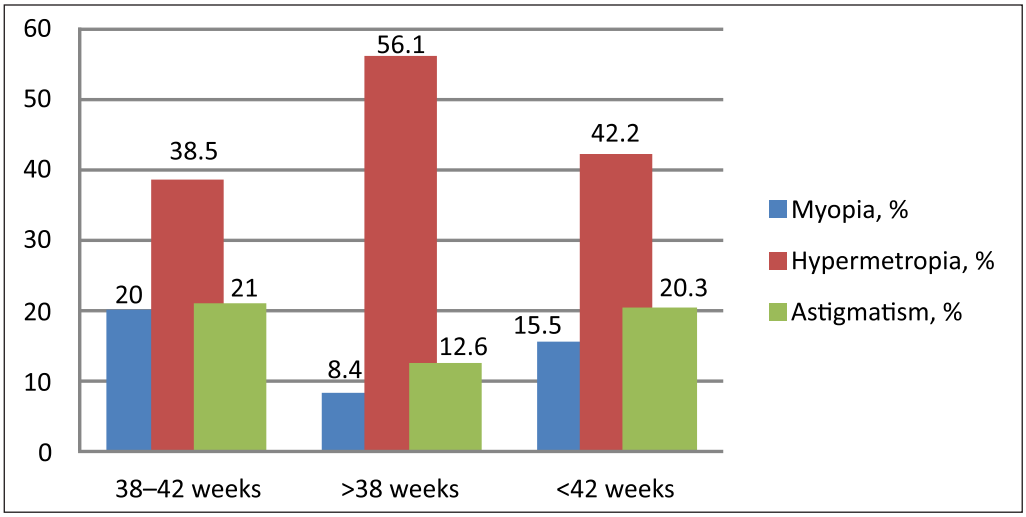

Fig. 4. Gestational age and refractive error

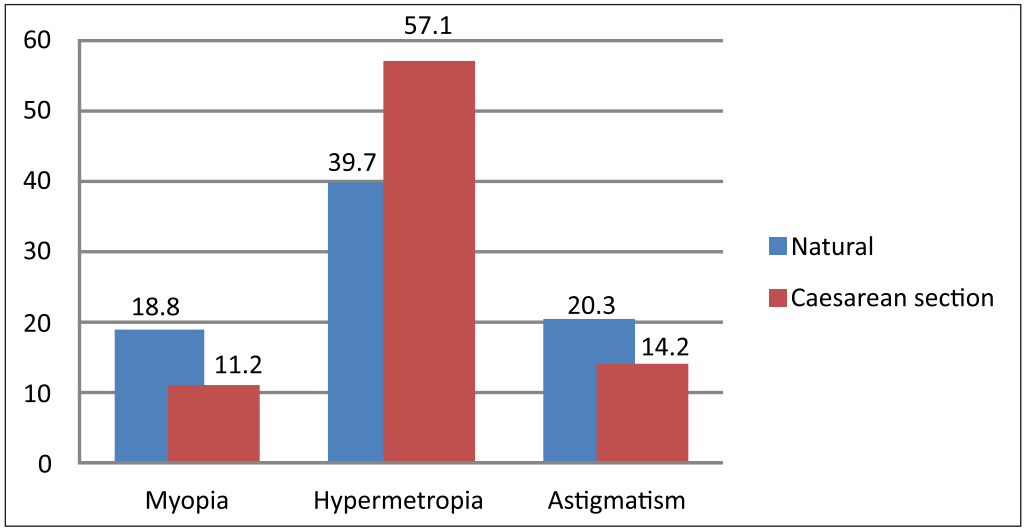

Fig. 5. Method of delivery and refractive error

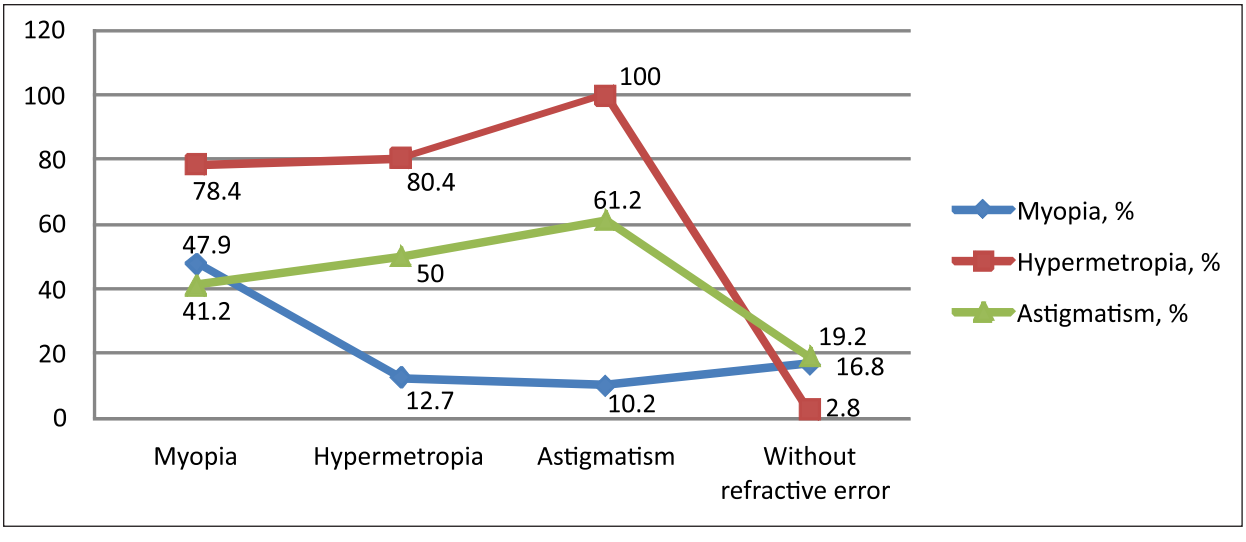

Fig. 6. Association between parents' refractive error and children's refractive error

DISCUSSION

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. Of these, about 43% are visually impaired as a result of refractive errors, which is the principal cause of visual impairment in children (22). Refractive error is a condition of the eye in which the eye fails to focus the image on the retina, resulting in blurred vision (23). 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. 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 an 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 between 5 and 15 years of age, making a global prevalence of 0.96% of this condition (24). The prevalence of myopia is still high among primary and middle school students. Myopia is associated with both genetic factors and individual eye health-related behaviours (25). Myopia usually starts around 9 years of age and progresses throughout adolescence. Hyperopia usually affects younger children, and astigmatism affects all age groups (26).

In several Asian countries the prevalence of myopia is over 80%. Among late teenagers and young adults in Korea, Taiwan, and China the prevalence is now between 84% and 97% (27–29). Children are becoming myopic at a younger age (30). In our study, the prevalence of myopia increased with older age as well (in the 0–1-year-old children the prevalence of myopia was 1.5% (95% CI:1.2, 1.8); in 14–18-year-old children it was 44.7% (95% CI:43.46, 45.94) ($p < 0.001$).

Astigmatism is a common condition in children. It may play an important role in visual development for a number of reasons. First, some researchers have speculated that persistent astigmatism may disrupt emmetropization by prohibiting the formation of a clear image on the retina (31–33). Studies have suggested that uncorrected astigmatism early in life could influence the development of myopia. Secondly, infants with higher astigmatism may develop amblyopia (34). Thus, some clinicians view any astigmatism as an urgent reason for refractive intervention. Thirdly, schoolchildren are considered a high-risk group because uncorrected refractive errors can seriously affect their learning abilities (35) and their physical and mental development (36). Studies have documented the prevalence of astigmatism in a range of samples, including urban and rural populations (37, 38), special groups (39, 40), and clinic patients (41).

Marked differences have been reported in different ethnic groups. The Refractive Error Study in Children (RESC), an international study of refractive error and other visual disorders in school-age children, was designed to assess the prevalence of refractive error and vision impairment in children of different ethnic backgrounds and cultural settings (42). Using a standardized study protocol, it is possible to compare studies of patients with different ethnic backgrounds and cultures. A random cluster design was used to recruit children from primary schools across urban and rural settings in Tunisia. In this investigation the prevalence of astigmatism was 6.67% and increased statistically significantly with age ($P = 0.032$), but was not significantly related to gender ($P = 0.051$). In our investigation we found similar results; the prevalence of astigmatism was 25.5%, astigmatism increased with older age and was not associated with gender (43).

Different studies have reported contradictory findings regarding the relationship between gender and astigmatism. We observed no statistical difference in the prevalence of astigmatism between genders. Similarly, other studies of similar age groups performed in Singapore (44, 45), rural Malaysia (46) and South Africa (47) did not find any differences in astigmatism between genders. However, there have been reports of a higher prevalence of astigmatism in females from Nepal (48), and the urban populations in India (49), Chile (50), and China (51, 52). Prematurity has been associated with increased refractive errors including myopia (53, 54). However, it is also associated with hypermetropia (55). Verma et al. also reported

an inverse relationship between gestational age and the incidence of refractive error (56). Infants with low gestational age and low birth weight had low spherical equivalent measurements; however, astigmatism is not associated with gestational age or birth weight (57). In a cohort study comprising low birth weight children who were born preterm, the prevalence of all refractive errors was reported to be higher than the control group who were born at term and involved in another study (58). In our study, we also included both premature and small gestation age (SGA) children and found that hypermetropia is associated with being SGA. Myopic children had higher birth weights than emmetropes.

The discrepancy between our study and the others may result from other factors that have a role in inducing myopia. Myopia has been shown to be affected by environmental factors such as near work, educational access, and urbanization, as well as genetic factors (59, 60). Genetic factors may have a greater contribution to the early development of refractive error compared to environmental factors (61). Chen T et al. found that the RASGRF1 gene may play a role in the development of high myopia, especially in Asians (62).

Received 1 August 2016
Accepted 1 June 2017

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REFRAKCIJOS YDOS, BŪDINGOS VAIKAMS, APSILANKIUSIEMS LIETUVOS SVEIKATOS MOKSLŲ UNIVERSITETO LIGONINĖS KAUNO KLINIKŲ VAIKŲ AKIŲ LIGŲ POLIKLINIKOJE NUO 2012 M. SAUSIO 1 D. IKI 2012 M. GRUODŽIO 31 D.

Santrauka

Įvadas. Refrakcijos ydos – vis aktualesnė vaikų sveikatos problema visame pasaulyje. Nuolatos daugėja vaikų, kuriems diagnozuojama trumparegystė. Statistikos duomenimis, pasaulyje yra apie 285 mln. silpnaregių, iš kurių net 90 % gyvena išsivysčiusiose šalyse. 80 % silpnaregystės atvejų galima išvengti atliekant reguliarų regos patikrinimą.

Tyrimo tikslas. Atlikti refrakcijos ydų tyrimą vaikams, apsilankiusiems Lietuvos sveikatos mokslų universiteto ligoninės Kauno klinikų Vaikų akių ligų poliklinikoje.

Tirtųjų kontingentas ir tyrimo metodai. Ištirti 11 406 vaikai nuo mėnesio iki 18 metų, turintys refrakcijos ydą ir 2012 01 01–2012 12 31 laikotarpiu lankėsi LSMUL KK Vaikų akių ligų poliklinikoje. Tiriamųjų vyzdžiai buvo plečiami tropikamidu 1 % arba ciclogiliu 1 %.

Rezultatai. Miopijos paplitimas tarp vaikų nuo 0–1 metų (1,5 %, 95 % PI: 1,2; 1,8) iki 14–18 metų (44,7 %, 95 % PI: 43,46; 45,94) išaugo ($p < 0,001$). Tam įtakos turėjo vyresnis amžius ir moteriškoji lytis (20,3 %; 95 % PI: 19,3; 21,3) ($p < 0,001$). Hipermetropijos paplitimas vaikų populiacijoje (14,1 %; 95 % PI: 13,23; 14,97) nuo 0–1 metų amžiaus (84,6 %; 95 % PI: 83,7; 85,5) iki 14–18 metų amžiaus (11,4 %; 95 % PI:10,61; 12,19) sumažėjo ($p < 0,001$). Hipermetropija buvo siejama su vyriškąja lytimi (43,4 %; 95 % PI: 42,16; 44,64), mažu gestaciniu svoriu (61,8 %; 95 % PI: 60,59; 63,01) ($p < 0,001$), mažu gestaciniu amžiumi (56 %; 95 % PI: 54,86; 57,34) ($p < 0,001$), gimimu po cezario pjūvio (57,1 %; 95 % PI: 55,87; 58,33) ($p < 0,001$). Astigmatizmo paplitimas siekė 25,5 % (95 % PI: 24,41; 26,59) ($p < 0,001$), jis siejamas su moteriškąja lytimi (20,1 %; 95 % PI: 19,1; 21,1) ir dideliu gestaciniu svoriu (22,1 %; 95 % PI: 21,06; 23,14) ($p < 0,001$).

Išvados. 44,7 % 14–18 m. vaikų diagnozuota miopinė refrakcijos yda. Hipermetropija diagnozuota 84,6 % ištirtų 0–1 metų amžiaus vaikų. Astigmatizmo paplitimas iki pilnametystės siekė 25,5 %. Refrakcijos ydoms pasireikšti įtakos turi amžius, lytis, gestacinis svoris, gestacinis amžius, genetika.

Raktažodžiai: miopija, hipermetropija, astigmatizmas