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REFRACTIVE DISORDERS IN CHILDREN

Larisa-Bianca Holhos[1], MD, Assoc. Prof. Mihaela Coroi[1,2], MD, PhD, Teodora Holhos[3], MD, Ioana Damian[4], MD, Jessica Chereches[1], MD, Prof. Lazar Liviu[1], MD, PhD

[1] Faculty of Medicine and Pharmacy, University of Oradea, Romania
[2] Emergency Clinical County Hospital, Oradea, Romania
[3] Faculty of Medicine and Pharmacy, "Vasile Goldis" West University, Arad, Romania
[4] "Iuliu Hatieganu" University of Medicine and Pharmacy, Cluj-Napoca, Romania

ABSTRACT

According to current estimations, globally, there are around 150 million people with an uncorrected refractive disorder, which means 27% of the world's population. Approximately 1.4 million of these are children and have a milder or more severe form of visual dysfunction secondary to refractive errors. Since 1990, refractive errors are considered to be a public health problem among children and cause visual dysfunction, with a prevalence of up to 43%. Vision maturation occurs in early childhood, when all the senses and motor skills work together to acquire language, first ideas about the environment and all the elements that define the person himself. Sight is a contributory perceptual system for the cognitive, social, sensory-motor development and for the assemblage of information about the environment. In the first years of life, the child increasingly discovers complex activities, requiring the ability to change the eyes fixation in space from one point to another and a normal binocular motility.

Keywords: refractive errros, children, sight, amblyopia

INTRODUCTION

A third from the population has an uncorrected refractive disorder [1] and of these, 1.4 million are children [2]. Visual impairment secondary to refractive errors are a major public health problem and have a prevalence of up to 43% [3].

Any process that interferes with the proper development of the eyeballs structure or any of the elements that make up the visual analyzer has the potential to cause visual impairment [4,5]. Visual impairment is a limitation of the eye function or of the visual system and can manifest as a reduction in visual acuity, loss of visual field, low sensitivity to contrast, photophobia, diplopia, visual impairment, or any combination of the above [6-8].

Uncorrected visual dysfunction is one of the most prevalent disabilities of children [9,10]. Almost 50% of the children, worldwide, are diagnosed with a refractive disorder of any type [2]. Sight, this sense so fragile, but also primordial and complex, requires the hierarchical participation of photoreceptors in the retina, the transmission of information through the optic nerve and optical radiation to the level of visual cerebral cortex. Once the information reaches the visual cortex, it begins its analysis and metamorphosis to obtain a visual perception [2].

The sense of sight can be tested through visual acuity, but also includes other functions such as visual field, color perception, contrast sensitivity, light / dark sensitivity, three-dimensional vision and binocularity. Sight incorporates three functions: the perception of form, light and movement.

An uncorrected refractive disorder can affect cognitive development, socio-professional integration [11], and it has been shown that cognitive development is delayed in children with severely affected visual function, compared to those children who have good visual acuity [12]. Although children with corrected refractive disorders have the same lifestyle as

Corresponding authors:
Larisa-Bianca Holhos, MD
E-mail: lariholhos@gmail.com
Assoc. Prof. Mihaela Coroi, MD, PhD
E-mail: opticlar@gmail.com

children without refractive errors, they still experience various restrictions in their free time, while playing a sport, but also social restrictions [13]. Visual dysfunction secondary to a refractive error produces a real psychological impact on the child, who becomes anxious and confused.

Approximately 90% of children with an unidentified refractive disorder and secondary visual impairment do not have access to adequate education due to combined factors such as stigma and discrimination, although most causes of ocular dysfunction secondary to uncorrected refractive errors are treatable. In Africa, the most common eye diseases in children are caused by vitamin A deficiency, eye infections, or the use of traditional eye remedies [14]. In highly industrialized Europe, uncorrected refractive errors, strabismus and amblyopia are most common in children [15].

Refractive errors are the leading cause of visual dysfunction in Asian children, but also in Hispanics [16]. The prevalence of refractive errors has been described as being higher among children with disabilities, but they are often lost out of sight due to the emphasis on other health issues and their management. Refractive errors are more common among premature babies, among those with cerebral palsy and genetic syndromes predisposed to eye abnormalities. If severe visual impairment or blindness can easily be observed, many mild deficits are not always easy to identify or to observe [16].

The American Academy of Pediatrics recommends that the eye exam be performed immediately after birth, then annually [17] until the age of 6-7 years old, and that the diagnosed eye diseases be treated early and intensively so that the future adult can have a successful socio-professional life. Children are born with a certain refractive status, related to gestational age. Premature babies can be born with myopia, and those born at term have hyperopia [18]. Sight guides all the other senses, the future child, all the tasks so they become cummulative, an early visual experience being the basis of everything that follows. 85% of everything that a child learns at school is achieved through his visual perception, so that any degree of visual dysfunction causes an imbalance of the general development of the child. If a developmental delay occurs, an attempt to remedy it should be made, but what matters is life expectancy [19], so that sight often suffers, due to the fact that this is not considered to be a contributing factor for a developmental delay [20]. Refractive errors and amblyopia are common and can be prevented and/or treated.

Testing of visual acuity must be performed by well trained staff and may be influenced by the instruments used to determine it, the brightness of the room where the test is performed, the individual motivation, the surrounding noise at the time of determination [21].

Visual dysfunction is a decline of the visual system functions, being a heterogeneous condition, depending on the cause, severity, age of onset and rate of progression. Severe visual dysfunction, even secondary to uncorrected refractive disorders profoundly affects the child's social development, with the possibility of leading to autism spectrum disorders [21].

RISK FACTORS FOR REFRACTIVE DISORDERS IN CHILDREN

Genetic and environmental factors, premature birth, family history can be risk factors for the occurrence of refractive errors. Certain genetic conditions such as Down syndrome, autism, cerebral palsy, deafness, mental retardation may be associated with the occurrence of certain eye conditions. Teratogenic factors, prematurity, cerebral palsy, Down Syndrome are all risk factors for refractive disorders in children.

About half of the children with visual impairment due to a refractive error also have other health problems, with a greater impact of the general development, requiring individual management [22].

REFRACTIVE ERRORS

Right after birth, the growth rate of the eye makes it hyperopic, a feature that will be reduced to the age of six, seven years old, when many children are without diopters or contrary, their eyes reach +2.00 diopters [23]. The distribution of the prevalence of refractive errors in children, worldwide, cannot be precisely defined, as this is often changeable by differences in ethnic groups, methods of measurement, even though studies still show an epidemic-type increase in myopia, globally. Usually, pediatric ocular morbidity is primarily caused by refractive errors [23].

Following a meta-analysis, it has been shown that the most common refractive error in children is astigmatism, followed by hyperopia and myopia [24]. The prevalence of refractive errors in that meta-analysis presents a different distribution, depending on the region, as exemplified in table 1 [23]:

TABLE 1. *Distribution of the prevalence of refractive errors, depending on the country*

Country	Refraction disorder		
	Myopia %	Hyperopia %	Astigmatism %
Australia	14.02%	8.4%	38.4%
China	54.1%	15.5%	undeclared
Poland	13%	undeclared	4%
Iran	17.2%	56.6%	30.3%

Myopia

In regions such as Asia, myopia is prevalent, even epidemic and is a public health issue, which is why its management needs to be adequately [25]. Recently, studies have shown an alarming increase in the number of cases of myopia worldwide, starting at the age of six, its overall prevalence being estimated at 1:6 [26]. Most often, myopia begins in early childhood, increasing in frequency and severity in both adolescence and adulthood [27].

Up to 90% of the East Asian pediatric population has myopia, the increase being linear with age, while the prevalence in European children is up to 20%. South Asians have much lower myopia values. Children in urban areas have a 2.6 higher risk than those in rural areas to develop myopia, for all ethnic groups and the ratio of girls vs. boys is 2: 1 until they reach the age of 18 [28]. The high rate of myopia in urban areas lies in the crowded environment [29], working too much in front of computer, documents [30,31], some researchers attesting there is a link between time spent outside and the onset of myopia [32].

Formerly considered a benign condition, myopia is an important risk factor for eye conditions such as retinal detachment, glaucoma, choroidal neovascularization that affects the quality of life [33].

Correction methods consist of wearing eyeglasses, contact lenses or even refractive surgery, without impact on the progression of axial elongation [34]. A risk factor for myopia is the family history of myopia [35], which correlates with the axial length of the eyeball [36]. It is the most studied refractive condition, among the causes being incriminated genetics, nutrition, accommodation of the lens and convergence of the eyes. The management of myopia depends on the etiology. Stopping the progression of myopia in the adolescent population has been and is still of great interest. Topical muscarinic antagonists, such as atropine, have confirmed in well-conducted clinical trials that they may delay the progression of myopia [37].

Recently, orthokeratology [38,39] or corneal remodeling using gas-permeable contact lenses have been shown to be effective in reducing the progression of myopia. The most important factor in the progression of myopia is its age of onset [40], the progression being faster once the myopia began at an early age. The frequency of myopia in rural areas varies between 2.60% - 23.2% in children aged 5-15 [41].

People with special needs have various myopia values that need to be corrected to ensure a good quality of life. 9.1% of children with various disabilities have myopia [42], more precisely 7.7% of those with Down syndrome, 46.7% of those with autism and 9.1% of those diagnosed with deafness. Those with Down syndrome usually have high myopia values [43].

Hyperopia

It is a common refractive error, with a prevalence that varies depending on ethnicity and geographical location. Moderate and high hyperopia can cause visual dysfunction, more precisely amblyopia, so an early detection is desirable so that the educational and socio-professional path of children is not affected. High value hyperopia is associated with strabismus or amblyopia. These children make an accommodation effort if the hyperopia is uncorrected, so they are at risk of developing esotropia, especially if the degree of hyperopia is higher [44].

Some risk factors for the onset of hyperopia are white race and consumption of toxins during pregnancy [45]. Consumption of toxins throughout pregnancy, especially tobacco, increases the risk of hyperopia for the child and is a race-independent factor. Moreover, smoking by one of the parents throughout the pregnancy protects against the development of myopia. Nicotinic receptors thus appear to play a role in modulating the axial elongation of the eye, so that it remains hyperopic [46]. The prevalence of hyperopia varies from 8.4% to 56.6% [47,48].

In the meta-analysis performed by Hashemi et al. [49], the prevalence of hyperopia has the lowest value in Europe, 1.04% and the highest prevalence is 32.59% in the Western Pacific. The prevalence of hyperopia in children raised in Iran is 4%, in Nigeria it is 6.1%, while in Malaysia is the highest, 28.2%. The prevalence of hyperopia in children with disabilities is 6.7% [49].

Astigmatism

Astigmatism may be secondary to corneal diformities, changes of the lens [49] and is a treatable cause of visual dysfunction. It develops if the incident rays do not converge on the retina at a single point, due to an irregularity of the cornea, or of the lens that does not have a spherical shape [49]. Associated symptoms are blurred vision, distortion of vision in space, asthenopia and headache. It may be associated with amblyopia [50]. This refractive error occurs when our visual system does not have a good perception of a point, because there are differences in the strength of the corneal meridians.

The prevalence of this refractive error differs depending on race [48,51], sex and age [52]. It is also influenced by genetic factors, with a higher prevalence than myopia and hyperopia, between 30% and

77% [52]. The African race, the presence of a high-grade of myopia or hyperopia, smoking during pregnancy are also risk factors for the occurrence of astigmatism. Nicotine influences the refractive status by activating the nicotinic receptors of the eyeball [53]. In emetropic eyes, a small astigmatism according to the rule, of corneal cause, is compensated by an astigmatism against to the rule, caused by the lens. If it occurs early, it may be associated with amblyopia.

Against the rule astigmatism is 2.5 times more common in children up to 3.5 years, and the one according to the rule is three times more common in those over 5 years. It is a risk factor for amblyopia [53].

Amblyopia

It is one of the causes of visual dysfunction in children and occurs when the corrected visual acuity is suboptimal in one or both eyes, resulting from the disruption of visual stimuli. Amblyopia is considered to be the third most common cause of eye morbidity, along with strabismus, in children under the age of 16 [54]. Amblyopia can be secondary to strabismus, deprivation one and refractive one. Deprivation amblyopia occurs as a result of various eye conditions such as cataracts, ptosis or corneal opacity [55]. Strabismic amblyopia is characterized by the presence of exotropia or esotropia. There are also mixed, deprivative and strabismic forms [56].

One of the main goals of visual screening is to detect amblyopia because of its effects on children and society. It is estimated that 2-4% of children are affected by amblyopia [57,58], with variations depending on the population studied, but also depending on the study. The percentage can rise to 13.8% [59]. Those diagnosed with amblyopia are more prone to bilateral visual dysfunction compared to the non-amblyopic population [60]. Amblyopia can be treated by optical correction, occlusion of one eye or the use of atropine in the non-amblyopic eye [59]. Various studies report that amblyopia can be treated later in life, but the most effective treatment is the one that is applied in childhood [56].

CONCLUSIONS

No matter the age, sex or nationality, children can be diagnosed with refractive errors of any type. Moreover, an uncorrected refractive error can lead to amblyopia, impacting negatively the quality of a child's life. A rigorously eye exam should be done before the child enters school so that the general development of the child can develop properly and thus, also the academic and social life can become easier for the child.

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