Mini Review

Refractive error & childhood visual impairment

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Introduction

Refractive error is the leading cause of visual impairment in school age children. Effective strategies need to be devised to provide low cost corrective spectacles in the community. It is reported that 5-25% of blindness in some countries is caused by refractive errors and as much as 4% of the population sees less than 6/18 because of this condition. Uncorrected refractive error is the main cause of low vision and the second cause of blindness globally.[1] Worldwide, nearly 1% of all children in the age group 5-15 years are visually impaired from uncorrected or inadequately corrected refractive errors, with the highest burden reported in urban areas of south-east Asia and in China.[2] In India, it is estimated that 2-3% of school children in rural areas have refractive errors, the proportion being higher in urban areas. A recent study from Delhi schools showed that the prevalence of myopia was 13.1% and only a 25% of them were wearing appropriate spectacles.[3] Large-scale community-level screening for refractive error at regular intervals under school eye screening programs has become the strategy of choice for its prevention.

Types of refractive errors among children

Refractive errors found among children are myopia, hypermetropia (or hyperopia) and astigmatism. This is based on whether parallel rays of light from a distant source get converged in front of retina (myopia) or behind retina (hypermetropia) while the eyes are not accommodating and whether the convergence of light rays is unequal along the two principal meridians (astigmatism). Astigmatism and myopia-hypermetropia can co-occur in the same eye.

Genesis of refractive error in children: theory of emmetropization

At birth, all humans are born hypermetropic and the ocular changes between birth and puberty follow a leptokurtotic distribution that overwhelmingly favors emmetropia and is skewed towards myopia.[4,5] It appears that emmetropization can be accounted for in part by coordinated growth of the eye and in part by some form of vision dependent feedback system for ocular refractive development. During childhood, vitreous depth increases, crystalline lens power and thickness decrease, and anterior chamber depth increases.[6,7] By itself, an increase in vitreous depth would cause a change towards myopia. By itself a decrease in crystalline lens power would cause a change toward hyperopia. As these changes occur simultaneously, the net change in refractive error is thus reduced.

Refractive changes in children occur as a part of the physiological growth of the eye and is a continuous, dynamic process. At the age of five years, most children are emmetropic.[8] Studies conducted in school-age children demonstrate that children with +1.50D or more of hyperopia at 5 or 6 years of age stay hyperopic at the age of 13-14 years. The authors also reported that majority of children with refractive errors in the range of +0.50 to +1.24D at 5-6 years remain in the emmetropic range at 13-14 years while children with either no refractive error or with myopic refractive error usually have manifest myopia at 13 or 14 years of age.[9,10]

Ocular growth and development of refractive error in children is influenced by a variety of genetic (familial clustering as well as ethnic variations), and environmental factors such as increased near work (reading, writing), and decreased time spent outdoors. Genetic linkage studies have revealed multiple loci and 25 different genes involved in changes in extracellular matrix composition and hence, ocular growth and various functional pathways, implicating the role of mitochondrial cell death and photoreceptor-mediated pathways in the genesis of refractive error.[11,12] The prevalence and degree of myopia is also dependent on ethnicity and geographic locations. Role of ultraviolet light exposure and serum levels of vitamin D has also been explored in various epidemiological studies for development of myopia.[13] From a public health perspective; the prevalence of uncorrected refractive error is dependent on facilitating factors and barriers to use of spectacles. Uncorrected refractive error is usually seen in populations with lack of screening and awareness about refractive error, non-availability of refractive error services, non-affordability of spectacles and various cultural and social barriers prevalent in a specific population.

Impact of uncorrected refractive errors among children

Identifying children with refractive error is important since the deficiency in vision may have an impact on the personal as well as academic development of the child. Children, usually do not complain of defective vision especially if only one eye is involved. They may not even be aware of their problem. They adjust to the poor eyesight by sitting near the blackboard, holding the books closer to their eyes, squeezing their eyes and even avoiding work requiring visual concentration. This evades early detection. High refractive errors if left untreated may lead to development of secondary amblyopia. Timely detection of these problems and their correction by spectacles can tremendously improve the child's potential during his formative years.

Efforts for prevention of uncorrected refractive errors

Eliminating visual impairment due to uncorrected Refractive error among school children is an important priority under the India's National Programme for Control of Blindness (NPCB). The School Eye Screening (SES) program was made an integral part of NPCB, India in 1994 and was implemented in students of middle and secondary schools i.e. 5th-10th standard classes. This included screening and refraction followed by provision of free spectacles to students requiring correction. To facilitate early screening, identification and management of refractive error in children, screening in primary schools has been included in the program since 2012 under the XIIth Five Year Plan.

Concerted efforts by other countries and governmental agencies have also shown similar results. A new model of preschool vision screening was implemented in Seoul where 36,973 kindergarten children aged 3-5 years were screened and they observed that although this model was accessible to parents and was easy to administer, poor participation rate was seen on referral to ophthalmologists.[14] In East Malaysia, an epidemiological study was conducted in school children to develop national strategies targeted at childhood refractive error. It was observed that a huge burden of uncorrected refractive error existed in this population.[15] Similarly, in Nepal, a school vision screening programme was targeted at poor government schools and this intervention proved to be appropriate for this population.[16] Another programme supported by Hellen-Keller foundation in South African school children demonstrated lack of association between degree of refractive error and level of visual impairment.[17]

Impact of school vision screening interventions

A recently conducted WHO-SEARO workshop involved primary school teachers and students of 25 schools of Delhi in an effort to strengthen the School Vision Screening programme. During this screening, 6066 children were examined and spectacles were provided free of cost to 270 children with refractive error. On follow up, which was conducted six months after the spectacles were dispensed, facilitating factors and barriers to use of spectacles by children were noted. The key facilitating factors for compliance to spectacles was the benefit and clarity of vision they perceived with use of glasses. Many students reported relief of symptoms like watering and headache after refractive correction. The main reasons for non-compliance were that the school children were mocked/teased by their fellow mates. Some students also had problem in handling and proper maintenance of spectacles. It was alarming to find that in certain cases, teachers had not distributed the spectacles to the children even when the spectacles had been dispensed by the optician. In some of the families, use of spectacles by the children is still a stigma and thus their parents disapprove to wear spectacles. In a small population, non-compliance to spectacles was associated with gender-discrimination and parents were more partial towards their male child as compared to the female child.

Authors recommendations

Uncorrected refractive errors among school age children are a priority for any health program for eliminating visual impairment. Mostly, the development of refractive errors can be attributed to variations in the normal physiological process of emmetropization. Certain modifiable risk factors (time spent indoors and outdoors) have been recently identified which may be targeted for primary prevention of refractive errors. Secondary prevention is a major strategy through early detection and treatment of refractive errors in school vision screening programs. Ensuring that the identified students are provided corrective spectacles and that they continue using them, remains a major challenge. It calls for a strong involvement of school teachers in not just the screening activity but also in follow-up of children as well as reaching out to parents of children to overcome gender biases and improve compliance.

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Conflicts of interest

Authors declare that there is no conflict of interest.

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