Global vision

Part 2 - Children and visual needs

Continuing our series looking at the impact of global trends on eye health, Dr Padmaja Sankaridurg examines the effects of population growth and demographic changes on children’s vision.

Uncorrected refractive errors

The RESC surveys and other studies have shown that, in both urban and rural populations, the proportion of children who suffer from visual impairment due to refractive errors is quite significant and ranges from 55-93 per cent. A WHO publication estimated that in 2004, there were 12.8 million children aged 5-15 yrs that were visually impaired due to uncorrected refractive errors.

The prevalence of uncorrected refractive error is said to be influenced by many factors. An important factor is socio-economic status leading to availability and affordability of corrective devices. A cross-sectional study evaluated the pattern of visual impairment in school children from low-income families (schools with a slum situated in half a kilometre radius and in the public system) in Kolkata, India. Of the 2,570 children, 372 had refractive errors amenable to correction but only four of these (1 per cent) were wearing spectacles.

Similarly, the presence of vision impairment due to refractive error was present in 267 of 4,238 (6.3 per cent) school children in central and rural Ethiopia but only 11 children (0.3 per cent of population) were wearing spectacles.

These data suggest that there is an unmet need for services in identifying children with vision impairment due to refractive error, providing them with a pair of spectacles and also monitoring compliance and overcoming barriers to the use of these interventions.

However, uncorrected refractive error may not simply be a problem isolated to low socio-economic or rural regions. The 2004 WHO publication found vision impairment to be high in urban areas and even in economically advantaged societies. Delving into the type of refractive errors causing visual impairment, it was found that refractive error was mostly due to myopia, with high prevalence in urban areas and in countries within Asia.

In addition, there is another noticeable fact: the mostly frequently seen refractive error is myopia. With this condition, there is an evident rural-urban divide with a greater number of eyes in urban areas presenting with myopia. It appears that urbanisation, with its close living spaces and lack of sufficient outdoor activity, is precipitating a change in the visual demands imposed on the eye and a trend towards increasing prevalence of myopia. Further, evidence indicates that both prevalence as well as the magnitude of myopia are on the rise.

Clearly, the approaches to remedying uncorrected refractive errors and to stemming the rising epidemic of myopia appear to be starkly disparate. The former is mostly a public health challenge that requires development of resources and infrastructure, and sustainable approaches to eliminating the problem. The latter requires research into factors involved in the development and progression of myopia, and ways to control the problem.

However, as detailed below, it appears that these issues are interrelated to a certain extent. Also, both issues are equally relevant as the burden of these conditions is substantial, affecting the economic and social circumstances of growing children and their families as well as society at large.
Clearly the problem is not entirely attributable to myopia. But there is enough evidence to suggest that targeting and understanding the development and progression of myopia is a critical element in the overall strategy aimed at reducing the burden, and providing excellent vision and vision-related quality of life for our current and future generations of children.

More immediately, the findings indicate a need for effective screening of children at community level, providing appropriate correction such as a pair of spectacles and addressing the barriers to uptake and compliance with these devices.

The rising problem of myopia

Taking a closer look at myopia, the prevalence of the condition has reached significant proportions in some East Asian countries, with nearly 80 per cent of those aged 18 years and over myopic. The evidence for the rise in prevalence is compelling and is also evident in the Western population. In 2013, approximately 22 per cent of the world population (1.45 billion people) is considered to be myopic and 8-10 per cent is considered to be myopic.

In 2013, approximately 22 per cent of the world population (1.45 billion people) is considered to be myopic and is estimated to increase to nearly 30 per cent (2.45 billion myopes) in just under two decades (year 2030).

More alarmingly, the prevalence of high myopia (>6.00D) will also concurrently rise, with a consequent increased risk of vision loss from sight-threatening conditions such as retinal detachment, glaucoma and chorioretinal degeneration.

Commonly used vision correction devices such as spectacles and contact lenses correct for refractive error and allow the eye to see clearly but do not counter the mechanism driving axial length growth. Myopia thus continues to progress and necessitates frequent eye care consultations and changes of spectacles. The associated direct costs are a significant burden. And, when uncorrected, myopia constrains the development of the child in all domains, ie health, social and economic, and affects their quality of life.

It is now generally accepted that both environmental and genetic factors play a role in the development and progression of myopia, but their individual contributions and interactions are not yet clear. A high correlation of refractive error between twins, and data showing that children with myopic parents are more likely to become myopic, support a genetic element. Conversely, the urban-rural divide in prevalence, along with animal studies that ocular growth and the refractive state of the eye can be modulated by optical defocus, support environmental factors.

Of the hypotheses advanced to explain myopia, the theory that myopia is associated with near work has received the most attention and, given the link between near work and ‘accommodation’, attention turned to the state of accommodation in myopia. Studies reported accommodative lag to be greater in myopic eyes than non-myopic eyes with resultant hyperopic defocus at near distance.

Bifocal and progressive addition spectacle lenses intended to reduce myopia progression make use of this observation to reduce accommodative demand. However, a large, well conducted clinical study using progressive addition spectacles found only a minor, but clinically insignificant, retardation of myopia. Also, ‘under-correction’ to reduce accommodative demand did not produce any observable benefits and, in fact, some studies showed acceleration in progression of myopia.

To date, Atropine and other muscarinic antagonists such as Pirenzepine were found to be most effective for treating myopia, but the associated side-effects during use and concerns regarding rebound phenomenon post-treatment have limited their uptake.

Myopia control – new strategies

As a routine, myopia correction strategies involve measuring and influencing the refractive error state only at the central retina and do not take into consideration the refractive error state at the peripheral retina. However, relative to the centre, myopic eyes are hyperopic in the periphery, and some reports suggested that emmetropic eyes with hyperopic defocus at the retinal periphery are more likely to become myopic.

There is also substantial evidence from animal studies that the peripheral retina and peripheral vision playing a significant role in refractive development. In primate studies, form deprivation at the peripheral retina produced axial myopia in spite of clear vision at the fovea, and foveal ablation did not disrupt the emmetropisation process. These findings laid the foundation for the hypothesis that peripheral retinal hyperopic defocus stimulates the progression of myopia, and it was suggested that optically imposed peripheral myopic defocus can slow the axial length growth and progression of myopia.

The treatment approach incorporating this strategy shows that it is possible to influence the rate of progression of myopia. After 12 months of spectacle lens wear, progression of myopia with a rotationally asymmetrical novel spectacle lens was found to reduce the progression of myopia significantly in younger children aged 6 to 12 years who had parent(s) with myopia (30 per cent less; 0.68±0.47D with novel spectacles versus -0.97±0.48D with conventional single-vision spectacles).

Contact lenses incorporating such treatment profiles show a greater reduction in progression of myopia. The annual progression in the rate of myopia was reduced by 34 per cent for spherical equivalent refractive error and 33 per cent for axial length in eyes wearing contact lenses with...
Eye care and global trends

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peripheral treatment in comparison to conventional spectacles. In addition, contact lenses that induce simultaneous myopic defocus over much of the retina have shown similar effects with slowing the axial growth.

Furthermore, orthokeratology with contact lenses has been shown to be effective and it has been suggested that the corneal changes induced with orthokeratology provide a refractive error profile at the retina that induces peripheral myopic defocus. These early results indicate that eye growth and progression of myopia can be influenced or altered in children with optical strategies and are encouraging.

While they indicate favourably, none of the aforementioned treatment strategies were optimised for the individual eye and further work is needed to understand the key factors and maximise efficacy for reducing the progression of myopia. Further, there are data indicating that outdoor activity may be protective for myopia and that there is seasonal variation in ocular growth with lesser growth in summer compared to other months and may be reflective of the nature of urban living.

These factors need to be considered in models that attempt to reduce the risk of development and progression of myopia.

Conclusions
The increasing shift towards urban living has influenced the ocular health and requirements of children. In spite of being contactable with a simple pair of spectacles, the prevalence of uncorrected refractive error is high in children and is seen across all populations. While it appears that in the low and middle income groups, the reasons are related to unavailability and unaffordability, increasing prevalence of myopia seems to be an important reason for driving the burden in urban populations, high socio-economic strata and in many Asian countries.

The burden of unavailability and unaffordability can be approached by allocating resources to screening for refractive errors and providing sustainable methods of delivery of correction. However, in the interest of reducing the burden long term across populations, especially the risk of sight threatening complications associated with high myopia, it is critical that we understand the factors that underpin the development and progression of refractive errors, especially myopia.

References


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