The Impact of Uncorrected Refractive Error on Global Health

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Purpose: The traditional definition of blindness was based on best corrected acuity. In 1999 the World Health Organization launched the Vision 2020 initiative which included uncorrected refractive error in its priority list of causes of preventable blindness. This paper is a summary of the research done recently on uncorrected refractive error.

Method: Studies reviewed in this paper addressed issues that included uncorrected refractive error, eyeglass utilization, visual quality of life issues with regard to uncorrected refractive error and low cost solutions to the problem of uncorrected refractive error.

Results: The Refractive Error in Children Studies showed a range of 1.4% incidence of significant uncorrected refractive error in South Africa to a high of 22.3% in urban China.

Spectacle coverage was measured to be 25.2% in Bangladesh. In a similar study in Timor-Leste only 15.7% of those with refractive error and 26.2% of the presbyopes had spectacle correction

Eyeglass utilization studies showed a widely varied level of compliance with only 13.4% wearing the glasses at follow-up in Mexico but 71.6% wearing them in Oman.
In Tanzania uncorrected presbyopia was shown to have a significant impact on vision-related quality of life and in Los Angeles the Visual Function Questionnaire was shown to correlate with visual acuity.

Conclusion: Much more needs to be done to determine the extent of the problem and the manpower and resources needed to solve the problem of uncorrected refractive error. In addition, quality of life issues, and impact of visual impairment on economic issues need to be studied so that their importance can be demonstrated to the public health decision makers.

Keywords: Refractive errors, presbyopia, blindness, visual impairment, eyeglasses, eyeglass/utilization, uncorrected refractive error, undercorrected refractive error.

Uncorrected refractive error is a major cause of blindness and the leading cause of visual impairment in the world. This work reviews the current literature on the prevalence of uncorrected refractive error, eyeglass utilization, the reported solutions to uncorrected and undercorrected refractive error and visual-related quality of life measurements.

In 1983 Schwab, L et al. reported that 13% of the significant vision loss in Kenya was due to uncorrected refractive error, which placed the condition third behind cataracts and trachoma on the list of preventable blindness Considering refractive error in the discussion of preventable blindness was unusual at this time.[1]

In 1992 the report entitled, "Epidemiologic Aspects of Global Blindness Prevention", listed cataracts, glaucoma, corneal blindness (mainly from trachoma), Vitamin A deficiency, macular degeneration, and onchocerciasis as causes of blindness but ignored refractive error problems.[2]

World Health Organization and Blindness Prevention

The World Health Organization (WHO) has a long history of blindness prevention starting with a trachoma program in the 1950's. In 1974 a program to control onchocerciasis was developed and in 1999 the Vision 2020 initiative was launched in Geneva with the following mission statement, ''Our mission is to eliminate the main causes of blindness in order to give all people in the world, particularly the millions of needlessly blind, the right to sight''. In the first phase of the initiative the focus was

placed on the prevention of cataract, trachoma, onchocerciasis, avoidable childhood blindness, uncorrected refractive error and low vision. [3]

In a press release on October 11, 2006 the World Health Organization announced its updated estimates of visual impairment. For the first time these figures included the 153 million people that have uncorrected refractive error. 13 million children and 45 million working age adults were reported to be affected globally with 90% of those living in low or middle income countries. These figures do not include the issue of presbyopia.

"These results reveal the enormity of the problem," said Dr Catherine Le Galès-Camus, WHO Assistant Director-General, Noncommunicable Diseases and Mental Health. "This common form of visual impairment can no longer be ignored as a target for urgent action."

"Correction of refractive errors is a simple and cost-effective intervention in eye care," said Dr Serge Resnikoff, Coordinator of WHO's Chronic Disease Prevention and Management unit. "Now that we know the extent of the problem of uncorrected refractive errors, especially in low and middle income countries, we must re-double our efforts to ensure that every person who needs help is able to receive it."[4]

Definition of Blindness and Visual Impairment

Blindness is defined in two ways. The traditional method is the best-corrected vision in the better eye of <3/60 (20/400). This is the acuity measured with the best possible lens correction. The other method uses presenting visual acuity, which measures the acuity with the presenting glasses or without glasses if uncorrected. The presenting

visual acuity method takes uncorrected refractive error into account and is a better method of measuring functional vision levels. The WHO uses the <3/60 (20/400) in the better eye for blindness, while the standard in the U.S. <is 6/60 (20/200) in the better eye.

With blindness defined as presenting visual acuity <6/60 in the better eye, blindness due to refractive error was reported to be 0.36% in India (1 in 280), in China it was 0.59% in people over 50,[5] and in the U.S. in people over 40, it was reported to be 0.33% in blacks and 0.34% in whites.[6]

Visual impairment is often set at <6/12 (20/40) and that is the level required for a driver's license in the U.S. but the WHO definition is <6/18 (20/60). Spectacle correction is the simplest and most cost effective method to improve vision but uncorrected or under corrected refractive error is the primary cause of vision impairment throughout the world. [7]

Refractive error in Children

Beginning in 1998 the Refractive Error in Children survey was conducted in several geographic districts. A population-based method was used in three different sites which included China, Nepal, and Chile. Children from 5 to 15 were tested with an ophthalmic assistant doing visual acuity, lensometry, ocular motility evaluation and cycloplegia. Ophthalmologists then did eyelid and anterior segment examination, cycloplegic autorefraction, cycloplegic retinoscopy, subjective refraction, and media and fundus examination. Refraction was considered significant if there was myopia less than -0.50

diopters , hyperopia of more than +2.00 diopters or astigmatism of 0.75 diopters or greater. Similar studies were subsequently done in South Africa, in rural and urban India and in rural and urban China. The percentage of children that had uncorrected refractive error of <6/12 in the better eye and could improve to <6/10 were as follows; South Africa 1.4%, rural India 2.7%, Nepal 2.9%, urban India 6.4%, rural China 12.8%, Chile 15.8%, and urban China 22.3%. [7-12]

In South Africa the percentage of children affected is the lowest with only 1.4% having uncorrected visual acuity of <6/12, but the lack of public services in the country results in many children that are uncorrected. Of the children identified as having significant refractive errors 81% were not wearing spectacles. [9]

The survey in urban Guangzhou, China produced the highest percentage of refractive error with 21.1% in need of refractive correction. Myopia was the most common condition and the incidence was much higher in the older children (73% of 15 year old children in Guangzhou were myopic). 74% of the children with refractive error had spectacles but 30% of that group were undercorrected by 2 lines or more in the better eye. Half of the children in need of first time or updated spectacles were without them.[8]

A study of grade seven students in Singapore showed 22.3% had uncorrected refractive error and it was more common among students with low academic ability. Due to the high level of myopia and the progressive nature of the myopia in Singapore the study concluded that children should have their vision examined once every 6 months.[13]

Adults Studies

In Ecuador causes of blindness in all the cases presenting in the ophthalmology clinic in a 3 week period where studied. The most common cause of bilateral blindness (WHO definition <3/60) was refractive error 37%, followed by cataract 23%, and glaucoma 17%. [14]

The Blue Mountain study in Australia in 2002 concluded that increasing age, disadvantage and isolation were correlated with uncorrected refractive error. They reported that 10% of the older population improved by two lines or more on the logMar acuity chart. There was a 51% increase in uncorrected refractive error for each 10 year increase in age.[15]

Aging was also cited in Proyecto VER, a study done of the Mexican American population in Arizona. Best corrected acuity worse than 20/40 increased from 0.3% in those from 40 to 49 years old to 18% in those 80 years old and older. The overall prevalence of presenting visual acuity worse than 20/40 was 8.2% with uncorrected refractive error accounting for 73% of that number.[16]

Bangladesh

In Bangladesh a large nationally represented sample of 12,782 adults over age 30 were selected and of those 11,624 were examined. 22.1% were myopic (<-.50 D) and 20.6% were hyperopic (>+.50D). This study introduced the concept of spectacle lens coverage percentage which the author describes as [met need/met need + unmet need] x 100%.

This gives a percentage of those who would benefit from glasses and have the appropriate prescription lenses. The spectacle coverage percentage was 25.2% using a <6/12 cut off.

They found that of the people with glasses 81% had inadequate correction and they estimated that 72.4% of the subjects that would benefit from spectacles would be suitable for "off the shelf" spectacles (equal sphere -3.00D to +3.00D pre-made spectacles). [17]

Timor-Leste

Spectacle coverage percentage for refractive error and presbyopia where addressed in this population based survey of Timor-Leste. Timor-Leste is a recently emerged democracy in Southeast Asia and in terms of social and health indicators is one of the poorest countries in the world. 1,414 people were examined and those with uncorrected or undercorrected refractive error (presenting acuity of >6/18 but <6/18 with pinhole), uncorrected or undercorrected presbyopia (near vision worse than N8) and/or who were using or had used spectacles were identified. The spectacle correction coverage was determined to be 15.7% for refractive error and 26.2% for presbyopia. This was one of the few studies that looked at the issue of presbyopia.

Rural dwellers, farmers and illiterates were found to be more likely to have uncorrected refractive error. 96% were found to be willing to wear spectacles but only 30% were willing to pay US$3.00 for spectacles and 43.3% were unwilling to pay at least US$1.00 for spectacles.

The study concluded that there was a large need for refractive error and presbyopia correction, especially in the elderly, illiterate people, farmers and rural dwellers. However, these are the people who are least able to pay and therefore some form of cross-subsidized program was suggested. (e.g. Very low cost pre-made spectacles for poor made possible by selling custom made spectacles to the wealthier groups.)[18]

Low Cost Solutions

There were a few solutions cited in the reviewed literature. Maini et.al looked at the feasibility of providing a stock of ready made spectacles for correction of refractive error. This study was conducted in Australia where adults age 40 to 60 were studied. Astigmatism of greater than .75D and anisometropia greater than .50D were excluded as they were considered unacceptable candidates for ready made spectacles. The study found that 20% of the population would be suitable for ready made spectacles and that an inventory from -3.50D to +3.50 would correct 89.2% of the non or low astigmatic, non-anisometropic population with refractive errors. [19]

In a report by Jerry Vincent, the International Rescue Committee trained 48 refugee health workers to do basic refraction. These workers provided the care for refugees in camps along the Thailand-Burma border. Equal sphere ready made glasses were dispensed to those in need. 84% were given for presbyopia, 10% for myopia and 6% for hyperopia. 11 powers were used +1.00 to +4.50 in .50D steps and -1.00 to -2.50 in .50D steps. Very few of the population studied required correction outside of the powers used. [20]

Compliance

A few studies have looked at spectacle lens compliance and the results have varied widely. In Oman 71.6% of schoolchildren were wearing their spectacles at a one year follow-up visit. [21]

In Guangzhou, China 70% of the children in need of spectacle lens correction were wearing glasses at the time of their examination. Of the children for whom spectacles were never purchased, lack of parental awareness was identified as the problem in half of the cases. For cases for which parental awareness was not the problem, half simply did not want their children wearing glasses and one fourth stated cost as the issue.[8, 22]

In India of the people over 15 years old with refractive error of +/-3.00D or worse were surveyed and only 34.2% were wearing their glasses at the time of the follow up. 43.8% of those not wearing their spectacles cited that either the prescription was incorrect or the frame was uncomfortable. Since people with refractive error of +/-3.00D or worse are likely visual impaired, it was speculated that the root cause was poor quality of refractive services.[23]

In a study of school age Mexican children, only 13.4% of the children were wearing their spectacles (another 34% had spectacles with them but were not wearing them). The glasses had been provided at no charge by Helen Keller International. The leading reason given for not wearing the glasses were related to appearance. The study used round

frames that could accommodate on the spot correction for astigmatism. The study concludes that new strategies are needed to improve compliance. [24]

Quality of Life

Vision-related quality of life issues were examined by two of the reviewed studies.

The Los Angeles Latino Eye Study used the 25 item National Eye Institute Visual Function Questionnaire (NEI-VFQ-25). The NEI-VFQ-25 was designed to assess visual functioning in relationship to a number of ocular diseases. It has been demonstrated to have a moderate correlation with glaucoma and a large correlation with cataract. This was a large population based study and it concluded that a 5 point difference in the NEI-VFQ-25 was associated with a 2 line difference in visual acuity. [25]

In a recent survey in Tanzania the impact of presbyopia on quality of life was examined. Distance and near visual acuities were measured and the subjects completed a near vision-related quality of life questionnaire. The prevalence rate of presbyopia was 62% and the majority (94%) did not have spectacles. The study concluded that uncorrected presbyopia has a significant impact on vision-related quality of life and that the high incidence of presbyopia and the increasing aging of the population in developing countries suggests that the WHO's Vision 2020 initiative should have a greater emphasis on presbyopia.[26]

CONCLUSION

There seems to be a lack of research available on the prevalence of refractive error. It was not always easy to compare information from the studies reviewed. There were may different approaches to measuring uncorrected refractive error. Some used the WHO's blindness guidelines, some used the U.S. guidelines. Study methods ranged from using simple visual acuities measurements to doing cycloplegic subjective refractions. The Refractive Error in Children Studies only counted hyperopes if their cycloplegic refraction was > +2.00 while others set the cut off at >+1.00.

There are studies that estimate the direct and indirect cost of visual impairment and blindness but they typically ignore uncorrected refractive error. Cost studies of the effects of uncorrected refractive error should be done so that the public health decision makers have the facts needed to implement a visual health care plan.

There have been more studies in children than in adults but uncorrected refractive error affects more of the adult population. Only one study addressed presbyopia and only one study addressed the willingness to pay for spectacle lenses.

Cultural differences need to be considered to help improve the awareness of the benefits of eyeglasses so that the efforts and materials are not wasted by the non-compliant. In addition, glasses that are attractive and durable should be a goal.

Without appropriate eyeglasses, millions of children are losing educational opportunities and adults are facing vocational limitations. Families are frequently pushed into a cycle of deepening poverty because of their inability to see well.

Uncorrected refractive error was virtually ignored until recent years. Now the problem is getting the world wide attention that it deserves. Models of sustainable vision care need to be developed and adapted to the cultures of each country in order for the goal of Vision 2020 to be achieved.

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