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The Evolution of Uncorrected Refractive Error as a Major Public Health Issue

This paper is an expanded version of the address given at the award of the 2013 James Cook Medal for Science and Humanity by the Royal Society of New South Wales.

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Abstract

Uncorrected refractive error has only recently (2006) been formally recognised as a significant cause of blindness and the major cause of impaired vision in the world. It is now known that over 625 million people have uncorrected refractive error (for distance and near vision), simply because of a lack of an eye examination and appropriate spectacles.

Accumulating evidence indicates that myopic macular degeneration (MMD) is a major cause of vision impairment and blindness – but this contribution of MMD to blindness prevalence is yet to be recognised by the World Health Organization (WHO) and national research bodies such as the US National Eye Institute (NEI). In 2010, there were an estimated 1.7 billion myopes worldwide – predicted to increase to around 2.2 billion by 2020 – with a small but significant percentage of those affected likely to progress to high myopia. High myopia significantly increases the risk of blinding conditions such as MMD, glaucoma and cataract.

This article details the crucial epidemiological work and advocacy efforts that have positioned uncorrected refractive error on the global health agenda and charts the evolution of myopia as a major public health issue which still requires a supreme coordinated effort to combat this encroaching 'epidemic'.

Keywords: uncorrected refractive error; myopia; presbyopia; blindness; myopic macular degeneration; vision impairment

Uncorrected refractive error – the major cause and most easily treated form of vision loss

More than half of the world population experiences clinically significant refractive errors for distance or near vision. In the United States (2004), for example, 55% of the US population 40 years and older had clinically significant distance refractive errors such as myopia, hyperopia and astigmatism (Vitale et al., 2008) and over 100 million people (32% of the population) were presbyopic in 2005 (Holden at al., 2008).

On World Sight Day 2006, the WHO released its 2004 findings that 153 million people were either blind or visually impaired due to uncorrected distance refractive error (World Health Organization, 2006).

The WHO Assistant Director General, Dr Catherine Le Gales-Camus, said in the associated press release: "These results reveal the enormity of the problem. This common form of visual impairment can no longer be ignored as a target for urgent action."

Even today the lack of available spectacle correction around the world is a major issue. In 2005, over one billion people (15% of the world population) had near refractive error (presbyopia) and more than half (517 million) were uncorrected (Holden et al., 2008).

In 2014, 108 million had uncorrected distance refractive error (Bourne et al., 2013). Altogether, 625 million people (9% of the world population) were still blind or vision impaired due to uncorrected distance and near refractive error. Despite WHO declaring uncorrected refractive error a global priority, agencies and civil society, with one or two exceptions, have been slow to respond.

Recognition of uncorrected refractive error

The impact of uncorrected vision impairment, whether distance or near, includes increasing social isolation, reduced employment and educational opportunities, increased morbidity and poverty (World Health Organization, 2006, Khanna et al., 2007, Naidoo, 2007, Taylor et al., 2006, Holden, 2007).

Key events that helped bring the issue of uncorrected refractive error to the forefront included the formation of the Refractive Error Working Group of the International Agency for the Prevention of Blindness (IAPB), the inaugural World Congress on Refractive Error and Service Development in Durban, South Africa (2007) and a key paper published in the Bulletin of the World Health Organization by Resnikoff et al. (2008).

The recognition of uncorrected refractive error required a change in the definition of vision impairment and blindness used by the International Statistical Classification of Diseases and Related Health Problems (ICD-10) from "best corrected distance visual acuity (vision with correction)" to "presenting distance visual acuity".

The limitation of the current ICD-10 classification is that it still excludes hundreds of millions of people (the majority living in developing communities) with near vision impairment.

In 1999, the IAPB and WHO jointly launched the Vision 2020: The Right to Sight initiative, which set the ambitious goal of eliminating avoidable blindness by the year 2020.

Cost of eliminating the burden of uncorrected refractive error

Studies have shown that the global cost of uncorrected refractive error due to lost productivity was US$202 billion each year (Smith et al., 2009, Fricke et al., 2012).

Part of the issue is the lack of availability of eye care personnel and to address this, a complex program of optometry school development, human resource development, infrastructure, affordable equipment and spectacles is required.

Addressing both distance and near uncorrected refractive error globally would require an investment of US$28 billion over 5 years (Fricke et al., 2012).

The US$28 billion would cover:

- 47,000 functional clinical eye care providers – to assess vision and eye health and prescribe corrective lenses needed to restore good vision;
- 18,000 optical dispensers – to provide appropriate glasses;
- Establish the service delivery facilities needed;
- Operating costs for facilities for 5 years, after which it is assumed that revenue generated by the service would cover costs.

The next phase would be to secure the continual support and funding to build the human resources and sustainable eye care systems required.

Despite uncorrected refractive error now being firmly on the blindness prevention agenda, it has yet to become a primary activity of the vast majority of non-governmental organisations (NGOs) and there is a general lack of awareness at the health ministry level.

Uncorrected presbyopia

As mentioned earlier, the ICD-10 definition of vision impairment and blindness is based on "distance visual acuity" only, resulting in 517 million people with uncorrected presbyopia (near vision impairment) unrecognised, despite uncorrected presbyopia being shown to have a similar quality of life impact as uncorrected distance vision impairment (Tahhan et al., 2013).

Uncorrected presbyopia is mentioned in the Resnikoff et al (2008) paper, where it is noted that "presbyopia is not included in this study given the present paucity of data, but it is recognized that uncorrected, it could lead to an impaired quality of life", and further, in the paper's conclusion, that presbyopia should be "…assessed and included in future estimates of visual impairment".

The formal recognition of near visual impairment due to uncorrected presbyopia awaits the alteration of the definition of visual impairment from "distance visual impairment" to "distance and near visual impairment".

The emerging threat of myopia

In addition to the burden of uncorrected refractive error, myopia and higher levels of myopia are a type of distance refractive error that is fast emerging as a major threat to vision throughout the world (Wong et al., 2014).

It is estimated that there were 1.7 billion myopes in 2010 and by 2020 there will be 2.2 billion (Holden et al., 2014). Despite a significant proportion of those having access to corrective lenses, the progressive nature of the condition means ongoing management is required. Although spectacle lenses provide an immediate solution to the poor distance vision resulting from myopia, they do not address the abnormal growth of the eyeball that occurs due to increasing levels of myopia which can lead to vision impairment and blindness later in life (Wong et al., 2014).

Higher levels of myopia, e.g. –6.00 dioptres or more (this level of myopia is often used as a 'convenient' arbitrary lower limit for 'high myopia', despite myopia being a continuum), lead to a significantly increased risk of sight-threatening conditions such as myopic macular degeneration (MMD) (Wong et al., 2014), retinal detachment (The Eye Disease Case-Control Study Group, 1993), glaucoma (Qiu et al., 2013) and cataract (Younan et al., 2002).

Of growing concern is that a substantial number of those with moderate myopia will progress to high myopia and evidence is now mounting that MMD is a major cause of vision impairment and blindness (Iwase et al., 2006, Wu et al., 2011).

A recent study by Wu et al. (2011) found that MMD is now the leading cause of blindness in Jing-An District, Shanghai, China (26% of all new blindness cases reported in 2007-2009), with rates of blindness increasing from 113.7 per 100,000 in 2003 to 165.9 per 100,000 in 2009. Iwase et al. (2006) also found that MMD was a leading cause of blindness in Tajimi, Japan.

However, MMD is not yet recognised by the WHO as a significant cause of vision impairment or by national research bodies such as the US National Eye Institute (NEI) and other epidemiological surveys, due largely to the lack of a categorical definition for MMD.

The prevalence of myopia in East Asia is increasing at alarming rates. In Taiwan, the rate of myopia in 12 year-olds increased from 37% to 61% between 1983 and 2000 (Lin et al., 2004) and 96% of university freshmen (males and females) were myopic in 2005 (Wang et al., 2009). In South Korea, 97% of male army conscripts were found to be myopic (Jung et al., 2012), while in Singapore 65% of college graduates have been reported as having myopia (Au Eong et al., 1993). In China, a country of over 1.3 billion people, a 2003 study (He et al., 2004) revealed rates as high as 78% among 15 year-old children in urban areas.

Myopia is also impacting western nations. For example, in Australia, the prevalence of myopia in children whose parents both have myopia is 44% (Ip et al., 2007) and 31% of 17 year-olds were found to be myopic (French et al., 2013). In the United States, the prevalence has increased markedly in the last 30 years from 25% (1971-1972) amongst those aged 12 to 54 years to 42% (1999-2004) (Vitale et al., 2009). In 2010, it was estimated that there were 34 million myopes in the US and projected to increase to 44 million by 2050 (National Eye Institute, 2010).

Alongside the increase in the prevalence of myopia is also a growing prevalence in high myopia among younger age groups in some areas of Asia. For example, Lin et al. (1999) found that in Taiwan, 20% of 18-year-old girls had high myopia and a study in Singapore by Saw et al. (2005) found that 18% of 7-year-olds had high myopia.

This increase is not only evident in Asia. In the US, Vitale et al. (2009) reported an eight-fold increase in 'severe myopia' (defined as −7.9 diopters or above by the study authors) for the 18-54 years age group between 1971-1972 and 1999-2004.

Summary

The solution to uncorrected refractive error is simple but the logistics and planning complex. Sustainable solutions (not quick fixes) based on the development of human resources, infrastructure and affordable technology have proven to work best.

The elimination of this unnecessary burden on hundreds of millions of people needs to be achieved through scaled-up investment, and inclusive and intensified collaboration and community access through government, civil society, educational systems and corporate collaborations and partnerships.

The threat of high myopia-induced blindness needs to be addressed by benchmarking, research and implementation of successful strategies for slowing the progress of myopia in children.

There is now an urgent need for epidemiological studies to determine the full extent of the threat posed by MMD, for advocacy efforts to generate greater awareness, for investment in the research and development of effective interventions, and for requisite action in the form of better provision of services and methods of prevention.

The simple issue of refractive error affects billions of people and its lack of correction and control have very far-reaching consequences on peoples' lives; science, technology, innovation and public and private health collaboration can make a huge difference to the outcome.

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