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Review Article

# Review of the impact of presbyopia on quality of life in the developing and developed world

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## ABSTRACT.

**Purpose:** To examine the public health impact of presbyopia regarding its effect on quality of life (QoL) and society in both the developed and developing worlds.

**Methods:** A database was created from articles found on PubMed, the Cochrane Library and Science Direct using the following search terms: presbyopia, QoL, accommodation, impact, cost, prevention, treatment and public health. Articles were accepted into the database if they addressed presbyopia and public health.

**Results:** This study showed in the developed world presbyopic subjects treated with reading glasses suffered a reduction in QoL parameters compared with those who were younger and emmetropic. A small minority of subjects were assessed to be a candidate for additional non-spectacle treatment measures. In undeveloped areas, the manifestations of presbyopia were similar to the developed world in symptoms, age and reduced QoL. However, there was inadequate treatment of this condition, even with reading glasses. The availability of reading glasses ranged from 6 to 45%. Activities of daily living could not be accomplished as easily without near correction of reading. Reasons described for the lack of correction included: lack of access to medical care, poor awareness of decreased near vision, lack of motivation and cost. Overall scant data exist regarding presbyopia and its impact and how treatment affects QoL.

**Conclusions:** This review suggests that the effect of presbyopia and its treatments on QoL remain poorly described and incompletely treated, especially in developing areas of the world.

**Key words:** presbyopia – public health – quality of life – treatment

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## Introduction

Presbyopia is an age-related visual impairment that results from the gradual decrease in accommodation expected with age and may affect quality of vision and quality of life (QoL). As the amplitude of accommo-

dation diminishes, the range of clear vision may become inadequate for the subject's commonly performed near tasks. Presbyopia has been a known affliction since ancient times and generated enough problems in society that Plutarchus speculated to its mechanistic causes as long ago as 100 AD

(Barbero 2013). Everyone eventually develops presbyopia but symptoms may vary. The major risk factor for presbyopia is age although the condition may be affected by other factors including disease, trauma and medications (American Optometric Association 2010).

Presbyopia is classically believed to result from hardening of the lens although other causes have been described as well such as changes in tissue elasticity and the ciliary body (Weale 1962; Glasser et al. 2001; Heys et al. 2004; Strenk et al. 2005; McGinty & Truscott 2006; American Optometric Association 2010). An important contribution to presbyopia is loss of lens viscoelasticity and lens growth that accompanies advancing age (Burd et al. 2006). This loss of lens elasticity may be at least in part due to oxidized protein sulphhydryl groups within lens fibre cells from intraprotein cross-links that, over time, contribute to accommodative amplitude loss (Garner & Spector 1980; Lou & Dickerson 1992; Takemoto 1996; Bron et al. 2000; Hanson et al. 2000; Lou 2003). Lens growth increases the inelastic mass that must change shape for accommodation to occur.

Current treatments are corrective in nature either by optical (bifocals, trifocals or contact lenses) or surgical (accommodative intra-ocular lenses or laser or conventional corrective surgical techniques) refractive modification. No current pharmaceutical treatment

or remedy exists that reverses the natural ageing of the lens. For a condition that affects every adult, with a potentially deep lifestyle impact, very little information is available about the QoL or financial impact of presbyopia on society.

The purpose of this review is to examine the public health impact of presbyopia regarding its effect on QoL and society in both the developed and developing worlds.

## Materials and Methods

### Study criteria

The database was created (ADG) from articles published between 2002 and 28 February 2013 found on PubMed ([www.pubmed.gov](http://www.pubmed.gov)), Science Direct ([www.sciencedirect.com](http://www.sciencedirect.com)) and The Cochrane Library ([www.thecochranelibrary.com](http://www.thecochranelibrary.com)) using the following search terms: presbyopia, QoL, accommodation, economics, impact, cost, prevention, treatment and public health. Complete English language articles were retrieved, and studies were accepted into the database if they addressed presbyopia and public health. No specific exclusion criteria were defined for the study.

Search terms (specified above) were searched twice in all utilized databases. All articles meeting the above criteria were used in the analyses. Searches were quality checked by two of the other authors (LAN and WCS). The authors must have agreed that the article fulfilled the entry criteria. Data from articles meeting the study criteria data were entered into an Excel spreadsheet for each treatment.

The 'developed world' data were compiled from studies in Canada, France, Israel, Spain and the United States. The 'undeveloped world' data were collected from studies in Africa, Brazil, India, Nigeria, Saudi Arabia, Tanzania, Thailand and Timor-Leste.

## Results

### Quality of life, developed world

McDonnell et al. found, using the National Eye Institute Refractive Error Quality of Life instrument (NEI-RQL) in 38 older ( $\geq 45$  years) versus 75 younger ( $< 45$  years) emmetropic Americans that presbyopia was associated with reduced

vision health-related QoL. Monovision correction of presbyopia improved some measures of QoL, but it remained worse in younger subjects with emmetropia (McDonnell et al. 2003).

Luo et al. (2008) demonstrated in a cross-sectional study in 110 American patients that presbyopia corrected with glasses was associated with a nominal decrease in QoL, similar to that of treated hypertension. Approximately 10% of these patients suffered such inconvenience from presbyopic correction that they might have been candidates for non-spectacle surgical intervention (Luo et al. 2008). Also, Spierer and Shalev, in a clinical trial of 100 healthy hyperopic Israeli subjects, noted that low amplitude of accommodation at the age of 20 might predispose to earlier onset of presbyopia (Spierer & Shalev 2003).

In contrast, Leat and Mohr demonstrated that pre-presbyopes with prior visual impairment, including children, had reduced accommodation (Leat & Mohr 2007). Using a case-control study, the authors examined 21 Canadian low-vision patients with a variety of ocular conditions and indicated that the near visual deficit increased with increasing accommodative demand.

Several articles have investigated the change in QoL following refractive treatment for presbyopia. Richdale and associates prescribed a contact lens for an eye with a previously implanted intra-ocular lens (IOL). The target refraction for distance was emmetropia. They found at baseline, and after 1-month of contact lens use in 38 US patients who completed the NEI-RQL survey, that most (76%) preferred the multifocal [SofLens<sup>®</sup> Multi-Focal (polymacon) Visibility Tinted Contact Lens; Bausch & Lomb, Rochester, NY, USA] compared with monovision [SofLens<sup>®</sup> 59 (hilafilcon B) Visibility Tinted Contact Lens; Bausch & Lomb] intra-ocular lens (IOL) correction alone (Richdale et al. 2006). The basis of the preference appeared to result from the better vision and stereoacuity. Stereoacuity was  $158 \pm 220$  seconds arc at baseline,  $126 \pm 137$  seconds arc with multifocals and  $205 \pm 214$  seconds arc with monovision ( $p = 0.002$ ). Maxwell et al. evaluated by cost-benefit analysis of multifocal IOLs (MF-IOL) and noted, in 495 American cataract surgery patients, that 86% of patients were willing to pay at least \$5 per day to be spectacle independent

(Maxwell et al. 2008). The acquisition cost associated with bilateral implantation of two MF-IOLs was estimated at \$4000. Of the sample, 86% in the MF-IOL and 8% in the monofocal IOL group reported postoperative spectacle independence. The net cost-benefit of \$11 670 in the MF-IOL group exceeded the \$155 net benefit in the conventional monofocal IOL group over a period of 14 years.

Exploring a non-surgical correction technique Polat and associates, in 30 Israeli subjects, observed that perceptual training tasks improved on average by about 17 words/min reading speed in presbyopes with uncorrected near vision (Polat et al. 2012). After training, a presbyope would save approximately nine minutes when reading a 2000 word article at the smallest font size.

### Quality of life in the developing world

Patel et al. (2006) found in a cross-sectional survey in 1564 African subjects  $> 40$  years of age that the prevalence of presbyopia was 62%. The majority of presbyopes (94%) did not have corrective near-vision glasses. Compared with younger subjects, presbyopia increased the odds of any difficulty with near-vision tasks by twofold and the odds of having a difficulty with very demanding near-vision tasks by  $> eightfold$ . The degree of presbyopia was associated with increasing difficulty with daily tasks (Patel et al. 2006).

Laviers et al. (2010) found in a cross-sectional, population-based study of 381 Africans  $> 40$  years of age that the prevalence of presbyopia was 89% ( $n = 340$ ) and spectacle coverage was 18% ( $n = 60$ ). Barriers to accessing services included spectacles not being considered a priority by the patient and insufficient funds to pay for glasses. At follow-up, 175/187 (94%) of participants given spectacles still had them. Average satisfaction was 90%. The mean amount subjects were willing to pay for spectacles increased from \$2 at baseline to \$3 at follow-up.

Bekibele & Gureje (2008) evaluated 5587 Africans  $> 65$  years of age by completing the World Health Organization Quality of Life assessment instrument and noted that 453 (22%) reported difficulties with distant vision, 377 (18%) had difficulties with near vision and 312 (15%) reported difficul-

ties with both far and near vision. Impairment of near vision had a significant impact on all domains of QoL including physical, psychological and social environments of daily life. Distant vision demonstrated a significant decrement only in the domain of environment. After adjusting for the possible effects of age, sex and chronic physical illness, near-vision impairment accounted for 4% decrease in the overall QoL of elderly persons.

Sherwin et al. (2008) found using a cross-sectional survey in 111 African subjects  $\geq 50$  years old, analysed by testing near vision, that the unmet presbyopic need was 80% and the needs of presbyopic correction were fully satisfied in 5%. The authors believed that in low-income regions a high prevalence of uncorrected presbyopia exists, which is associated with near-vision functional impairment.

In Brazil, Duarte et al. (2003) studied 3007 subjects  $>30$  years old by cross-sectional surveying and observed a prevalence of presbyopia of 55%. The greatest increase in prevalence by age occurred between the ages of 35–39 and 40–45 years (from 11% to 28%) as well as from 40 to 44 and 45 to 50 years (28% to 66%). They noted a linear trend between age and the increase in presbyopia.

In Asia, Marmamula et al. (2011) observed in 3095 Indians that among the 974 subjects  $>35$  years, evaluated using the Rapid Assessment of Refractive Errors survey, presbyopia was present in 616 (63%) and was uncorrected in 512 (83%). The most frequently cited barrier to utilizing services was the lack of 'felt need' in 237 (46%) for correction. 'Lack of awareness' of presbyopia symptoms was reported by 82 (16%) of participants. Also, 'lack of access' and economic and personal reasons were reported by 13%, 13% and 12%, respectively. Spectacle correction for presbyopia was 19%.

Further, Nirmalan et al. (2006) in a population-based cross-sectional study, determined the prevalence of presbyopia in southern India in 5587 subjects  $\geq 30$  years was 70% ( $n = 3907$ ). Twenty per cent ( $n = 364$ ) of the 3907 subjects with presbyopia reported the onset of noticeable symptoms during these years. They noted an effect on performing activities related to near-vision tasks. Of the 3907 with presbyopia, 2734 (70%) were not currently using

spectacles, 2085 (76%) had difficulty recognizing small objects, and 1057 (38%) stated they were unable to manage any near work. Ramke et al. (2007) also used population-based cross-sectional surveying to investigate presbyopia in 1414 subjects with ages  $>40$  in East Timor in South-East Asia. A total of 32% ( $n = 457$ ) participants having under-corrected or uncorrected near vision were classified as having an 'unmet presbyopic need'. The presbyopia correction coverage was 26%. Lower correction coverage was associated with rural domicile, illiteracy and farming.

Vincent (2006) evaluated treating refractive errors in a rural adult population of refugees living along the Thailand–Burma border, to whom were distributed 7219 eyeglasses. Approximately 84% of corrective lenses were for presbyopia. The spectacle provision rates per 100 000 persons were 4284 for presbyopia. Eye care training was provided to local refugee healthcare workers, which allowed for effective sustainable, low-cost spectacle provision to a large population over an extensive geographic area in a challenging environment. The authors concluded that spectacle distribution programme could be implemented in areas where lack of resources or lack of technical support would prevent acquisition.

Lu et al. (2011) found in 776 Chinese  $>40$  years using population-based cross-sectional surveying that the 538 (69%) persons with presbyopia demonstrated worse self-rated (distance and near) vision and greater difficulty with activities of daily living than younger subjects. Odds of reporting any difficulty with daily tasks remained higher for presbyopes after adjustment for age, sex, education and distance vision. Compared with non-presbyopic persons, presbyopes more often reported diminished accomplishment in terms of household activities, social interaction, work and leisure time pursuits. Of the presbyopes, 65 (12%) reported requiring help from others, 80 (15%) and 46 (7%) stated feeling ashamed or embarrassed due to poor vision. In this study, the presbyopia-related limitations caused participants to restrict social interaction, household and leisurely activities due to shame and embarrassment of vision problems.

## Discussion

This study showed that subjects with presbyopia suffered reduced QoL both in the developed and developing world. In the developed world, several articles showed that presbyopic subjects treated with reading glasses suffered a reduction in QoL parameters compared with those who were younger and emmetropic. A minority of subjects were assessed to be a candidate for additional non-spectacle treatment measures.

Overall there remains a lack of data regarding the impact on QoL from presbyopia- and treatment-related QoL. This is a surprise to the authors because this condition affects nearly every middle-aged and older adult throughout the global community, although myopia or astigmatism may limit symptoms in some adults.

Most QoL-related studies reviewed were performed in the developing world, particularly in Africa and Asia. The authors found generally in undeveloped areas that the manifestations of presbyopia were similar to the developed world in symptoms, age and reduced QoL.

However, in the developing world, there was a lack of treatment or under-treatment of this condition, even with reading glasses, that is assumed generally in the developed world to be the easiest treatment intervention. The range of availability of reading glasses in these studies was from 6% to 45%.

In addition, several studies noted a reduction in QoL measures because activities of daily living could not be accomplished as easily without near correction of reading. One study indicated a host of factors for the lack of correction including: lack of access to medical care, poor awareness of decreased near vision, lack of motivation and cost.

What is the clinical significance of this review? The lack of data indicates, both in the developing and developed worlds, more research is needed to better quantify the problems related to presbyopia and ways to most effectively treat it in a cost effective manner. In addition, research to discover avenues of new treatment, both pharmaceuticals and devices, which would reverse the condition instead of correcting by refractive means, might also benefit presbyopic subjects.

Further, better cost analyses of current and new treatments would help private and government policy makers to decide on the best treatments to offer to presbyopic subjects in poorer areas. In these areas, the lack of spectacles also provides opportunity and challenges for religious-based charities and government agencies to assist developing areas.

This review suggests that the effect of presbyopia and its treatments on QoL remain poorly described and incompletely treated, especially in developing areas of the world.

This review was limited to reviewing past studies of QoL and cost measures of which many were cross-sectional evaluations. Although such studies are valuable, future study methods also might include prospectively designed longitudinal studies and randomized evaluations to best evaluate the most cost effective means of better treating presbyopia in the developing and developed worlds.

## Competing interests

The authors report no conflict of interest. The authors alone are responsible for the content and writing of the paper.

## Author Contributions

AD Goertz - acquisition of data. WC Stewart - conception and design, interpretation of data, drafting/revising the article, final approval. WR Burns - revising the article. JA Stewart - conception and design, revising the article, final approval. LA Nelson - acquisition of data, analysis of data, revising the article.

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