Impact of Presbyopia and Its Correction in Low- and Middle-Income Countries

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Abstract: Presbyopia affects more than 1 billion people worldwide, and the number is growing rapidly due to the aging global population. Uncorrected presbyopia is the world's leading cause of vision impairment, and as with other causes. The burden falls unfairly on low- and middle-income countries (LMICs), in which rates of presbyopic correction are as low as 10%. The importance of presbyopia as a cause of vision impairment is further underscored by the fact that it strikes at the heart of the productive working years, although it can be safely and effectively treated with a pair of inexpensive glasses. To galvanize action for programs to address uncorrected presbyopia in the workplace and beyond LMICs, it is crucial to build a solid evidence base detailing the impact of presbyopia and its correction in important areas such as work productivity, activities of daily living, visual function, and quality of life. The aim of this review was to provide an up-to-date reference for program planners and policymakers seeking to build support for programs of presbyopia correction, particularly in low-resource settings.

Key Words: blindness, presbyopia, quality of life, vision impairment, work productivity

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Presbyopia, an age-related condition, stems from a gradual loss in the eye's ability to change its optical power.[1] Although the precise mechanism underpinning the development of presbyopia is disputed,[2–5] it manifests as an inability to bring near objects into focus. To enable clear vision at near distances, inexpensive refractive devices such as near vision spectacles must be used.

Globally, there are an estimated 1.09 billion people living with functional presbyopia (2017),[6] 26 million of whom have near vision impairment (NVI) because they were not corrected or undercorrected (2018),[7] and a total global productivity loss of US$25 billion (2015).[8] Approximately 80% of these persons are unable to perform near vision–related activities satisfactorily.[9] More than 90% of the burden of presbyopic vision impairment falls on low- and middle-income countries (LMICs),[9] where rates of presbyopic correction with glasses are as low as 10%.[10,11]

The prevalence of presbyopia in LMICs ranges from 43.8% to 93.4%.[10,12–39] However, most of these studies are of somewhat limited value in understanding the burden of presbyopia, as they largely focus on distance vision, few were population-based, and definitions of disease and age group cut-offs also vary.

The definition of presbyopia is also potentially problematic. Many studies[10,16–19,40,41] define NVI as uncorrected bilateral near visual acuity (NVA) worse than N6 or N8 at 40 cm (the 40 cm equivalent of less than or equal to 6/12 and 6/15, respectively). However, most studies do not subdivide NVI into that which is correctable with near glasses alone (presbyopia) and that caused by other ocular morbidities, such as cataract. This distinction is of crucial importance to program planners and policymakers, as these conditions will require very different resources and strategies to manage.

A multicountry study conducted by He et al[10] resolves this issue by subdividing NVI into correctable NVI (best-corrected bilateral NVA > 6/12) or uncorrectable (≤ 6/12). Only persons with bilateral NVA less than or equal to 20/63 improving to more than 6/12 with spectacles are considered to be requiring near correction. This multicountry study also offers the advantages of having been population-based with standard age cut-offs in all settings and having focused primarily on near vision and its impairment. This approach offers the important advantage of highlighting presbyopia's strong association with the prime working years: prevalence of presbyopia defined as correctable NVI increased after 40 years, peaked by 55 years at most sites, and declined thereafter as uncorrectable NVI became more prevalent. This peak of presbyopia during working age has significant economic implications for presbyopic persons and the families and communities dependent on their earning power.

IMPACT OF UNCORRECTED PRESBYOPIA: NONTRIAL DATA

A variety of factors exacerbate the economic burden of uncorrected presbyopia in LMICs, for examples, the peak of presbyopia prevalence during the most economically productive years,[9] insufficient access to trained health care professionals who are able to perform necessary eye examinations, spectacles of low quality, and with low population coverage and compliance.[12,42,43] Despite the negative impact and high prevalence of presbyopia among older people,[1] vision impairment caused by presbyopia is not included in the World Health Organization's report on uncorrected refractive error.[44,45]

A growing body of literature, with a large majority of it being observational, has begun to document the impact of uncorrected

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presbyopia on a variety of important activities of daily living. Cross-sectional population studies in rural China[41] and Tanzania[32] provide low-quality evidence of significantly increased difficulty with activities of daily living among individuals with presbyopia. Lu et al[41] assessed the impact of NVI on visual functioning and quality of life in a rural adult population in Shenyang, northern China. Among the 538 subjects with functional presbyopia, compared with nonpresbyopes, they rated their overall vision (distance and near) to be worse; these patients faced greater difficulty with daily activities, and reported diminished accomplishment due to vision.

In another comparative study, Patel et al[32] determined the impact of uncorrected presbyopia on quality of life among 1564 rural Tanzanian adults aged 40 years and above. Among the presbyopic subjects (62%), over 90% did not possess near vision spectacles. Compared with those who were not presbyopic, those with presbyopia were twice as likely to report some difficulty with near vision tasks, 5 times as likely to experience moderate difficulty, and more than 8 times as likely to have great difficulty. Similarly, Nirmalan et al[19] have reported among 2734 uncorrected presbyopic adults in India that a fifth had moderate-to-severe difficulty in reading small print and more than three-quarters had moderate-to-severe difficulty in recognizing small objects and performing near work. Bekibele and Gureje[46] also found that among 453 elderly persons in Nigeria, NVI had a more significant impact on all domains of quality of life than distance vision impairment, and NVI accounted for a nearly 4% decrement in the overall quality of life of elderly persons.

A World Economic Forum report summarizing largely unpublished data indicated that 23% of office employees in a survey in Bangladesh reported NVI which compromised their ability to generate income.[47] The report further noted that workers with uncorrected poor vision in Rwanda were 3 times more likely to have their work rejected by quality control supervisors before their vision was corrected. Another survey among self-employed women in the slums of Delhi and Gujarat showed that 41% of respondents older than 35 years with uncorrected presbyopia reported less pay and fewer shifts worked due to blurry vision. Three months after the women's vision was corrected with reading glasses, the rate of people reporting a negative impact had dropped to 23%.[48]

More powerful are studies demonstrating that correction of presbyopia with glasses can reverse or alleviate reported difficulties with activities of daily living. A 6-month longitudinal study by Naidoo et al[49] investigated the impact of correction of presbyopia on productivity among 268 South African textile factory workers aged 40 years and above engaged in various visually intensive tasks. Work productivity was calculated as the weight of product (in kilograms) passing quality assurance per day. Machinists (6.6%), clothing pressers and quality controllers (5.8%) all recorded significant increases ($P < 0.001$) in productivity over baseline in the 6 months after receiving near vision spectacles. However, there was no control group included in the study. A longitudinal study conducted by Pradhan[50] in Madurai, India, compared the impact of presbyopic correction on work productivity among 238 cotton spinners and winders. The spinners showed an average improvement of 9.5%, with more than 67% of them improving their productivity by at least 10%. Nearly a quarter (23%) of winders also showed an increase of 10% in productivity. However, the quality of the study was compromised due to the inability to track individual data. Essilor's Eye Mitra optician program in India found that 59% of workers reported an increase in productivity after near vision correction with glasses, though productivity was not measured objectively in this study.[51]

Chan et al[52] assessed the impact of near vision spectacles on vision-related quality of life among 423 South African textile factory workers aged 40 years and above. Face-to-face interviews were conducted before and 6 months after the provision of glasses using the National Eye Institute 25-Item Visual Function Questionnaire.[53] An overall increase of 36.5% in vision-related quality of life scores was observed at endline, with scores increasing significantly ($P < 0.01$) for both men and women. Workers with lower education levels had significantly ($P < 0.01$) higher quality-of-life score gains than those who had begun or completed secondary school. It was suggested that those who were less educated benefited more from near spectacles because the impact of presbyopia on their near vision was accentuated by hyperopia. However, there was no control group included in this study.

A cohort study by Tahhan et al[54] investigated the utility associated with uncorrected refractive error among 246 patients with some form of NVI. It was found that adjusted utilities for those who had distance vision impairment, NVI, and those with distance and near vision impairment were 0.82 ± 0.16, 0.81 ± 0.17, and 0.68 ± 0.25, respectively. People with distance and near vision impairment rated their utility worse than those with either distance vision impairment or NVI (adjusted and unadjusted, $P < 0.01$).

A small study (n = 187) in Zanzibar addressing the impact of presbyopia correction with near vision spectacles on persons aged 40 years and above found moderate-quality evidence of large effects on work-related activities of daily living.[55] Near vision–related quality of life (measured with an adapted vision-related quality of life questionnaire from India[19] and Tanzania[12,32]) was the lowest of all subscores at baseline and had improved dramatically (effect size = 3.9, $P < 0.001$) by 6 months after provision of spectacles, whereas the effect of near vision on difficulty with daily activities such as reading small print and threading a needle had declined markedly as well (effect size = 2.43, $P < 0.001$).

IMPACT OF UNCORRECTED PRESBYOPIA: TRIAL DATA

To firmly establish causal association between provision of spectacles and real-world benefits such as improved work productivity, randomized controlled trials are needed. These have been unavailable in the peer-reviewed literature until recently. A randomized controlled, investigator-masked trial by Reddy et al[56] reported a highly significant 21.7% (more than 5 kg) increase in work productivity, measured as daily weight of tea picked, among presbyopic tea plantation workers in Assam, India, randomized to receive glasses versus those in the control group. Biologic plausibility of the finding was enhanced by significantly greater increases in productivity with spectacle provision among older workers, as might be expected for this age-related condition. Very large majorities of workers in the intervention group found glasses helpful and would pay to replace them if broken or lost. Vision-related quality of life also improved significantly among intervention versus control participants, with greater increases noted among older persons.

FUTURE TRENDS AND RECOMMENDATIONS

Along with the rapid aging of the population in LMICs, the

impact of NVI is likely to be further accentuated by the increasing dependence of near activities performed with electronic devices, such as computers and smartphones. It is estimated by the World Bank that the mobile cellular subscriptions per 100 people are 98.6 worldwide and 93.2 in China.[57] The latest mobility report from Ericsson also estimated that there are currently 3.9 billion smartphone subscriptions worldwide, which will reach 8.9 billion by the year 2022.[58] Although studies of the impact of presbyopia and its correction on use of devices such as smartphones in LMICs are still rare, a report from a population-based cohort in Guangdong, China (Congyao Wang, written communication, August 2018) found that among 451 people with correctable NVI who owned a smartphone, approximately 64% of them had difficulties using their smartphones. Difficulty of using smartphones was higher among people who had higher education level, worse NVA, and more time spent on using smartphones (1–5 hours per day).

Uncorrected presbyopia is a global problem but can be readily addressed with provision of low-cost, high-quality near glasses. Fricke et al[7] suggested that the prevalence of uncorrected presbyopia will decrease modestly in the years ahead on account of the rapid increase in the prevalence of myopia.[59] This reduction, though encouraging, should not diminish the drive to implement large-scale presbyopia-correction programs, not only because they are relatively affordable, but also because they can play an important role in the development of integrated eye care systems. Older persons with presbyopia are at a higher risk of developing sight-threatening conditions such as cataract, glaucoma, and diabetic eye disease. This can be accomplished by providing adequately trained personnel with the equipment required to detect ocular comorbidities, referring those in need of specialist care for treatment. Advances in smartphone-based telemedicine and artificial technology have the potential to accelerate and scale these initiatives.

Large-scale programs to accomplish this can help to achieve Sustainable Development Goals 1 (poverty alleviation), 3 (good health and well-being), 5 (gender equality), and 8 (decent work and economic growth).[60] To achieve this will require concerted action in LMICs, including elimination of artificial regulations prohibiting over-the-counter sales of near glasses in many countries, a significant increase in the number of personnel trained to refract, and investment on the part of ultimate corporate and government beneficiaries in sustainable and affordable systems of near spectacle delivery in the workplace and elsewhere. Correction of distance refractive error has been shown to be one of the most cost-effective blindness prevention interventions,[61] and given its higher prevalence and lower technical demands for correction, this is all the more likely true for presbyopia.

Correction of presbyopia also has a positive ripple effect, especially in LMICs[62] where spectacle uptake is still very low. Presbyopia correction motivates people to seek refractive care[61–64] and at the same time they are able to be screened for other ocular morbidities. With an effective health education strategy, the community can be sensitized with the necessary eye health knowledge.

CONCLUSIONS

Additional trials in other work settings such as factories are needed to extend the evidence base for workplace programs of spectacle distribution. Although over-the-counter sales of near glasses are commonplace in many rich countries, evidence of the safety and effectiveness of distribution models which do not rely on highly trained professionals is needed to remove artificial barriers to direct sales existing in many LMICs. This includes operational research on the efficiency of various distribution channels (such as community health workers, primary care clinics, and pharmacies or medical shops) in reaching low-income consumers, with different models of service delivery (such as spectacles provided free of charge versus sales models). Further qualitative studies are needed to better understand the dynamics of the demand-side and supply-side barriers to uptake of near glasses in different settings and to craft effective strategies to overcome them. With no trials and limited cohort studies which assessed the risk of occupational accident and vision impairment,[65,66] we recommend that the association of presbyopia and workplace accidents should be studied to further strengthen advocacy efforts. Finally, the gains in productivity attained with provision and regular wear of near vision glasses are at least equal to the declines in performance preceding job loss in similar workplace settings.[56,67] This implies that provision of near glasses at work can not only lead to enhanced productivity but may also result in greater job retention among older workers. Given declining rates of workplace participation in LMICs among workers aged 55 years and above,[68] there is a compelling need for trials which address the question of whether provision of near spectacles can allow presbyopic laborers to continue working, while supporting their families and communities.

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