THE IMPACT OF UNCORRECTED PRESBYOPIA: A SYSTEMATIC REVIEW

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ABSTRACT

Background: Although presbyopia is believed to be the 'most' common ageing physiological condition producing near vision impairment, little is known of its impact on quality of life of an individual.

Objective: To systematically review relevant literature investigating the impact of presbyopia on individuals.

Design: Systematic review.

Participants: People 35 years and older.

Methods: A systematic extensive search of data bases and the reference lists of retrieved studies were conducted using the standard methodology adhering to the PRISMA statement. The identified studies were assessed by 2 independent reviewers. The checklists from the Critical Appraisal Skills Programme (CASP) and Consolidated Standards of Reporting Trials (CONSORT) Guidelines tools were used to determine inclusion of studies in the review. Descriptive statistics was used to analyse the data.

Main Outcome Measures: Quality of life.

Results: A total of 3663 studies were retrieved and only 14 met the inclusion criteria. These studies included 11 cross-sectional studies and 3 cohort studies.

Conclusions: This review has demonstrated that while there are studies investigating the impact of presbyopia and presbyopic correction on quality of life and vision function, there is a limited number of studies that follow the scientific rigor to conclusively deduce the impact.

INTRODUCTION

Presbyopia is an age-related condition wherein there is a gradual age-related, irreversible recession of the near point of focus usually reported between 40 to 45 years of age.[1] The condition is believed to be the 'most' common ageing physiological condition resulting in universal near vision impairment[2] and occurs due to the weakening of the circular fibres of the ciliary muscle producing a decrease in the ability of the lens to change shape to focus clearly on near vision objects. This is because the lens is connected by fibres (zonules) to the ciliary body of the eye which relaxes by contraction of the circular fibres of the ciliary muscles, permitting the lens to widen (increase in size in its anterior-posterior diameter) and focus more clearly on near objects.[3] Variability in the onset and degree of presbyopia can depend on climate, geographic location, sex, and ethnicity.[3] It is reported to begin any time between 38 to 48 years of age.[1]

Presbyopia can be differentiated into two types, viz. functional presbyopia and objective presbyopia. Functional presbyopia describes the situation whereby the person has vision of <N8 at near (i.e., <6/18 visual acuity) that can be restored to ≥N8 with near addition lenses, but does not include moderate myopes who can read without the aid of spectacles. Objective presbyopia occurs when a person is fully corrected for distance vision but reduction in accommodation has resulted in near vision <N8. In objective presbyopia, near vision can be improved to ≥N8 with near addition lenses and it includes myopes. Prevalence of functional presbyopia is estimated to range from 1-47% in 35-39 year olds[4,5] rising to 30-92% in people aged over 40 years[6,7]. The rates for objective presbyopia would be significantly higher. In the Fricke *et al*.[8] estimate there were 1.8 billion (25%) of people globally in 2015 with presbyopia of whom 826 (95%CI: 686 – 960) million with near vision impairment had no, or inadequate vision correction.

Presbyopia, if not corrected or under-corrected, can affect the quality of life of individuals, their family and society[9] hampering economic development, through productivity losses among older otherwise healthy working adults[10], and has negative implications towards an individual's employment.[11] The simplest and most cost-effective method of correcting presbyopia is through spectacle correction that could significantly improve an individual's vision, thus their lives and increase their potential to perform everyday near tasks, improve educational opportunities, and increase their economic productivity.[12] However rates of correction range from an estimated 96% in Europe to as low as 6% in Africa.[13] According to Fricke *et al*.[8] people with presbyopia living in an urban area in a developed context with higher expenditure were more likely to have adequate optical correction. Optical treatment modalities for presbyopia include single-vision near, bifocal, and progressive spectacle lens solutions and contact lens modalities while surgical modalities include intraocular lenses or corneal surgery.[14]

In addition to reading, uncorrected or under-corrected presbyopia is associated with negative impacts on quality of life and visual function as shown in studies in a rural Tanzanian population,[15,16] rural Chinese population[17] and in a Fijian population[18] where people read and write less often, however, perform a range of other near vision day-to-day tasks. Sherwin *et al*.[19] corroborates the findings as their study demonstrated that presbyopia is associated with functional impairment even in areas where people are often illiterate and where agricultural practices are a common daily function. The study suggests that uncorrected near vision problems may be the cause of the low productivity of older farmers in comparison to productivity from their younger counterparts.

A study examining the public health impact of presbyopia on quality of life and society[20] found that in the developed world presbyopic subjects treated with near vision glasses experienced a reduction in quality of life parameters compared with those who were younger and emmetropic. Notably, the review suggests that the effect of presbyopia and its correction on quality of life remain poorly described and incompletely treated, especially in developing areas of the world.[20]

Despite numerous studies, evidence of the impact of uncorrected presbyopia on a number of parameters islimited and thus the collection of evidence and a systematic review of the available scientific literature would allow for the specific data regarding uncorrected presbyopia to be extracted and critically assessed. For the purposes of this study, presbyopic individuals will be classified as individuals 35 years and older who have difficulty seeing at near. The aim of this systematic review was to evaluate published scientific research studies on the impact of uncorrected presbyopia in presbyopic patients, aged 35 years and older and who experience difficulty at seeing at near, on their visual, personal, socio-economic, mental health and quality of life status as well as the impact of correcting their near vision impairment.

METHODS

The methods used in this study were defined in advance using the Prepared Items for Systematic Reviews and Meta-Analysis (PRISMA) guidelines.[21]

Criteria for considering studies

Eligibility Criteria

The studies included in the review were randomised control trials, cluster randomised trials, non-randomised control studies, prospective and retrospective cohort studies, population-based studies and qualitative and quantitative studies. The studies investigated the impact of presbyopia, or the negative or positive impact of correction on people 35 years and older with near vision difficulties. Studies in urban and rural settings conducted in all countries and in all regions of the world between 1996 and 2016 were included.

Outcome measure(s)

The outcome measure of the review included visual functioning, psychosocial, quality of life, economic (cost-effectiveness; cost-benefit; cost-utility) and educational outcomes (adult education). Also included among the outcomes was positive or negative emotional and psychological impact of wearing near vision correction.

Information sources and search strategy

The search strategy to access both published and unpublished data comprised of three stages:

(1) A limited search of Medline to identify relevant keywords contained in the title, abstract and subject descriptors: ‘presbyopia’; ‘impact’; ’35 years’ and ‘near vision difficulty’

(2) An extensive search of the literature in the respective databases on the terms and their synonyms: MESH terms and free text terms (text words) were subsequently developed from the initial search

(3) Comprehensive database search using the terms identified in stage two. The databases used were: MEDLINE, PubMed, EMBASE, Cochrane Library, CINAHL, Global Health, PsychINFO, ERIC,

Scopus, Science Direct, Web of Science (SCI, SSCI, A&HCI, CPCI-S, CPCI-SSH) Open Grey and the New York Academy of Medicine Grey Literature Report.

In addition to the database searches, non-government organisations and experts in the field were consulted with regards to their knowledge of ongoing research or unpublished reports relevant to the review. Articles from reference lists or bibliographies were also considered based on their titles and grey literature from Google and Google scholar were also included.

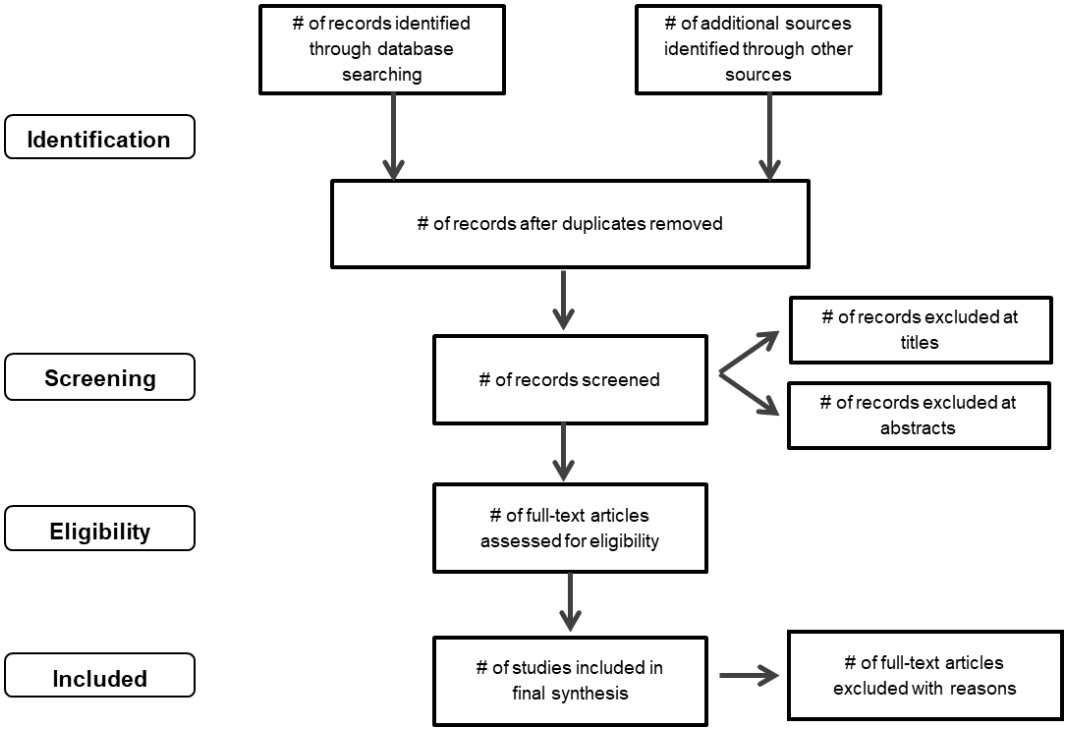

Figure 1. Different phases of the systematic review

Study records

The abstracts of all identified studies were uploaded to EndNote software where they were pre-screened and de-duplicated by the Information Specialist (IS) using the inclusion criteria based on their titles, abstracts and subject descriptors. These studies were further screened by two independent reviewers and full copies of articles identified were requested for critical appraisal and data synthesis. Disagreements of inclusion or exclusion between the reviewers were resolved through discussion and a third reviewer where needed. Excluded studies were documented with clear reasons for exclusion.

Data extraction

A data extraction tool was developed specifically for quantitative research data extraction, drawing from the Cochrane Collaboration data extraction tool. The data comprising administrative details, study characteristics, interventions, outcomes and main findings were independently extracted by 2 reviewers from all studies. In addition, measures of effect and an assessment of bias were deduced on further review.

Critical appraisal

A critical appraisal method was used to assess the quality of all studies included based on the Critical Appraisal Skills Programme (CASP) tool.[22] In order to suit our research study, a checklist was developed using the combined tools available in many different designs and this tool was used for all studies which were selected. The developed checklist had 15 questions which were assessed on a scale of 0 (poor) to 2 (good. All studies were critically assessed by the two reviewers and differences in scores were discussed for consensus. Risk of bias was assessed as well.

Data synthesis and assessment of robustness

The included studies were not homogeneous with respect to study design, study sample size, study setting and intervention and for this reason, only descriptive-synthesis could be done since it is not proper to combine all these studies into a single large study. In such narrative synthesis, the interrogation of the studies entirely depends on the reviewer but mainly looking at quality of studies, consistency in reporting results, impact of the aspects measured, generalisability and applicability of the findings. In this review, 4 main categories used were screening the selected studies, exploring relationships and mutual characteristics of the studies, CASP for quality assessment and lastly synthesis of finding in all studies on the various impact factors.

RESULTS

Study selection

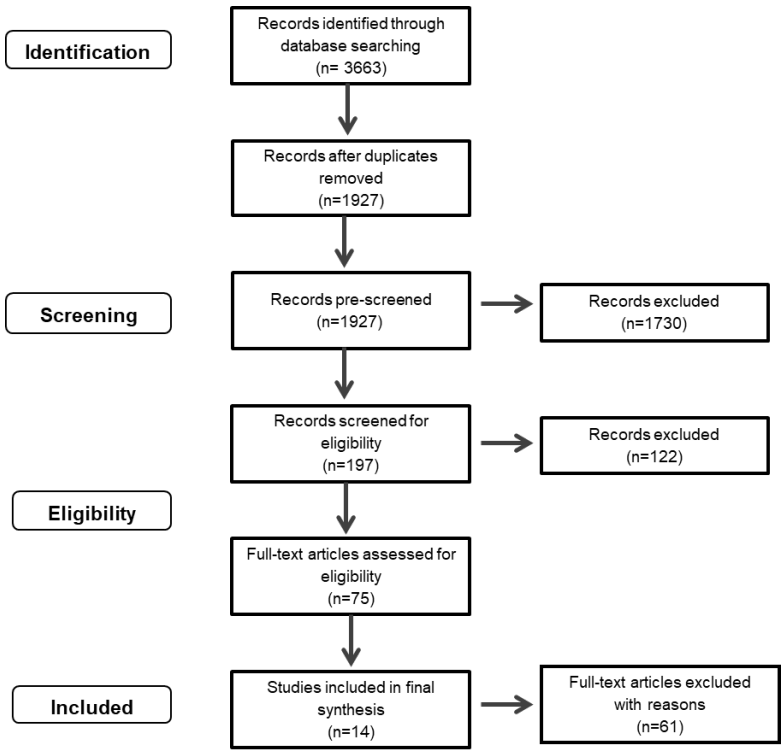

Figure 1. Flow diagram showing the selection process for inclusion of studies in the systematic review

Study characteristics

Ultimately, 14 studies were included for the descriptive synthesis (Table 1). Amid the included studies 11 studies were cross-sectional (Chiroma *et al.*[23]; Laviers *et al.*[3]; Lu *et al.*[17]; Man *et al.*[24]; Marmamula *et al.*[25]; Muhammad *et al.*[6]; Patel *et al.*[16]; Sherwin *et al.*[19]; Uche *et al.*[26]; Williams *et al.*[18]; Wubben *et al.*[27]) and 3 were cohort studies

(Chu *et al.*[28]; Luo *et al.*[29]; Patel *et al.*[15]). All studies were quantitative in nature and no study was classified as qualitative.

Table 1: Included papers, outcome measures and study results

Design	Quality of life (reading, threading needle, sewing, mobile phone, counting grain) (14)	Psychological impact (5)	Positive impacts of correction (6)	Negative impacts of correction (3)
Cohort study (3)	Chu *et al.*[28]; Luo *et al.*[29]; Patel *et al.*[15]		Chu *et al.*[28]	Chu *et al.*[28] Luo *et al.*[29]
Cross-sectional (11)	Chiroma[23]; Laviers *et al.*[3]; Lu[17]; Man *et al.*[24]; Marmamula *et al.*[25]; Muhammad *et al.*[6]; Patel *et al.*[16]; Sherwin *et al.*[19]; Uche *et al.*[26]; Williams *et al.*[18]; Wubben *et al.*[27]	Chiroma[23]; Lu *et al.*[17]; Muhammad *et al.*[6]; Patel *et al.*[16]; Patel *et al.*[15]	Laviers *et al.*[3]; Man *et al.*[24]; Muhammad *et al.*[6]; Patel *et al.*[15]; Patel *et al.*[16]	Marmamula *et al.*[25]

Key: SP – Spectacles, CL – Contact lenses; SR – Self-reported

Of the included studies, 8 were in rural settings and conducted by Chiroma[23], 2008; Lu *et al.*[17]; Marmamula *et al.*[25]; Patel *et al.*[15]; Patel *et al.*[16]; Sherwin *et al.*[19]; Uche *et al.*[26]; Wubben *et al.*[27], 2 were in an urban setting and conducted by Luo *et al.*[29]; Man *et al.*24 and 2 studies were conducted in both rural and urban study settings and were by Laviers *et al.*[3] and Williams *et al.*[18] Two (2) studies did not specify their study setting and were conducted by Muhammad *et al.*[6] and Chu *et al.*[28]. Three of the 14 studies were conducted in Nigeria (by Chiroma[23]; Muhammad *et al.*[6]; Uche *et al.*[26]), 2 in Tanzania (Patel *et al.*[15] in 2006 and Patel *et al.*[16] in 2010), 1 in Zanzibar (Laviers *et al.*[3]), 1 in China (Lu *et al.*[17]), 1 in Pensuvilia (Luo *et al.*[29]), 1 in India (Marmamula *et al.*[25]), 1 in Kenya (Sherwin *et al.*[19]), 1 in Fiji (Williams *et al.*[18]), 1 in the Philippines (Wubben *et al.*[27]), 1 in Singapore (Man *et al.*[24]) and 1 in Australia (Chu *et al.*[28]).

Among the 14 included studies, 11 were investigated using random sampling methods, either on cluster selection or on participants selection (Chiroma[23]; Laviers *et al.*[3]; Lu *et al.*[17]; *Man et al.*[24]; Marmamula *et al.*[25]; Muhammad *et al.*[6]; Patel *et al.*[15]; Patel *et al.*[16]; Sherwin *et al.*[19]; Uche *et al.*[26]; Williams *et al.*[18]) and 3 did not use random sampling methods (Chu *et al.*[28]; Luo *et al.*[29]; Wubben *et al.*[27]).

Included studies were published between 1996 and 2016. The studies included examined the impact issues summarised in Table 3 below.

Table 3: Impact issues identified in the included papers

Quality of life (14)	
General QoL (14)	Chiroma[23]; Chu *et al.*[28]; Laviers *et al.*[3]; Lu *et al.*[17]; Luo *et al.*[29]; Man *et al.*[24]; Marmamula *et al.*[25]; Muhammad *et al.*[6]; Patel *et al.*[16]; Sherwin *et al.*[19]; Uche *et al.*[26]; Williams *et al.*[18]; Wubben *et al.*[27]
Reading (10)	Chiroma[23]; Laviers *et al.*[3]; Lu *et al.*[17]; Man *et al.*[24]; Muhammad *et al.*[6]; Patel *et al.*[15]; Sherwin *et al.*[19]; Uche *et al.*[26]; Williams *et al.*[18]; Wubben *et al.*[27]
Threading needle/Sewing (10)	Chiroma[23]; Laviers *et al.*[3]; Marmamula *et al.*[25]; Muhammad *et al.*[6]; Patel *et al.*[15]; Patel *et al.*[16]; Sherwin *et al.*[19]; Uche *et al.*[26]; Williams *et al.*[18]; Wubben *et al.*[27]
Driving (2)	Chu *et al.*[28]; Man *et al.*[24]
Mobile phone (3)	Laviers *et al.*[3]; Muhammad *et al.*[6]; Williams *et al.*[18]
Grain picking/counting (3)	Sherwin *et al.*[19]; Uche *et al.*[26]; Williams *et al.*[18]
Psychosocial	
Psychosocial	Chiroma[23]; Lu *et al.*[17]; Muhammad *et al.*[6]; Patel *et al.*[15]; Patel *et al.*[16]
Correction	

Spectacles(6)	Chu *et al.*[28]; Laviers *et al.*[3]; Marmamula *et al.*[25]; Patel *et al.*[16]; Williams *et al.*[18]; Wubben *et al.*[27]
Contacts lenses (1)	Chu *et al.*[28]

Quality assessment: Risk of Bias

Allocation (selection bias) of clusters in study areas and allocation of participants to different clusters was considered low risk (L) if it was done randomly, or high risk (H) if it was done using non-random methods. Some studies did not specify the selection methods and were rated unclear (UN). Studies that used random sampling and were rated as low risk included those by Chiroma[23]; Laviers *et al.*[3]; Lu *et al.*[17],; Man *et al.*[24]; Marmamula *et al.*[25]; Muhammad *et al.*[6]; Patel *et al.*[16]; Sherwin *et al.*[19]; Uche *et al.*[26]; Williams *et al.*[18]. There were 3 studies that were rated high risk and these were conducted by Chu *et al.*[28]; Luo *et al.*[29]; Wubben *et al.*[27].

All selected studies were unclear on the blinding of participants and assessors and were ultimately classified as neither high nor low risk. All of the included studies did not explicitly reveal the participation rate, with some not providing reasons for non-participation or poor participation rate. Among the selected studies, Man *et al.*[24] showed the highest participation rate of 100% while Wubben *et al.*[27] showed the lowest participation rate of 24%. In the longitudinal studies with follow-up periods, among the reasons for non-participation on the follow-up visit were travelling[15,16] and refusal[18, 26]. While it is a norm for completeness to compare the results between the protocol and final manuscripts, in this review, no protocol was compared and selective outcome reporting was classified as unclear.

No other sources of bias were identified.

Table 4: Risk of Bias

No.	Study	Risk of bias		Reasons for the risk of assessment
1	Chiroma[23]	Random sequence generation	L	Randomization and probability proportional sampling methods were used for selection of 15 clusters of 40 participants.
		Allocation concealment	U	No allocation concealment was mentioned.
		Participants blinding	U	Masking of participant was not clear
		Assessor blinding	U	Provision of information on assessor blinding was not clear
		Incomplete outcome data	L	Participation rate was high (78%). Non participation was not clear stated.
		Selective outcome reporting	U	Protocol for the study was not reviewed and it was uncertain whether the published reports comprised of all anticipated outcomes.
2	Chu *et al.*[28]	Random sequence generation	H	Non random selection was used
		Allocation concealment	U	Allocation was not adequately concealed.
		Participants blinding	U	Participants blinding was not mentioned.
		Assessor blinding	U	No information provided.
		Incomplete outcome data	L	Non participation was reported
		Selective outcome reporting	U	Protocol for the study was not reviewed and it was uncertain whether the published reports comprised of all anticipated outcomes.
3	Laviers *et al.*[3]	Random sequence generation	L	Randomization method was used for selecting clusters and in each cluster, compact segment sampling was used
		Allocation concealment	U	No allocation concealment was mentioned.
		Participants blinding	U	Masking of participant was not clear
		Assessor blinding	U	Provision of information on assessor blinding was not clear
		Incomplete outcome data	L	Non participation was mostly men due to being away from home

		Selective outcome reporting	U	Protocol for the study was not reviewed and it was uncertain whether the published reports comprised of all anticipated outcomes.
4	Lu *et al*.[17]	Random sequence generation	H	Random selection of participants was not clear
		Allocation concealment	U	Allocation was not adequately concealed.
		Participants blinding	U	Participants blinding was not mentioned.
		Assessor blinding	U	No information provided.
		Incomplete outcome data	U	Insufficient reporting of attrition/exclusions to permit judgment of 'Low risk' or 'High risk'.
		Selective outcome reporting	U	Protocol for the study was not reviewed and it was uncertain whether the published reports comprised of all anticipated outcomes.
5	Luo *et al*.[29]	Random sequence generation	H	Random selection of participants was not clear and some patients' inclusion was based on voluntary
		Allocation concealment	U	Allocation was not adequately concealed.
		Participants blinding	U	Participants blinding was not mentioned.
		Assessor blinding	U	No information provided.
		Incomplete outcome data	L	Two participants were excluded due to inability to estimate number of years to live and one for not using reading glasses
		Selective outcome reporting	U	Protocol for the study was not reviewed and it was uncertain whether the published reports comprised of all anticipated outcomes.
6	Man *et al*.[24]	Random sequence generation	H	Random selection of participants was not clear.
		Allocation concealment	U	Allocation was not adequately concealed.
		Participants blinding	U	Participants blinding was not mentioned.
		Assessor blinding	U	No information provided.
		Incomplete outcome data	U	Insufficient reporting of attrition/exclusions to permit judgment of 'Low risk' or 'High risk'.
		Selective outcome reporting	U	Protocol for the study was not reviewed and it was uncertain whether the published reports comprised of all anticipated outcomes.
7	Marmamula *et al*.[25]	Random sequence generation	L	Study districts were subdivided and clusters were picked at random with repeated attempts for participants
		Allocation concealment	U	No allocation concealment was mentioned.
		Participants blinding	U	Masking of participant was not clear
		Assessor blinding	U	Provision of information on assessor blinding was not clear
		Incomplete outcome data	L	Non participation was stated (5.1%).
		Selective outcome reporting	U	Protocol for the study was not reviewed and it was uncertain whether the published reports comprised of all anticipated outcomes.
8	Muhammad *et al*.[6]	Random sequence generation	L	Two stage cluster sampling for selection of participants with probability proportional to size
		Allocation concealment	U	Allocation was not adequately concealed.
		Participants blinding	U	Participants blinding was not mentioned.
		Assessor blinding	U	No information provided.
		Incomplete outcome data	L	High response rate (97.7%) was reported
		Selective outcome reporting	U	Protocol for the study was not reviewed and it was uncertain whether the published reports comprised of all anticipated outcomes.
9	Patel *et al*.[15] (2006)	Random sequence generation	L	Randomization and allocation methods were used.
		Allocation concealment	U	Allocation was not adequately concealed.
		Participants blinding	U	Participants blinding was not mentioned.
		Assessor blinding	U	No information provided.
		Incomplete outcome data	U	Insufficient reporting of attrition/exclusions to permit judgment of 'Low risk' or 'High risk'.

		Selective outcome reporting	U	Protocol for the study was not reviewed and it was uncertain whether the published reports comprised of all anticipated outcomes.
10	Patel *et al.*[16] (2010)	Random sequence generation	L	Randomization and allocation methods were used for participants who were 40 and older.
		Allocation concealment	U	No allocation concealment was mentioned.
		Participants blinding	U	Masking of participant was not clear
		Assessor blinding	U	Provision of information on assessor blinding was not clear
		Incomplete outcome data	L	Reasons for non-participation on the follow-up mostly travelling (6.8%), refusal (1.5%), illness (0.1%) and relocation (2.5%).
		Selective outcome reporting	U	Protocol for the study was not reviewed and it was uncertain whether the published reports comprised of all anticipated outcomes.
11	Sherwin *et al.*[19]	Random sequence generation	L	Random selection of participants using segment sampling
		Allocation concealment	U	Allocation was not adequately concealed.
		Participants blinding	U	Participants blinding was not mentioned.
		Assessor blinding	U	No information provided.
		Incomplete outcome data	L	Participation rate was high (93.1%), with few refusals and some unable to attend.
		Selective outcome reporting	U	Protocol for the study was not reviewed and it was uncertain whether the published reports comprised of all anticipated outcomes.
12	Uche *et al.*[26]	Random sequence generation	L	Cluster random sampling with probability proportional to size was used to select eight clusters and 90 individuals
		Allocation concealment	U	Allocation was not adequately concealed.
		Participants blinding	U	Participants blinding was not mentioned.
		Assessor blinding	U	No information provided.
		Incomplete outcome data	L	Of the enumerated participants, high participation rate (81.1%) was reported, and no subjects refused to participate.
		Selective outcome reporting	U	Protocol for the study was not reviewed and it was uncertain whether the published reports comprised of all anticipated outcomes.
13	Williams *et al.*[18]	Random sequence generation	L	Probability based portion sampling was used for picking out participants
		Allocation concealment	U	No allocation concealment was mentioned.
		Participants blinding	U	Masking of participant was not clear
		Assessor blinding	U	Provision of information on assessor blinding was not clear
		Incomplete outcome data	L	Of the targeted sample, 921 of the 928 were reported eligible for the study.
		Selective outcome reporting	U	Protocol for the study was not reviewed and it was uncertain whether the published reports comprised of all anticipated outcomes.
14	Wubben *et al.*[27]	Random sequence generation	H	Non random sampling selection was used
		Allocation concealment	U	Allocation was not adequately concealed.
		Participants blinding	U	Participants blinding was not mentioned.
		Assessor blinding	U	No information provided.
		Incomplete outcome data	U	Insufficient reporting of attrition/exclusions to permit judgment of ‘Low risk’ or ‘High risk’.
		Selective outcome reporting	U	Protocol for the study was not reviewed and it was uncertain whether the published reports comprised of all anticipated outcomes.

NARRATIVE SYNTHESIS

The narrative synthesis was reported mainly on Quality of Life and focussed on: 1) General quality of life (reading, threading needle/sewing, grain picking, mobile phone, recognizing small objects, driving); 2) Impact of uncorrected presbyopia (negative and positive impact); 3) Impact of correction (positive and negative impact).

Quality of life:

Luo *et al.*[29] used time trade-off utility analysis as a measure of the quality of life associated with presbyopia. To calculate this, the quotient of the time traded by the subject to receive perfect vision at near with an intervention that could potentially decrease their survival while providing a permanent solution for presbyopia-related near vision decrease and time of remaining life is subtracted from 1.0. Utility analysis ranges from 1.0 (perfect health) to 0.0 (death), with better quality of life indicated by values closer to 1.0. The mean utility of the presbyopic cohort used in the study by Luo *et al.*[29] based on 23.4 years of remaining life was 0.98., indicating that their sample would generally not give up too much time to be rid of their spectacles and that only a mild decrease in quality of life was associated with presbyopia.

Laviers *et al*.[3] in their cross-sectional population-based RAAB survey of presbyopia also investigated the impact of presbyopic correction on visual function and quality of life using instruments that were used in a study in Tanzania[15]. This study was among the only 2 studies in this review to assess the impact of correction in a follow-up survey. Laviers *et al*.[3] found that the lowest mean quality of life score at baseline was due to near vision (44.9). Six months after correction was provided, this score improved (90.9) with an effect size of 2.43.

A population-based cross-sectional study of adults aged 40 and above in Fiji using multistage random sampling was used to evaluate an 18-item vision specific quality of life questionnaire by Williams *et al*.[18]. In this study, a questionnaire was used as the means of outcome measure on the comparison of the Likert scale and the rating scale, where the former was somehow influenced by the demographics. The tasks that produced a daily impact on quality of life and were ranked most difficult were reading, using a mobile phone, preparing grains and weaving and sewing.

Impact of uncorrected presbyopia

Negative impact of presbyopia: The cross-sectional, population-based study by Lu *et al*.[17] investigated the impact uncorrected and corrected presbyopia on visual function. This study found that persons with presbyopia rated their overall vision at distance and near poorer compared to persons without presbyopia. Furthermore, almost all presbyopes (> 90%) reported difficulty with activities of daily living whereas just under two-thirds of those without presbyopia reported any difficulty. Multiple logistic regression in the Lu *et al*.[17] study indicated that persons with presbyopia were more likely to report greater dependence on others, a feeling of shame and embarrassment and diminished sense of accomplishment than their non-presbyopic counterparts. The female majority in the sample and self-reported responses were listed among the limitations of this study.

Chu *et al*.[28] in their cross-sectional survey of presbyopic patients explored driving difficulties during day and night time driving conditions while using various forms of presbyopic correction (including bifocal or progressive spectacles, monovision or multifocal contact lenses). The study found that presbyopes who did not need a distance correction and who did not wear a near correction either, experienced problems with viewing at intermediate

distances for tasks like reading the odometer or a map when driving. The group not wearing a near correction experienced significantly more difficulty ($p<0.0001$) when reading a street directory compared to subjects using any type of near correction.

Chiroma[23] in his cross-sectional, population-based masters research explored the impact of uncorrected presbyopia on vision-related quality of life of subjects in rural Gwagwalada, Abuja, Nigeria. This study found that the presbyopes engaging in near activities like reading, writing, sorting grain, winnowing grain, threading a needle, cutting fingernails, dressing children, weeding, harvesting and recognising faces reported having difficulty with their tasks. This study found that the presbyopes reported significant moderate/severe difficulty with reading, sorting grains, threading, cutting nails and recognising small objects compared to non-presbyopes ($p<0.05$). Further the presbyopes were also more likely to report dissatisfaction with their near vision and general health when compared to non-presbyopes. The presbyopes in this study reported three times more rates of dependency compared to non-presbyopes and female presbyopes were more likely to have problems with family thereby illustrating a psycho-social impact presbyopia. Chiroma[23] also recorded psychosocial impact where presbyopes were more likely to have problems with family and looked down upon compared to non-presbyopes and female presbyopes being more likely than male presbyopes ($p<0.001$) to experience this difficulty.

Patel *et al.*[15] found in a cross-sectional survey in 1564 Tanzanian subjects greater than 40 years of age that the prevalence of presbyopia was 62%. The majority of presbyopes (94%) did not have corrective near-vision glasses. A near vision-related quality of life questionnaire was used to determine the degree of self-rated difficulty with tasks including reading, writing letters, writing numbers, cooking food, sorting rice or grain, threading a needle, weeding, harvesting sorghum, cutting fingernail and toenails, dressing children, lighting and adjusting a lamp and recognising faces of people standing near. Compared with non presbyopes, being presbyopic increased the odds of reporting any difficulty with the above near-vision tasks by two-fold, odds of reporting moderate difficulty by five-fold and the odds of reporting high difficulty by more than eight-fold. The degree of presbyopia was associated with increasing difficulty with various activities of daily living and presbyopes reported twice as much dependency due to vision compared to non-presbyopes.[15]

Muhammad *et al.*[6], found, using a vision-related quality of life (QoL) questionnaire and visual function (VF) questionnaire in a population-based cross-sectional study among adults 40 years and older that the VFs most impaired were the ability to read, write, use mobile phones, the wind blowing of grains, and threading needles. The older a presbyope, the more the difficulty in using a mobile cell phone. The higher the degree of presbyopia the lower the mean VF score ($P = 0.00$). Moreover, the higher the degree of presbyopia, the lower the reported level of satisfaction with both distant and near vision The mean QoL score generally decreased with increasing age although this was only statistically significant in response to “noticing obstacles while walking,” “going down stairs,” and “carrying out outdoor activities.” However, other ocular and systemic conditions associated with increasing age might also have influenced the QoL findings as older participants are more prone to other age-related diseases.

In Asia, Man *et al.*[24] found in a population-based cross-sectional study to examine the impact of uncorrected presbyopia on visual functioning (using a VF-11 questionnaire), that compared with corrected presbyopia, non-correction was associated with worse overall VF and reduced ability to perform individual near and distance

vision-specific tasks even after adjusting for distance VA and other confounders (all P < .05). The questionnaire included visual function tasks of cooking, reading newspapers, recognising faces, reading street signs, seeing stairs, reading phone books, filling in lottery tickets, watching television, driving during the day and driving at night. Results were very similar for myopic individuals. This suggests that correcting presbyopia in older visually impaired individuals may benefit their distance and overall near vision specific QoL.

Wubben *et al*.[27] conducted a study in the rural Filipino population to determine the burden of uncorrected presbyopia using a non-random sampling method based on voluntary participation and a self-reported questionnaire. The change in stereoacuity was used to represent a measure of impact after near vision correction with near vision glasses and the results showed improvement in over 75% of participants ($p < 0.05$). Furthermore, the near vision glasses produced an improvement in near vision to 20/40 or better in 77.7% of participants. A greater chance to earn a living was reported in 84% of participants. The study reported that near vision is a common problem in the rural set up impacting most of near tasks performed on a daily basis.

A nested cross-sectional study was carried out in a rural Kenyan population on the unmet presbyopic need by Sherwin *et al*.[19]. The study also aimed to quantify the functional impairment (defined as an individual needing a reading prescription of at least +1.00 dioptres to read print of N8 size at a 40cm viewing distance) associated with presbyopia in the sample. This self-reported study found that sewing was the task which produced the greatest amount of vision-related difficulty, with women being more likely to experience this than men ($p<0.001$). Other activities also incurring some level of difficulty were reading, writing, harvesting grain and mobile phone use. This study demonstrated that presbyopia also had an impact on rural populations with low literacy. The use of an instrument that was not validated to assess function impairment and the small sample size were cited as the limitations of this study.

Uche *et al*.[26] conducted a population-based cross-sectional study in a rural population in Nigeria, using cluster random sampling, with probability proportional to size. Participants with presbyopia were asked to rate their level of difficulty with various tasks including: reading, writing, threading a needle, sorting grain and some agricultural activities, grooming, cooking and recognizing small objects. The tasks that posed the greatest difficulty included threading a needle and reading. Though the results of this study can be conclusive, some participants were not sure about their date of birth and hence historic events were used to estimate their ages.

Impact of correction for presbyopia

Positive impact:

Laviers *et al*.[3] in their investigation on the impact of near vision correction on visual function, found that near spectacles had the greatest impact on near activities such as reading small print and threading a needle. Baseline measurements of vision showed that only 10.2% of subjects were able to achieve good near vision (N8) while this number increased to 98.2% after spectacles were prescribed. More than 90 percent of individuals who were given a pair of near spectacles still had them 6 months later at the follow-up examination, showing that the majority of near vision spectacle recipients valued them. They were also eager to recommend a near correction to others with near vision problems. The regression analysis in this study showed that illiterate subjects were just as likely to recommend near vision spectacle wear to others as people who were literate, indicating that near spectacles are valued not only by literate individuals.

Patel *et al*.[16] examined changes in self-reported and performance-based near vision, 2 months after the provision of near vision spectacles in a population-based cohort study in Tanzania of subjects 40 years and older. At baseline, subjects were asked to thread a needle. They were also asked questions on the perception of difficulty with near vision, perceived role limitation due to near vision limitation and general health. At 2 months, subjects were again asked the same. Only 31% had successfully threaded a needle at baseline, increasing to 91% at follow-up ($p<0.001$). Spectacle-users showed a significant improvement in satisfaction with near vision, and improvement from feeling limited in their function and needing help from family members to feeling independent, but no change in perception of general health, from baseline to follow-up.

In the study conducted by Wubben *et al*.[27], functional improvement was assessed on the comparison of the participants with and without near vision correction (reading spectacles). Using a stereoacuity as a measure on outcome, an improvement in the near vision correction was reported. Uche *et al*.[26] stated the enhancement of near vision after correction and increasing in efficiency of near activities such as sewing and hairdressing.

Presbyopic correction is known to improve visual performance at near, it is also known to affect driving performance variably during day- and night-time conditions [28]. Chu *et al*.[28] found that presbyopic subjects progressive addition lenses or a monovision contact lens corrections did not experience the same level of difficulty as those subjects not wearing a correction for distance or near.

Negative impact:

In their study, Chu *et al*.[28] found that bifocal spectacle wearers experienced the least satisfaction when driving under day-time conditions and reported more difficulties with tasks requiring changes of focus, progressive spectacle lens wearers noticed more distortion of peripheral vision, while multifocal contact lens wearers experienced the least satisfaction under night-time driving conditions due to troublesome glare and haloes. In comparison to the group with no prescription, the multifocal contact lens wearers experienced poorer clarity of the road ahead during day-time viewing

Another negative impact of wearing spectacles for near vision is reported by Marmamula *et al*.[25], (2013) among cloth weaving communities in Southern India. Of 122 individuals who had no spectacles at the time of the examination but reported having spectacles previously, 57 (46.7%) of the 122 individuals who had no spectacles reported discomfort as their reason for discontinuing spectacles for near vision. However, the scope of the study did not allow for further explanation.

Psychosocial aspects of quality of life

The presbyopes in the study by Chiroma[23] reported three times more rates of dependency compared to non-presbyopes, with female presbyopes being more likely to have problems with family thereby illustrating a psycho-social impact of presbyopia. The study by Laviers *et al*.[3] explored family relations and levels of confidence in their survey and reported that while family relations ranked the highest at baseline (82.0), it improved when investigated at follow-up with an effect size of 1.90. The level of confidence also improved together with subjects' overall perception of their general health. The study by Lu *et al*.[17] also explored subjects' functional dependence, feelings of being ashamed or embarrassed and feelings of reduced accomplishment due to vision.

DISCUSSION

The impact of uncorrected presbyopia on quality of life is examined in several studies (Chiroma[23]; Chu *et al.*[28]; Laviers *et al.*[3]; Lu *et al.*[17]; Luo *et al.*[29]; Man *et al.*[24]; Marmamula *et al.*[25]; Muhammad *et al.*[6]; Patel *et al.*[16]; Sherwin *et al.*[19]; Uche *et al.*[26]; Williams *et al.*[18]; Wubben *et al.*[27]). The studies have used validated tools or the ability of respondents to perform activities of daily living as indications of the quality of life the individual. While they all conclude that there is an undeniable impact of presbyopia on the quality of life of the individual, the studies lack the scientific rigor necessary to make conclusive deductions. Furthermore, there were studies where the same tool is used across varying contexts. It is generally advisable to use context-specific tools since those used in developed countries may be include the relevant information to address quality of life issues in rural or developing contexts.

The positive impact of presbyopic correction was affirmed by Laviers *et al.*[3] who ascertained the noteworthy impact of the correction on near activities like reading and threading a needle. They inferred the significance and value attributed to the correction since the majority of presbyopes retained their spectacles 6 months later in the follow-up examination. While traditionally it is believed that near-vision correction has a significant impact on reading ability, it should be noted that even illiterate individuals valued the correction as much as literate individuals. This implied that near-vision correction has a significant impact on near activities, rather than just reading. This encompasses a range of activities including grain picking/counting[18, 19, 26], operating a mobile phone[3, 18, 26], sewing/threading a needle[3, 6, 15, 16, 18, 19, 23, 25, 27]. It is therefore safe to assume that presbyopic correction has the potential to improve one's ability to be productive, find gainful employment, earn a living and ultimately alleviate poverty.

Numerous studies provided self-reported accounts of the impact of presbyopia on vision function and activities of daily living.[15, 17, 24, 28]. Research shows that the findings could be influenced by response bias and in some cases when an intervention is used, results may be prone to response-shift bias where the respondent's frame of reference varies between the points of measurement.[30] The authors have listed self-reporting amongst the limitations of their studies.

Psychosocial impact of uncorrected presbyopia and presbyopic correction cannot be minimalised. Studies by Chiroma[23], Patel *et al.*[15]and Lu *et al.*[17] explored subjects' dependence and loss of independence. Teutsch *et al.*[31] emphasise that near vision loss affecting instrumental activities of daily living like reading (bank statements, medication labels, recipes, etc.) or manipulating small objects (sewing, replacing batteries, etc.) has an amplified impact on dependency. Lu *et al.*[17] also go on to say that individuals with uncorrected presbyopia can suffer extensive social deficiency where social interaction and leisure activities become restricted. More studies are needed to elucidate the specific impact of near vision impairment on social functioning.

The study by Muhammad *et al.*[6] highlighted the impact of uncorrected presbyopia on the use of mobile phones. This finding was not only significant for the study population under investigation but can be expanded to the global population. Technology advances daily creating accessible and portable mobile solutions that are able to take health care, communication and education to some of the deepest recesses in the globe through online teaching, telemedicine, etc. It therefore becomes necessary to ensure that vision correction is available to enable smooth, unhindered access for all.

The use of varying definitions of presbyopia can result in disparity amongst the findings of studies. Both of the definitions (functional and objective) consider the need for correction to achieve a near visual acuity of N8 based on distance optical correction, however, the functional definition of presbyopia considers the presenting distance correction, while the objective definition considers the best distance optical correction.[13] In reality, the limited access to refractive care in many parts of the world results in less than optimal distance vision correction, if any. While the majority of studies in the review used the functional definition, the lack of uniformity amongst the studies make it difficult to generalise findings to a wider population.

Cost was among the barriers to obtaining a near vision prescription. In the study by Wubben *et al.*[27] even though an improvement was reported after the use on near vision spectacles, the cost of the correction was a barrier to obtaining them. Sherwin *et al*.[19] also concurred on the cost as a barrier. These findings should be emphasised in eye care programme planning as it illustrates the need for creating access to affordable refractive solutions.

CONCLUSION

The studies in the review emphasise the detrimental impact of uncorrected presbyopia on the quality of life of an individual. They also elaborate on a similar psychosocial impact as well as the impact on vision function, however, they lack the scientific rigor necessary to determine conclusively causality and attribution effects. While the majority of studies used probability sampling methods, they were not explicit with the exact methods of blinding used, if any. There also appears to be a weakness in the use of context specific questionnaires. Furthermore, there is also a paucity of studies which explore the impact of various refractive correction options for presbyopia. There is therefore an urgent need for more well-structured studies that address the methodological as well as scope of issues.

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