Original Article

Prevalence of refractive errors, uncorrected refractive error, and presbyopia in adults in India: A systematic review

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Purpose: The objective of this review is to estimate the prevalence of refractive errors, uncorrected refractive error (URE), and uncorrected presbyopia in adults aged ≥30 years in India. **Methods:** The Preferred Reporting Items for Systematic Reviews and Meta-analyses (PRISMA) guidelines were followed. A detailed literature search was performed to include all studies published from India from the year 1990 using the Cochrane Library, Medline, and Embase. Refractive error was defined by >0.50 D ametropia. URE was defined by presenting visual acuity (PVA) worse than 6/18 improving with pinhole or spectacle correction, and uncorrected presbyopia by near vision <N8 improving with correction in the absence of distance URE. **Results:** Fifteen studies were included from South India, one each from Western and Central India, and one study covered 15 states across India. The prevalence of RE of at least 0.50 D of spherical equivalent ametropia was 53.1% [(95% confidence interval (CI): 37.2–68.5), of which myopia and hyperopia was 27.7% and 22.9%, respectively. The prevalence of URE was 10.2% (95% CI: 6.9–14.8), but heterogeneity in these estimates was very high. The prevalence of uncorrected presbyopia was 33% (95% CI: 19.1–51.0). **Conclusion:** This review highlights the magnitude of refractive errors among adults in India. More studies are needed using standard methods in regions where there is a lack of information on UREs. Programs delivering spectacles for adults in India will need to primarily focus on reading glasses to correct presbyopia along with spectacles for hyperopia and myopia.

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Refractive error (RE) is one of the most common ocular conditions affecting all age groups and a priority under the VISION 2020 initiative. Most REs can be easily corrected at the primary care level with spectacles. Despite the availability of a cost-effective intervention to address this problem, uncorrected refractive error (URE) is a major public health challenge. Worldwide, URE is the leading cause of vision impairment and the second leading cause of blindness in developing countries, including India.[1,2] Visual impairment and blindness caused by URE in adults can have severe impact on social and economic well-being, including limiting the educational and employment opportunities of economically active persons.[3] Globally, economic loss due to lost productivity caused by URE was estimated around $269 billion[4] and due to uncorrected presbyopia was US$11.023 billion.[5]

There has been an increase in the number of population-based studies from India in the last decade on various eye conditions, and there are many reports published with the aim of determining the prevalence of REs among various age groups across different populations in India. However, a variety of methodologies and different definitions have been used to make these estimates. The reported prevalence varies considerably between studies due to differences in the study populations, methodologies, and definitions of conditions studied. Of all the variations, the definitions used in the studies particularly influence the estimated prevalence rates. Population-based pooled estimates provide evidence for policy decisions, hence, we performed a systematic review to estimate the pooled prevalence of REs, with a uniform definition in India. The aim of this study is to determine the prevalence of REs among adults aged ≥30 years in India and the need for refractive services through estimates of the prevalence of URE and uncorrected presbyopia.

Methods

We followed Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines for this review.

Search strategy

We searched Medline, Embase, CINAHL, and Cochrane library from 1990 to 2018. (The date of last search was September 2018 via OVID and EBSCOHOST). The search was based on medical terms using MeSH for medical subject headline and keywords to search in the title and abstract. Broad search strategy combined terms related to epidemiology (including MeSH search using exp prevalence *

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and exp epidemiology * and keyword search using the words prevalence, epidemiology, incidence, rates and proportions), terms related to disease (including MeSH search using exp refractive error *, exp myopia*, exp hypermetropia*, exp astigmatism*, exp presbyopia*and keyword search using the term refractive error, myopia, hypermetropia, astigmatism and presbyopia), and terms related to population (including MeSH search using exp India * and keyword search using the words India). We also searched the reference lists of included studies to identify further studies.

Inclusion and exclusion criteria

We searched all studies focused on estimating the prevalence and/or incidence of REs and/or presbyopia among all age groups from any location within India. We defined prevalence as the number of individuals in a population that have RE at a given point in time divided by those at risk. Incidence was defined as how many new cases of RE occur within a defined period of time. We included all incidence and prevalence reports from epidemiological studies. We also reviewed all relevant National, Regional, and International reports published from 1990 onwards. We excluded studies that used only qualitative methods and review papers, as well as studies published only as an abstract or presented in conferences without full subsequent publication. We removed duplicate publications from the same study. In this systematic review, we included data reported on adults aged ≥30 years and the results related to REs in children from this search has been published previously.[6]

Definitions used

RE was defined by spherical equivalent (SE) ametropic with the two major subgroups: myopia as SE worse than −0.50 D and hyperopia as SE worse than +0.50 D. URE was defined as presenting VA <6/18 and improving to ≥6/18 on using a pinhole in either eye or with spectacle correction. Uncorrected presbyopia was defined as binocular presenting near vision <N8 and improving to ≥N8 with correction and presenting distance VA of at least 6/18 in the better eye.

Data abstraction and quality assessment

The lead reviewer (SS) conducted the detailed search and identified all relevant studies. Both the lead and second reviewers (SB) assessed the included studies independently based on the abstract and title according to the inclusion criteria and shortlisted the studies for full-text review. A detailed methodological quality assessment was done independently on the full-text of shortlisted studies, using the critical appraisal checklist developed for prevalence studies by Munn *et al*. 2014.[7] We developed a data extraction form to extract study characteristics such as study design, geographical location, study population, participant demographics (including age and gender), screening tools, definition used, and prevalence data. Any discrepancies between the reviewers at each stage was discussed and resolved by consensus. We attempted quantitative data synthesis using MetaXL in Microsoft office.[8]

Statistical methods

We obtained an overall estimate of prevalence and incidence across included studies after stabilizing the variance of individual studies as we expected a high degree of heterogeneity among the included studies in the design and outcome measures. This was done with the use of Freeman–Tukey double arcsine transformation[8] using MetaXL software. We assessed the heterogeneity using the χ^2 test on Cochrane's Q statistic and quantified by calculating the I^2.[9] The I^2 statistic describes the percentage of total variation between studies that is due to heterogeneity rather than chance. A value of 0% indicates no heterogeneity and larger values indicates increasing levels of heterogeneity. Further, we also examined the overlap of confidence intervals in the forest plot and assessed the heterogeneity.

As there are various metrics used to describe refractive errors and spectacle coverage for both RE and presbyopia in the included studies, we calculated the overall prevalence under three categories: (1) prevalence of REs with subcategories of myopia and hyperopia, (2) prevalence of URE based on presenting visual acuity (PVA) improving with pinhole and/or after best correction, and (3) prevalence of uncorrected presbyopia. The prevalence of REs and spectacle coverage for distance RE and presbyopia are important for planning refractive services. Where definitions were different, data were summarized separately and not included in pooled estimates.

Results

Out of a total of 169 potentially relevant titles/abstracts, 43 full-text articles based on population-based data were found eligible. The review strategy is summarized in Fig. 1, and details of the 25 excluded studies with reasons are presented as Table 1.

Study characteristics and methodological quality

Eighteen studies that reported prevalence of REs were included in the final analysis. Two studies[10,11] presented data on both REs and presbyopia, and data from these studies were extracted under the respective categories for the analysis. In the final analysis, we included 14 studies which reported data on distance RE and URE,[10-23] and 6 studies reporting data on

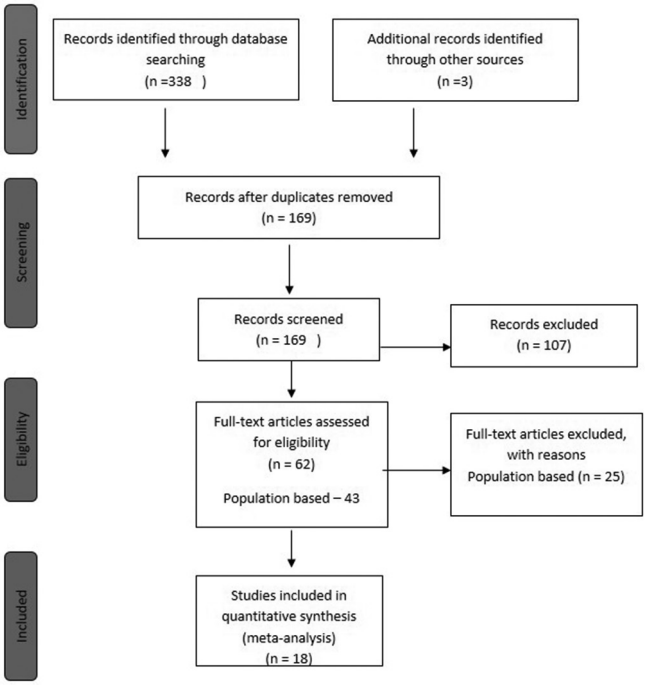

Figure 1: Summary of review strategy – PRISMA flow diagram

Table 1: Characteristics of excluded studies

Title/year	Reason for exclusion
He M, *et al*. Ophthalmology. 2014;121(1):417-22.	Another publication related to near vision impairment from this study has been included for final analysis. Although this article covers the follow-up data, we could not obtain absolute number of persons with near visual impairment from the follow-up data.[37]
Dandona L, *et al*. Investigative Ophthalmology & Visual Science. 2001;42(5):908-16.	Another publication with more relevant information related to refractive errors from this study has been included for final analysis.[38]
Dandona L, *et al*. Ophthalmology. 1999;106(3):497-504.	Another publication with more relevant information related to refractive errors from this study has been included for final analysis.[39]
Dandona R, *et al*. The British Journal Of Ophthalmology. 2002;86(4):373-7.	Another publication with more relevant information related to refractive errors from this study has been included for final analysis.[40]
Marmamula S, *et al*. Indian Journal Of Ophthalmology. 2013;61 (12):755-8.	Data from two studies are presented in this article. Those two studies are already included separately for this review.[41]
Sharma M, *et al*. Annali italiani di chirurgia. 2008;79(5):341-6.	No information on the definition used to categorize the refractive errors.[42]
Marmamula S, *et al*. Clinical & Experimental Optometry. 2014;97(6):523-7 5p.	No prevalence data reported in this article.[33]
Marmamula S, *et al*. BMJ Open. 2011;1 (1):e000172-e.	No prevalence data reported in this article.[43]
Dandona R, *et al*. Indian Journal Of Ophthalmology. 2002;50 (2):145-55.	Primary outcome of this article is spectacle use and another publication with more relevant information related to refractive errors covering both urban and rural data from this study has been included for final analysis.[44]
Vijaya L, *et al*. Indian journal of ophthalmology. 2014;62 (4):477-81.	Another publication with more relevant information related to refractive errors from this study has been included for final analysis.[45]
Krishnaiah S, *et al*. Clinical Ophthalmology. 2009;3 (1):17-27.	Another publication with more relevant information related to refractive errors from this study has been included for final analysis. This article's primary outcome was identifying risk factors.[46]
Raju P, *et al*. Investigative Ophthalmology & Visual Science. 2004;45 (12):4268-72.	Another publication with more relevant information related to refractive errors covering both urban and rural data from this study has been included for final analysis.[47]
Marmamula S, *et al*. BMC Ophthalmology. 2011;11:26-.	Another publication with more relevant information related to uncorrected refractive errors and presbyopia data from this study has been included for final analysis.[48]
Dandona R, *et al*. Investigative Ophthalmology and Visual Science. 1999;40 (12):2810-8.	Another publication with more relevant information related to refractive errors covering both urban and rural data from this study has been included for final analysis.[49]
Marmamula S, *et al*. International Journal Of Ophthalmology. 2016;9 (5):763-7.	Another publication with more relevant information related to refractive errors covering both urban and rural data from this study has been included for final analysis.[50]
Shrote VK, *et al*. International Journal of Collaborative Research on Internal Medicine and Public Health. 2012;4 (9):1692-702.	There was no information on how the refractive errors were defined and on the persons involved in screening.[51]
Perkins ES. Et al. The British Journal Of Ophthalmology. 1984;68 (5):293-7.	No data from India included in this study.[52]
Singh MC, *et al*. Journal Of The Indian Medical Association. 1994;92 (11):361.	Could not access the full text of this article.[53]
Wong TY, *et al*. The British Journal Of Ophthalmology. 2006;90 (4):506-11.	Review article and all the studies included in the review from India are considered in this review.[54]
Thakur R, *et al*. Annals Of Medical And Health Sciences Research. 2013;3 (1):19-25.	No definition given on how the visual impairment was assessed. Results of both distance and near visual impairment is clubbed and reported.[55]
Bandrakalli P, *et al*. Journal of Pediatric Ophthalmology and Strabismus. 2012;49 (5):303-7.	Data on refractive errors leading to amblyopia is only presented in this article.[56]
Singh MM, *et al*. Indian Journal Of Ophthalmology. 1997;45 (1):61-5.	Standard assessment method was not adopted in estimating the refractive error.[57]
Dandona R, *et al*. Investigative Ophthalmology & Visual Science. 2002;43 (3):615-22.	Data related to refractive errors in children aged 7-15 years is presented in this article.[58]
Murthy GVS, *et al*. Investigative Ophthalmology & Visual Science. 2002;43 (3):623-31.	Data related to refractive errors in children aged 5-15 years is presented in this article.[28]
Nirmalan PK, *et al*. American Journal of Ophthalmology. 2003;136 (4):703-9.	Data related to refractive errors in children aged 0-15 years is presented in this article.[59]

presbyopia.[10,11,24-27] The characteristics of these studies are presented as Tables 2-4.

All eighteen studies included in the final analysis were population-based studies using various methodologies in

Table 2: Characteristics of the studies that reported data on refractive errors based on Myopia and Hyperopia in adults aged ≥30 years

First author and year of publication	Location	Study period	Study Design	Age group	screening tools used	Screening done by	Definitions used	Subject locations (%)		Total no of persons			No of persons with RE			*With myopia			*With hyperopia		
								Rural	Urban	M	F	T	M	F	T	M	F	T	M	F	T
Dandona R, 2002*	Andhra pradesh	1996-2000	Cross sectional	≥30	Tumbling E, streak retinoscopy	Optometrist and ophthalmologist	Myopia - SE worse than−0.50D and hyperopia as SE worse than +0.50D	77	23	NR		5434	NR		2309	NR		1556	NR		753
Raju P, 2008	Tamil nadu	June 2001 to May 2004	Cross sectional	≥40	ETDRS, streak retinoscopy and pinhole	Optometrist and ophthalmologist	Emmetropia between SE−0.50 D and+0.50 D; Myopia−SE < −0.50 D and SE < −5.00 D as high Myopia; Hyperopia−SE+0.50 D	44	56	2546	3105	5651	1517	1942	3459	655	692	1347	862	1250	2112
Nangia V, 2010	Maharastra	2006-2009	Cross sectional	≥30	Modified ETDRS chart, automated refractometry, kerotometry, slit lamp	Optometrist and ophthalmologist	Myopia and hyperopia as ametroprias of more than 0.50D; high myopia more than−8D	100	0	2147	2472	4619	NR		1616	NR		785	NR		831
Joesph s, 2018	Tamil nadu	2005-2007	Cross sectional	≥40	ETDRS, Streak retinoscope, Jackson's cross Cylinder, slit lamp biomicroscopy	Optometrist and ophthalmologist	Myopia as SE < −0.75 dioptres (D); low myopia (≤−0.75 to >−3 D); moderate myopia (≤−3 to >−6 D) and high myopia (≤-6 D). Hyperopia SE ≥ +1 D	NR				3267			2370	NR		1490	NR		880

* - only data ≥30 years included for comparison with other studies; NR - Not reported

Table 3: Characteristics of the studies that reported data on uncorrected refractive errors (URE) in adults aged ≥30 years

First author and year of publication	Location	Study period	Study Design	Age group	Screening tools used	Screening done by	Definitions used	Subject locations (%)		Total no of persons			No of persons with RE		
								Rural	Urban	M	F	T	M	F	T
Murthy GVS, 2010	Gujarat	2007	Cross-sectional	≥50	LogMAR tumbling E chart, slit lamp and indirect ophthalmoscope, near vision LogMAR chart at a distance of 40 cms	Ophthalmic assistants and ophthalmologist	URE was assigned as the cause for those eyes where distance visual acuity improved to >=20/32 with refractive correction. Near normal vision (mild VI): <20/32 to 20/63 (<6/9.5 to 6/18); moderate VI: <20/63 to 20/200 (<6/18 to 6/60); moderate blindness<20/200 to 20/400 (<6/60 to 3/60); severe blindness <20/400 (<3/60)	75	25	2153	2585	4738	NR		993
Thulasiraj RD, 2003	Tamilnadu	Nov 1995 to Feb 1997	Cross-sectional	≥40	LogMAR chart, pinhole streak retinoscope, slit lamp, indirect ophthalmoscope	Ophthalmic assistants and ophthalmologist	VI - BCVA of<6/18 to light perception in the better eye. Blindness - BCVA <6/60 after best correction	100	0	NR		4915	NR		1280
Nirmalan PK, 2002	Tamilnadu	May to May 2000	Cross-sectional	≥50	Retroilluminated logMAR tumbling E charts, streak retinoscopy, slit lamp and direct ophthalmoscopy	Ophthalmic assistants and ophthalmologist	NN - normal or near normal vision, >=6/18 in both eyes; VI - unilateral or bilateral VI<6/18 to >=6/60 in the worse eye and >=6/60 in the better eye; UL <6/60 in the worse eye and >=6/60 in the better eye; MB <6/60 in the worse eye and <6/60 to >=3/60 in the better eye; SB <3/60 in both eyes with best correction	76	24	2420	2985	5405			230
Singh N, 2014	Andhra Pradesh	NR	Cross-sectional - RAAB	≥50	tumbling E chart, pin hole measurement	Ophthalmic assistants and ophthalmologist	Blindness was defined as VA worse than 6/60 in the better eye with available correction and VI was defined as VA worse than 6/18 but not worse than 6/60 in the better eye with available correction. URE was defined as VA <6/18 improving >6/18 with pinhole	61 (non-tribal) 31 (tribal)	0	3219	4062	7281	NR		905
Thulasiraj RD, 2002	Tamilnadu	Feb - May 1999	Cross-sectional	≥50	LogMAR tumbling E chart, slit lamp and direct ophthalmoscope	Ophthalmic assistants and ophthalmologist	RE was assigned as the cause of impairment for eyes that improved to normal/near normal vision (VA >=6/18) with best correction;	81	19	2111	2521	4632	NR		178
Marmamula S, 2013	Andhra Pradesh	2011-2012	Cross-sectional - RAVI	≥50	Snellen tumbling E chart, pin hole and for Near vision, N notation chart at a fixed distance of 40 cm	Vision technician	Blindness - Presenting VA <6/60 in the better eye; Moderrate VI - presenting VA <6/18 to 6/60. URE - presenting distance VA was <6/18 and improving to 6/18 or better with a pinhole	67	33	3421	3957	7378	NR		467

Table 4: Characteristics of the studies that reported data on uncorrected presbyopia in adult's ≥30 years

First author and year of publication	Location	Study period	Study Design	Age group	Screening tools used	Screening done by	Definitions used	Subject locations (%)		Total no of persons			No of persons with uncorrected Presbyopia		
								Rural	Urban	M	F	T	M	F	T
Nirmalan PK, 2006	Andhra pradesh	1996-2000	Cross-sectional	≥30	LogMAR chart, light meter, streak retinoscope	Optometrist and ophthalmologisit	Presbyopia - an addition of at least 1.0D in any eye in addition to best corrected distance vision to improve near vision to at least N8.	75	25	2595	2992	5587	1787	2120	2734
Marmamula S, 2009	Andhra pradesh	1999-2000	Cross-sectional -RARE	≥30	LogMAR tumbling E, multiple pinhole. Near vision using the N notation near vision chart at the customary working distance	Vision technician	Presbyopia binocular near vision <N8 at the subjects customary working distance and who had binocular distance VA of 6/12 or better	100	0	NR		1082	NR		560
He M, 2012	Taminadu	NR	Cross-sectional	≥35	LogMAR near vision tumbling E chart	NR	Uncorrected binocular Near VI - VA <=20/40 (<N6); >20/40 (>N6); 20/40 to 20/63 (N8 - N10); <20/63 (<N10)	73	27	1068	1563	2631	NR		1476
Marmamula S, 2012	Andhra pradesh	June to Sep 2010	Cross-sectional - RAVI	≥40	Snellen tumbling E chart, multiple pin hole and for Near vision, N notation chart at a fixed distance of 35-40 cm	Vision technician	Presbyopia binocular presenting near vision<N8 improving to >=N8 with correction and presenting distance VA of at least 6/18 in the better eye	100	0	709	851	1560	NR		439
Marmamula S, 2013	Andhra pradesh	NR	Cross-sectional - RAVI	≥40	Snellen tumbling E chart, pin hole and for Near vision, N notation tumbling E chart at a fixed distance of 35-40 cm	Vision technician	Presbyopia - unaided near vision worse than N8 improving to N8 or better with near addition lenses. Uncorrected (functional) presbyopia - binocular presenting near vision worse than N8 and improving to N* or better with near addition lenses	100	0	1127	1321	2448	350	509	859

NR - Not reported

cross-sectional studies: Rapid Assessment of Avoidable Blindness (RAAB), Rapid Assessment of Visual Impairment (RAVI), and Rapid Assessment of Refractive Errors (RARE). Fig. 2 summarizes the results of the detailed assessment for the 18 included studies using the checklist.

Fifteen studies were included from South India including nine from Andhra Pradesh and six from Tamil Nadu, one each from Western and Central India (Gujarat and Maharashtra), and one study covered 15 states across India. There was no information reported on the gender characteristics of the study participants in the two studies,[21,28] and only two studies reported the prevalence of REs by gender.[12,19] No data were available on the incidence of REs in India. The heterogeneity of the estimates from the included studies under the three categories was very high [Figs. 3-5].

There were four population-based studies that estimated the prevalence of RE in adults. The prevalence of RE of at least 0.50 D is 53.1% (95% CI: 37.2–68.5), of which the prevalence of myopia is 27.7% (95% CI: 18.3–39.6) and hyperopia is 22.9% (95% CI: 13.9–35.3). This was the average of estimates from four population-based studies and the range in these estimates was large (37–68%).

The prevalence of URE based on best correction or improving with pinhole is estimated at 10.2% (95% CI: 6.9–14.8). This was based on the synthesis of nine studies with equivalent definitions for URE. The pooled estimate was highly heterogeneous, and prevalence was as high as 26% in Tamil Nadu[21] in the late 1990s and 21% in Gujarat[15] in 2007. Further, we grouped the studies and analyzed the prevalence of URE using cross-sectional, RAAB, and RAVI methodology, and the pooled prevalence was 10.2 (95% CI: 4.2–22.8), 10.8 (95% CI: 8.3–14.1), and 9.6 (95% CI: 5.5–16.2), respectively.

The prevalence of uncorrected presbyopia among adults in India is estimated at 33% but the confidence limits for this estimate were very wide (95% CI: 19.1–51.0). Only two studies from Andhra Pradesh[25,26] reported data on uncorrected presbyopia by gender and overall pooled prevalence in males and females were 50% (95% CI: 17.4–82.6) and 55% (95% CI: 24.7–82.3), respectively.

There was not enough data available to calculate the prevalence by urban vs rural and by gender, which is essential for planning strategies to address the problem in these groups.

Discussion

This is the first systematic review of all population-based studies on the prevalence of REs and the need for refractive correction

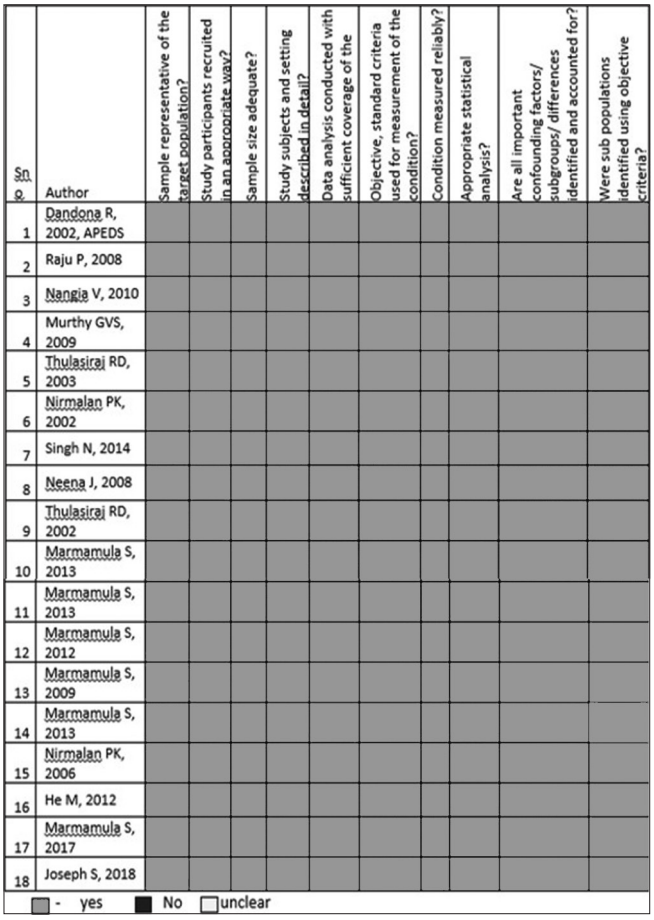

Figure 2: Methodological quality assessment of the 18 included studies

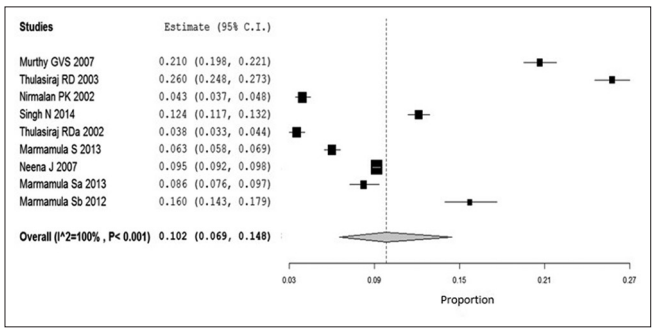

Figure 4: Forest Plot on the prevalence of uncorrected refractive errors (URE) among adults aged 30 years and above

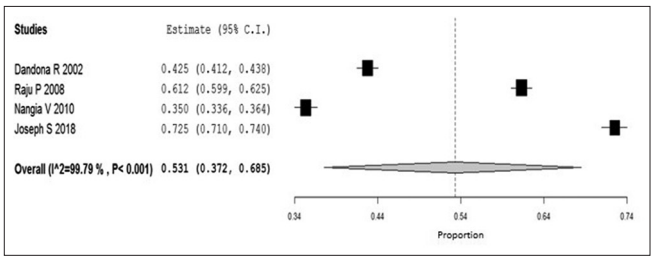

Figure 3: Forest Plot on the prevalence of refractive errors (RE) among adults aged 30 years and above

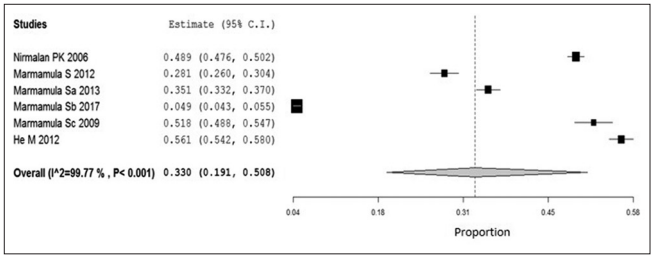

Figure 5: Forest Plot on the prevalence of uncorrected presbyopia among adults aged 30 years and above

in adults in India. REs are relatively common in India and the prevalence of half a dioptre or more of myopia or hyperopia in adults is 53.1%. Overall, 10.2% of adults in India were estimated to have URE. Nearly one-third of adults in the country have uncorrected presbyopia. As the overall magnitude of the problem is huge, it becomes imperative to prioritize refractive services and spectacle delivery programs for policy action. Of the three estimates provided in this review, the prevalence of RE as a cause of visual impairment and blindness should be the top priority as it has a profound impact on the productivity and quality of life of the individuals. Maintaining clear near vision is also important and can be easily corrected with reading glasses.

RE causing visual impairment and blindness in our review (10.2%) is much higher than the global estimates of 5.7% (95% CI: 5.0–6.9%) in population above 50 years of age.[29] Other than the age differences in these two reports, the majority of participants in this review are from rural areas of India. The relative lack of refractive services in rural areas may be a cause for the higher reported prevalence, indicating a potential area to focus on when planning any intervention. Another probable reason for the higher prevalence of RE could be cataract-induced index myopia in the rural population.[30]

Most systematic reviews aim to arrive at a single estimate for understanding the magnitude of the given problem. However, as there are different solutions for various refractive problems, findings have been presented under three categories, which are needed to plan refractive services and spectacle delivery programs.

Previous reports[31,32] suggests that subjective refraction is the better way to assess the REs compared to the method of estimating REs based on vision improvement with pin hole. Consistent with earlier findings, we found that the prevalence of URE with pinhole assessment is lesser than URE diagnosed through refraction. The prevalence of visual impairment and blindness which is resolved after refractive correction in India is 10.2% and prevalence of RE based on vision improvement with pinhole is 9.4%. However, considering the logistics, time, and resource requirements for population-based assessments, pinhole assessment with the VA cut-point of <6/18 is more convenient to use in rapid assessment surveys and community-based vision screenings.[33] One study by Marmamula and colleagues published in 2009 used the cut-point of 6/12 rather than the WHO cut-point of 6/18.[10] This study was not included in the pooled estimates as the majority of studies used 6/18 as the cut-point, which is the WHO definition. However, it could be argued that 6/12 is a more appropriate cut-point for estimating visual impairment.[34]

Heterogeneity of the included studies was quite high, almost 100%, and due to this, low confidence is given to the pooled estimates. The reasons for these differences are not apparent. Heterogeneity can be due to differences in the methodology adopted or definitions used in the included studies. However, the quality assessment on the methodology adopted in the included studies were rated very high. Moreover, very close confidence intervals reported in the included studies suggest a low variance in the sample studied. It is also possible that prevalence of RE, URE, and uncorrected presbyopia are inherently variable due to differences in socioeconomic status, urban or rural geographical location, and time period of assessment. The prevalence and types of REs is subject to temporal trends. Further, economic factors can determine spectacle coverage for both RE and presbyopia. Considering the high quality of included studies, the pooled estimates were calculated for the three categories; however, more population-based data across India are needed to further characterize the determinants of RE and spectacle coverage.

This review is dominated by studies from the southern parts of India, 15 out of 18 included studies. Considering the diversity in the demographics and the healthcare infrastructure in the country,[35] it is recommended to have prevalence data, using standard methodology from each region separately for a reliable estimate. We found no evidence on the incidence of refractive errors from India in adults. Because REs such as myopia typically emerge in childhood, most incidence studies are conducted among children. Moreover, there is very little information on the prevalence of RE in many regions. More studies are required using standard methodology in regions from where data is inadequate or not available.

Correcting REs in adults is less challenging compared to other vision impairing eye problems. Most RE correction services are offered as part of primary eye care service delivery and there are many established models for providing RE correction services within affordable prices. Given the variation in availability and uptake for RE correction across India, the high prevalence suggests that further exploration on availability of, access to, and utilization of services is needed. Individual, cultural, and social barriers that possibly prevent the utilization of existing services also require further examination.

Even though most of the included studies collected information on gender, only two studies reported data on REs by gender. Gender-based estimates are very important to determine the level of need and ensure equity in access to services. Previous studies have reported that REs and other eye conditions are higher among females compared to males.[36] Moreover, wearing spectacles causes inconvenience in certain occupations such as agricultural workers and other jobs, in which leaning forward often is a job requirement. The majority of the participants included in the studies in this review are from rural areas and agricultural activities are the predominant occupation in these communities, hence, these considerations are important in this setting.

We did not consider astigmatism in estimating the overall prevalence of REs in this review. If we include astigmatism, it would further increase the reported estimate of prevalence of refractive errors among adults in India.

Lack of uniform methodology and definitions adopted in the studies reviewed makes it challenging to arrive at a single estimate, which is ideal for policy decisions, however some estimates can be made.

Conclusion

This review concludes that REs among the adult population is a huge public health problem which has an economic impact of lost productivity due to URE and uncorrected presbyopia in India. This potential huge loss to the national economy can be prevented if the government invests in providing RE services at a larger scale through public–private partnerships involving all stakeholders to address this problem.

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Conflicts of interest

There are no conflicts of interest.

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