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Prevalence and risk factors for visual impairment among elderly residents in 'homes for the aged' in India: the Hyderabad Ocular Morbidity in Elderly Study (HOMES)

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ABSTRACT

Background/Aim To investigate the prevalence, causes and risk factors of visual impairment (VI) among the elderly in 'home for the aged' in Hyderabad, India.

Methods Individuals aged ≥60 years were recruited from 41 'homes for the aged'. All participants had complete eye examinations including presenting visual acuity, refraction, slit-lamp examination, intraocular pressure measurement and fundus imaging by trained clinicians. VI was defined as presenting visual acuity worse than 6/18 in the better eye. Multivariate logistic regression was used to determine the risk factors associated with VI.

Results 1512 elderly residents from 41 homes for the aged were enumerated, of whom 1182 (78.1%) were examined. The mean age of examined participants was 75.0 years (SD 8.8 years; range: 60–108 years); 35.4% of those examined were men. The prevalence of VI was 30.1% (95% CI 27.5 to 32.8). The leading cause of VI was cataract (46.3%, n=165), followed by uncorrected refractive error (27.0%, n=96), posterior capsular opacification (14.9%, n=53) and posterior segment disease (6.5%, n=23). Overall, 88.2% of the VI was either treatable or correctable. In multiple logistic regression, those aged 80 years and older (OR: 1.7, p<0.01), living in 'free' homes (OR: 1.5, p<0.01) and who were immobile/bedridden (OR: 3.02, p<0.01) had significantly higher odds of VI. Gender was not associated with VI.

Conclusions VI was common and largely avoidable in residents of 'homes for the aged' in Hyderabad, India. Screening for vision loss in 'homes for aged' and the provision of appropriate services should become routine practice to achieve the goal of healthy ageing in India.

Ageing is associated with declines in health status, physical function, cognition, frailty, and other physical and physiological functions.[1] Ageing also makes one vulnerable to other health problems, including vision loss. Over 250 million people are visually impaired globally,[2] and 80% of them are 50 years of age or older. A large proportion of this vision loss is avoidable (preventable, treatable or correctable) with relatively simple interventions such as use of spectacles and cataract surgery.[3–7] Vision loss adversely impacts the quality of life of the elderly population[8–10] and is associated with mortality.[11–13] Previous studies have found that vision loss is more common in institutionalised populations and among the elderly in residential care.[14–18]

According to the 2011 Indian census, 8% of the population is aged ≥60 years or 'elderly', and this proportion will increase to 20% by year 2050. This translates to 195 million elderly individuals by year 2030 and 324 million by year 2050.[19] The population of India will grow by 55% by 2050, and the percentage of elderly people will increase by 326%, with those aged ≥80 years increasing by 700%, making them the fastest-growing age group.[19]

The longitudinal Hyderabad Ocular Morbidity in Elderly Study (HOMES)[20] is designed to (1) investigate the prevalence, causes, risk factors and impact of visual impairment (VI) among the elderly individuals living in residential care facilities in Hyderabad (pre-intervention), and (2) assess the impact of interventions such as spectacles and cataract surgery on visual functions, falls, fear of falls and depression (post-intervention). In this paper, we report on the prevalence, causes and risk factors of VI in this study population.

MATERIALS AND METHODS

Participants provided written informed consent. HOMES was carried out in the 'home for the aged' centres in Hyderabad and adjoining regions of the Greater Hyderabad Municipal Corporation in the south Indian state of Telangana.[20] In total, 46 of 76 (60.5%) 'homes for the aged' in this region were selected and invited to participate in the study (including 5 for pilot study). The residents who were aged ≥60 years at the time of enumeration and had been residing in these homes for at least 1 month and agreed to participate were included in the study.

Eye examinations

The details of the design and the study methodology of HOMES were described in our previous report.[20] In brief, the field investigators visited the selected homes and enumerated all residents. Informed consent was obtained, and detailed interviews were conducted. Personal and demographic information such as age, gender, level of education

(years of education) and years of residence in the home and other details were collected using precoded questionnaires. Data were also collected on risk factors such as smoking (never smokers and ever smokers, including current and past smoker) and alcohol consumption (no alcohol and ever alcohol, including current and past alcohol consumption), and a self-report of systemic conditions (diabetes, hypertension and heart disease) and current medication for these conditions. Based on the interviewer's observations and self-report, the mobility status of the participants was classified as 'independently mobile', 'mobile with assistance' and 'immobile/bedridden'. Homes for the aged were classified as (1) private homes, where the individual or their kin pay a monthly or annual user fee; (2) aided/partially subsidised homes, where the individuals or their kin pay a part of the user fee and the rest of the amount is met by philanthropic support or other funding sources; and (3) free homes, where individuals need not pay any user fee as homes are supported by external funding sources.

A 'makeshift' clinic was set up in each of the homes and eye examinations were carried out by trained clinicians that included optometrist and vision technicians. Interviews and the clinical examination were conducted on different days to ensure that elderly participants were adequately rested. Interviews were done prior to the clinical examinations. At least two attempts were made within a period of 2 weeks to enrol participants who were not available at the time of the first visit.

The eye examination included assessment of visual acuity (VA) for distance and near using logMAR (logarithm of the minimum angle of resolution) charts.[20] Distance VA was assessed at a distance of 3 m in a well-illuminated room (at least 180 lux), and near vision was assessed at a fixed distance of 40 cm. The charts with tumbling E optotypes and English letter alphabets were used. Presenting VA and pinhole VA were assessed. Both manual and autorefraction were done. Subjective refraction was performed on all participants and best corrected VA was obtained. The anterior segment of the eye was examined using a handheld portable slit-lamp biomicroscope (BA 904, Haag-Streit Clement Clarke International, UK). Intraocular pressure was measured using a Perkins applanation tonometer (Mk3, Haag-Streit Clement Clarke International, UK). Fundus images were taken through undilated pupils using a non-mydriatic fundus camera (Visuscout 100 Handheld Fundus Camera, Carl Zeiss Meditec, USA). Both disc-centred and macula-centred images were attempted for each eye, which was graded by trained graders. Among those with aphakia or pseudophakia, distance direct ophthalmoscopy was done in a semi-dark room to grade density, area and extent of posterior capsular opacification (PCO) in the pupillary area. This was graded as (1) no posterior capsule, (2) clear posterior capsule (clear fundus glow visible), (3) hazy posterior capsule (dull fundus glow visible or few dark spots visible), (4) opaque posterior capsule (no fundus glow visible), and (5) cannot examine posterior capsule (for reasons such as opaque cornea, absent globe, phthisis bulbi).

The main cause of VI was assigned by the clinician for each eye and then for the person.[20] Where there were multiple causes, based on the clinical examination and the retinal images, the cause that was more likely to explain the vision loss was considered as the main cause in that eye. At the person level, in cases where there were different causes of VI in both the eyes, the cause that was more easily correctable or treatable was assigned. For example, if the cataract was the cause of VI in the right eye and undercorrected/uncorrected refractive error (URE) in the left eye, URE was marked as the main cause of VI and used for analysis. Similarly, if one eye had mature cataract and the other had PCO, then the main cause of VI for the individual was considered PCO as it is easier to address compared with cataract surgery.

VI was defined as presenting VA worse than 6/18 in the better eye. VI was subdivided into blindness (worse than 3/60), severe VI (worse than 6/60–3/60) and moderate VI (worse than 6/18–6/60). VI caused by cataract, URE or PCO was considered as avoidable, which included treatable and correctable causes. All participants who had VI due to URE were provided with spectacles. Those with VI due to other causes such as cataract and/or those who needed further care were referred to the L V Prasad Eye Institute for services. All services and spectacles were provided at 'no cost' to the participants.

Data management

Data were collected using precoded questionnaires and entered in a database developed in Microsoft Access, with validation checks for minimising data entry errors using double data entry. Data analysis was conducted using Stata Statistical Software for Windows V.14.[21] Prevalence estimates were calculated and presented with 95% CI. Multiple logistic regression models were used to examine the strength of association between VI and all the potential risk factors. Hosmer-Lemeshow goodness-of-fit test was used to assess the goodness of the model fit. Variance inflation factors were used to test for collinearity between the covariates after fitting a multiple regression model. Adjusted ORs with 95% CIs were presented. Statistical significance was assessed at the conventional level of p value less than 0.05 (two-tailed).

RESULTS

Study participants

In total, 1513 elderly participants were enumerated from 41 homes for the aged, of whom 1182 (78.1%) were examined, 179 (11.8%) were not available for examination after two attempts and 152 (10.1%) refused to undergo eye examinations. Those examined and non-examined were similar in terms of age (p=0.05) and gender (p=0.31). Participation rates ranged from 80.2% among the free homes, 80.8% in aided/partially subsidised homes and 75.0% in private homes (p=0.03) (table 1). The mean age of examined participants was 75.0 years (SD 8.8 years; range: 60–108 years), and 35.4% (n=418) were men.

Table 1 Characteristics of the participants examined and not examined (n=1513) in the HOMES

	Total enumerated (n)	Examined (n)	Response rate (%)	P value comparing examined and not examined
Age group (years)				0.05
60–69	415	329	79.3	
70–79	604	453	75.0	
80 and above	494	400	81.0	
Gender				0.31
Male	525	418	79.6	
Female	988	764	77.3	
Type of home				0.03
Private home	668	501	75.0	
Aided/partially subsidised	608	491	80.8	
Free	237	190	80.2	
Total	1513	1182	78.1	

HOMES, Hyderabad Ocular Morbidity in Elderly Study.

Table 2 Categories of visual impairment (n=356) among the elderly in residential care

Level of visual impairment	n (%)	95% CI
Moderate visual impairment (worse than 6/18–6/60)	279 (23.6)	21.1 to 26.1
Severe visual impairment (worse than 6/60–3/60)	38 (3.2)	2.3 to 4.4
Blind (worse than 3/60—no perception of light)	39 (3.3)	2.4 to 4.5
Total visual impairment	356 (30.1)	27.5 to 32.8

Of the participants, 20.3% (n=240) had no formal education, 60.7% (n=717) had school education and 19% (n=225) had higher education. Among those examined, 9.2% (n=108) were bedridden or immobile, 32.0% (n=378) were mobile with assistance and 58.8% (n=695) were independently mobile. In total, 42.4% (n=190) of the participants were from private homes, 41.5% (n=491) were from aided/partially subsidised homes and the remaining 16.1% (n=190) were from free homes. More than two-thirds of the participants reported living in homes for less than 5 years (68.2%, n=806), 17.3% (n=205) reported living in homes for 5–9 years, and 14.5% (n=171) reported living in homes for 10 years or more.

Prevalence and causes of VI

Based on presenting VA, the prevalence of VI was 30.1% (95% CI 27.5 to 32.8), which included moderate VI in 279 (23.6%) participants (95% CI 21.1 to 26.1), severe VI in 38 (3.2%) participants (95% CI 2.3 to 4.4), and blindness in 39 (3.3%) participants (95% CI 2.4 to 4.5) (table 2). Using a better level of cut-off and defining VI as presenting VA worse than 6/12 in the better eye, the prevalence of VI was 52.7% (95% CI 49.8 to 55.6) (table 2). The leading cause of VI was cataract (46.4%, n=165), followed by URE (27.0%, n=96) and PCO (14.9%, n=53). Posterior segment disease was a cause of VI in 6.5% (n=23) of the cases and included age-related macular degeneration (n=9), optic atrophy (n=7), diabetic retinopathy (n=1) and other retinal conditions (n=7). Overall, 88.2% of the VIs were either treatable or correctable (table 3). The causes of VI stratified by categories of VI are shown in figure 1.

Table 3 Distribution and prevalence of causes of visual impairment (n=356) among the elderly

Cause	n	Cause-specific prevalence (95% CI)	% of the total visual impairment
Cataract	165	14.0 (12.0 to 16.1)	46.3
Uncorrected refractive errors	96	8.1 (6.6 to 9.8)	27.0
Posterior capsular opacification	53	4.5 (3.4 to 5.8)	14.9
Glaucoma	9	0.8 (0.3 to 1.4)	2.5
Age-related macular degeneration	9	0.8 (0.3 to 1.4)	2.5
Optic atrophy	7	0.6 (0.2 to 1.2)	2.0
Other posterior segment disease*	7	0.6 (0.2 to 1.2)	2.0
Corneal scar	5	0.4 (0.1 to 10)	1.4
Other causes†	5	0.4 (0.1 to 10)	1.4
All causes	356	30.1 (27.5 to 32.8)	100.0

*Includes diabetic retinopathy (n=1), healed chorioretinitis (n=1), myopic retinal degeneration (n=1) and other retinal conditions (n=2).
†Includes glaucoma, phthisis bulbi (n=3) and unexplained vision loss (n=2).

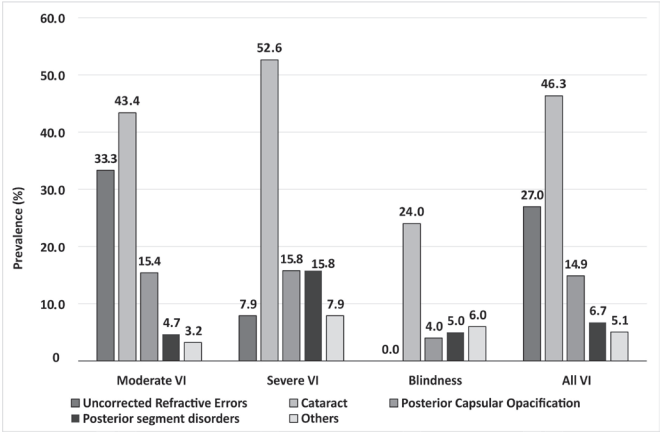

Figure 1 Distribution of causes stratified by categories of visual impairment (VI) (n=356).

VI and associations

In multivariate logistic regression analysis, those aged 80 years and older had higher odds of VI (OR: 1.70; 95% CI 1.6 to 2.47) compared with their younger counterparts. Compared with those with no formal education, those with school education (OR: 0.35; 95% CI 0.25 to 0.49) or higher education (OR: 0.21; 95% CI 0.13 to 0.35) had lower odds of VI. When compared with those residing in private homes, those living in free homes (OR: 1.51; 95% CI 1.00 to 2.30) had higher odds of VI. VI was more common in those with shorter length of stay in the homes. Compared with those living in residential care for less than 5 years, those who resided for 5–9 years had similar odds of VI (OR: 0.82; 95% CI 0.56 to 1.20), while those residing for 10 years or more had lower odds of VI (OR: 0.46; 95% CI 0.30 to 0.72). Compared with the elderly who were independently mobile, those with mobility with assistance (OR: 1.44; 95% CI 1.06 to 2.16) and those who were immobile/bedridden (OR: 3.02; 95% CI 1.91 to 4.80) had significantly higher odds of VI. Smoking status, alcohol consumption, gender and heart disease were not associated with VI. Those reported to have diabetes had lower odds of VI (OR: 0.68; 95% CI 0.49 to 0.96). The odds were also lower for those who self-reported hypertension (OR: 0.67; 95% CI 0.50 to 0.88) (table 4).

DISCUSSION

Nearly one-third of the elderly individuals living in homes for the aged centres in Hyderabad had bilateral presenting vision worse than 6/18 and 52% had bilateral presenting VA of 6/12 or worse. Furthermore, over 3% were blind. A large proportion of this VI (88%) was avoidable with either cataract surgery, glasses or laser treatment (for posterior capsule opacification). We previously reported a higher prevalence of VI (56.7% vs 30% in the present study) in residential care homes in Prakasam district in India in 2012.[18] This difference could be due to a few factors. First, Prakasam is a rural district and access to eye care services may be even more limited compared with the urban location of the present study. Second, there has been an expansion of eye care services in the region since the previous research was conducted and more residents are likely to have received care, leading to a lower prevalence. However, the burden of vision loss remains high and needs to be addressed.

Studies done among the elderly institutionalised populations from other parts of the world report large variability in the prevalence and causes of VI. The prevalence of VI is higher in studies reported from developing countries when compared

Table 4 Association of visual impairmentwith sociodemographic characteristics and systemic conditions (multiple logistic regression analysis) (n=1182)

	Total in the sample (n)	Visual impairment, n (%)	OR (95% CI)*†‡	P value
Age group (years)				
60–69	329	85 (25.8)	Reference	
70–79	453	123 (27.1)	1.09 (0.76 to 1.56)	0.63
80 and above	400	148 (37.0)	1.70 (1.16 to 2.47)	<0.01
Gender				
Male	418	117 (28.0)	Reference	
Female	764	239 (31.3)	0.98 (0.66 to 1.45)	0.91
Education level				
No education	240	129 (53.7)	Reference	
School education	717	188 (26.2)	0.35 (0.25 to 0.49)	<0.01
Higher education	225	39 (17.3)	0.21 (0.13 to 0.35)	<0.01
Marital status				
Married	254	55 (21.7)	Reference	
Widowed/separated/single	928	301 (32.4)	1.64 (1.14 to 2.36)	0.01
Home type				
Private	501	136 (27.1)	Reference	
Aided/partially subsidised	491	142 (28.9)	1.21 (0.87 to 1.66)	0.25
Free	190	78 (41.0)	1.51 (1.00 to 2.3)	0.05
Years of residence at the home				
<5	806	264 (32.7)	Reference	
5–9	205	57 (27.8)	0.82 (0.56 to 1.20)	0.31
≥10	171	35 (20.5)	0.46 (0.30 to 0.72)	<0.01
Diabetes				
No	851	286 (33.6)	Reference	
Yes	331	70 (21.1)	0.68 (0.49 to 0.96)	0.02
Hypertension				
No	503	177 (35.2)	Reference	
Yes	679	179 (26.4)	0.67 (0.50 to 0.88)	0.01
Heart disease				
No	1065	332 (31.1)	Reference	
Yes	117	24 (20.5)	0.77 (0.47 to 1.27)	0.31
Smoking status				
Never	976	293 (30.0)	Reference	
Current/past	206	63 (30.6)	1.10 (0.69 to 1.78)	0.68
Alcohol consumption				
Never	971	282 (29.0)	Reference	
Current/past	211	74 (35.1)	1.42 (0.94 to 2.16)	0.09
Mobility score				
Fully independent	696	166 (23.9)	Reference	
Mobile with support	378	135 (35.7)	1.44 (1.06 to 2.0)	0.02
Immobile/bedridden	108	55 (50.9)	3.02 (1.91 to 4.80)	<0.01
Total	1182	356 (30.1)		

*Based on multiple logistic regression with visual impairment as the outcome and all the predictors entered at the same time.
†Hosmer-Lemeshow test for goodness of fit for the regression model, p=0.64.
‡Mean variance inflation factor for the multiple logistic regression model=1.28.

with those in developed countries. For example, using a similar definition for VI, a study among the elderly in residential care in Nepal reported an overall prevalence of 31.9%, which was higher than what we found in this study.[22] Using the <6/12 definition, the prevalence of VI among the elderly in residential care in Singapore and Australia was 46.4% and 41.5%, respectively, compared with 51.5% in the present study. This difference in the prevalence can be attributed to the mean age of the participants in these studies and due to other factors.[8 14] Few studies in the USA have reported the prevalence of VI among those in residential care. Tielsch *et al*[23] in 1995 reported a very low prevalence of VI (15.2%), and Owsley *et al*[15] reported that over 57% of those examined had VI. However, Tielsch *et al* included all individuals in residential care, including those aged 40 years and older, whereas Owsley *et al* included participants aged 55 and older. Using the same definition <6/12 definition for VI, West *et al* in 2003 reported a 38% prevalence of VI among nursing home residents in the USA, and this prevalence declined to 29% after refractive correction.[24]

The two most common causes of VI were cataract and URE, a finding that is common to almost all population-based prevalence surveys in adults.[18] Of note, PCO was the third leading cause of VI and this was a novel finding in our study. One explanation is the high rate of cataract surgery in Hyderabad, resulting in large numbers of elderly who are pseudophakic. Access to a Nd:YAG (Yttrium Aluminum Garnet) laser may not be simple, and many in the home for the aged do not receive routine eye care, and thus easy-to-manage cases of PCO remain unattended. One possible solution is the development and wider use of portable YAG laser for treating PCO in elderly homes. This may be necessary as poor mobility, poor systemic health and access to care remain major barriers to the uptake of services in the elderly. The elderly with poor mobility were at a higher risk for VI, as has been reported in other studies done in nursing homes.[18 25 26] This could either be a risk factor or it could be a cause of VI as those with poor vision are less mobile.

The elderly with poor mobility cannot independently attend eye examinations, and hence a higher prevalence of VI was an expected finding. Access to care is likely an important factor in determining who has VI in these facilities. Residents in private homes had better visual status compared with those living in aided/partially subsidised care, and even better vision than those in free homes. This suggests that those with more resources are more likely to access eye care. 'Homes for the aged' in India lack regulatory oversight, leading to considerable variation in services provided. There are often no standard operating procedures in these homes, and no state-wide regulations requiring regular eye examinations.

As expected, age was a major risk factor of VI. However, gender was not associated with the prevalence of VI, which is in contrast to what is reported in the recent Global Burden of Disease studies and other studies from India.[2 27] Our earlier study in elderly people in Prakasam district also did not find a significant association between VI and gender.[18] It may be that the overall effect of being institutionalised levels the playing field in terms of access to care, and therefore men are equally as likely as women to have VI. Those with diabetes and hypertension were less likely to have VI, and there was no significant association between smoking, alcohol consumption and VI. The most likely explanation is 'survival bias', where those elderly individuals with more serious morbidity from these conditions either never entered the homes or were more likely to die after entry, leaving the more healthy ones in the homes. It is also possible that those with diabetes and hypertension are more likely to attend health checks and also eye check-up. Also, home authorities may be biased about admitting individuals with significant morbidity, which may impact the resources available to them. Nursing homes and rehabilitation centres would be more likely to have a higher burden of severe disease than the homes for the aged centres.

Our study is one of the most comprehensive eye health studies done among the elderly in India. The inclusion of a large number of 'homes for the aged' as well as a large number of individuals examined combined with the high response rate are important strengths of our study. Of the total number of homes

in Hyderabad, 60% participated in our study. Our inability to carry out dilated fundus examination may have led to an underestimation of the prevalence of posterior segment disease especially in cases of dense cataract. While we took fundus images to help in making an accurate diagnosis of the posterior segment disorders, some of these images were not gradable due to cataract and other media opacities.

In conclusion, we found that the elderly individuals living in 'homes for the aged' in Hyderabad have a high burden of treatable or correctable vision loss. The results likely can be extrapolated to other urban locations in India. Strategies are needed to reach out to this elderly and vulnerable population, to implement vision screening, and to provide eye care. As the Indian population ages, there will be an increasing burden of vision loss in these homes. Screening for vision loss in 'homes for the aged' should become standard practice similar to that of school screening programmes to ensure that this vulnerable population does not suffer due to needless vision loss in their 'sunset' years of life.

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Contributors SM conceived the idea, designed and conducted the study, analysed the data, and wrote the manuscript. NRB, RC, TRK, SBM and MB are involved in data collection. RY assisted in data management. RCK and DF reviewed the earlier version of the manuscript and provided intellectual input.

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Competing interests None declared.

Patient consent for publication Not required.

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Cross-sectional study of cognitive impairment and visual impairment among the elderly population in residential care in India: the Hyderabad Ocular Morbidity in Elderly Study (HOMES)

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ABSTRACT

Objective To report the relationship between visual impairment (VI) and cognitive impairment (CI) among the older population living in residential care homes in Hyderabad, India.

Study design Cross-sectional study.

Setting 41 homes for the aged centres in the Hyderabad region.

Participants 965 participants aged ≥60 years from homes for the aged centres.

Primary outcome measures Visual impairment and cognitive impairment.

Methods The Hindi mini-Mental Status Examination (HMSE) questionnaire was used to assess the cognitive function. The final HMSE score was calculated after excluding vision-dependent tasks (HMSE-VI). A detailed eye examination was conducted, including visual acuity (VA) measurement for distance and near vision, using a standard logarithm of the minimum angle of resolution chart under good illumination. CI was defined as having a HMSE-VI score of ≤17. VI was defined as presenting VA worse than 6/12 in the better-seeing eye. Near VI (NVI) was defined as binocular presenting near vision worse than N8 and distance VA of 6/18 or better in the better-seeing eye. Multiple logistic regression was done to assess the association between VI and CI.

Results The mean age (±SD) was 74.3 (±8.3) years (range: 60–97 years). There were 612 (63.4%) women, and 593 (61.5%) had a school education. In total, 260 (26.9%; 95% confidence intervals: 24.2 to 29.9) participants had CI. The prevalence of CI among those with VI was 40.5% compared with 14.6% among those without VI (p<0.01). The logistic regression analysis showed that the participants with VI for distance vision had three times higher odds of having CI (OR 3.09; 95% confidence intervals: 2.13 to 4.47; p<0.01). Similarly, participants with NVI had two times higher odds of having CI (OR 2.11; 95% confidence intervals: 1.36 to 3.29; p<0.01) after adjusting for other covariates.

Conclusions CI was highly prevalent among those with distance and near VI. VI was independently and positively associated with CI after adjusting for potential confounders. Interventions can be planned to address VI in this vulnerable population which could have a ripple effect in preventing cognitive decline.

STRENGTHS AND LIMITATIONS OF THIS STUDY

⇒ Large sample size, comprehensive eye examination including visual acuity assessment and use of a standard questionnaire to assess cognition.
⇒ Vision dependent tasks in the cognition assessment were excluded to control for the effect of visual impairment on cognition test results.
⇒ Prevalence of cognitive impairment among those with distance visual impairment and those with near vision impairment with normal vision for distance are reported.
⇒ Participants with severe grades of hearing impairment could not complete the cognition assessment, and hence, the overall prevalence of cognitive impairment could have been underestimated.
⇒ The results from this study cannot be extrapolated to community-dwelling older people, as it was carried out among older people living in residential care in an urban area.

INTRODUCTION

Visual impairment (VI) and cognitive impairment (CI) are twin public health challenges that predominantly affect older people. VI affects over 1.1 billion people worldwide, with a higher prevalence in older age groups.[1] By the year 2050, 1.7 billion are projected to be affected.[1] VI significantly impacts the emotional, social and economic well-being of an individual. It adversely affects the individual's quality of life and leads to a substantial loss in economic productivity.[2 3] VI also increases the risk of mortality.[4] In India, one

out of every three adults aged 60 years and older has VI.[5 6] However, approximately 9/10 cases of VI in India can be addressed using cost-effective interventions, such as spectacles and cataract surgery.[7]

Dementia is a severe form of CI that affected over 57.4 million people worldwide in 2019. This number is expected to rise to approximately 152 million (117% increase) by 2050.[8] Moreover, this increase is expected to affect low-income and middle-income countries the most.[8] The prevalence of CI in population-based studies ranges from 3%–44%.[9–11] The Longitudinal Ageing Study in India-Diagnostic Assessment of Dementia (LASI-DAD), one of the largest nationally representative studies conducted in India, reported the prevalence of dementia as 7.4% (affecting 8.8 million people).[12]

Vision and cognition seem to be intricately interwoven, as many cross-sectional and longitudinal studies have revealed a positive association between them.[13–16] In a recent systematic review of 110 studies, 91 reported a significant positive association between VI and CI.[17] However, this systematic review included only a few studies from developing countries and none from India.[17] In India, the first study investigating the relationship between cognition and vision reported a positive association between VI and CI.[18] It also found that cognitive function was lower with higher levels of VI, even when vision-dependent cognitive tests were excluded.[18]

Understanding the relationship between VI and CI is important to plan interventions. VI could be a modifiable risk factor for CI and dementia. Theoretically, visual stimulation affects the cognitive load on the brain and prevents cognitive decline by improving physical and social functioning and overall quality of life.[19] A few longitudinal studies have indicated improvements in cognitive functions after cataract surgery.[20 21] Both CI and VI are more common among older people. India is ageing, and projections are that by 2050, every fifth Indian will be aged 60 years or older, accounting for 320 million people. In addition to this demographic transition, many social changes are evident, such as new living arrangements and family structures due to urbanisation, including residential homes for the aged.[22] At this crucial juncture, understanding the impact of these changes on the lives of the elderly is vital.

In India, homes for the aged are a recent and emerging concept.[23] These homes are diverse in terms of scope, services provided and the number of individuals residing in them.[23] There are no standardised guidelines for admission into these homes. While most homes admit people aged 60 and older, few even admit those aged 50 years and older. Few homes restrict admissions to older people with independent mobility while others also include those who need assistance for mobility and a few who are bedridden. In addition, there are specific homes which are typical nursing homes or rehabilitation centres for the older people with disabilities and those who are bedridden. Non-governmental, religious or voluntary organisations with support from the government and philanthropists manage these homes. In some homes, the elderly themselves or their kin pay the monthly or annual 'user fee'.[23]

With this background, the Hyderabad Ocular Morbidity in Elderly Study (HOMES) was designed to assess the prevalence, causes and risk factors of VI among elderly individuals living in homes for the aged in Hyderabad, India.[23] A secondary objective of this study was to assess the relationship between cognitive function and VI. The prevalence of VI, its causes and risk factors have been reported previously.[24] The current study focuses on cognitive function and VI among older adults living in residential homes for the aged in Hyderabad, India.

METHODS

Study participants

The HOMES included 1515 participants enumerated from 41 residential care homes for the aged in Hyderabad.[23 24] Residents aged ≥60 years residing in these homes for at least 1 month at the time of enumeration and who agreed to participate were included in the study. Of the 1182 participants examined in HOMES, 217 were bedridden or had serious medical issues and were excluded from these analyses. Therefore, data from the remaining 965 participants were included in the analyses.

Assessment of cognitive function

The Hindi mini-Mental Status Examination (HMSE) questionnaire is used to assess cognition in India.[25] Similar to the Mini-Mental Status Examination (MMSE)-blind, the final HMSE score was calculated after excluding vision-dependent tasks (HMSE-VI).[15 26–28] The maximum possible score was 22 points compared with the 30 in the conventional HMSE.[25] A high HMSE-VI score was defined as >17, and a low HMSE-VI score was defined as ≤17. Other researchers have used a similar cut-off for the MMSE-blind scale.[15] In this study, trained investigators conducted the HMSE-VI assessments in the local language in homes for the aged facilities.

Eye health assessment

A detailed eye examination was performed after the interview, as reported in our previous publications.[23 24 29] This assessment included visual acuity measurement for distance and near vision using a standard logarithm of the minimum angle of resolution (logMAR) chart under good illumination. Visual acuity was assessed with spectacles, if available. Distance visual acuity was assessed at 3 m in a well-illuminated room (at least 180 lux), and near vision was assessed at a fixed distance of 40 cm. Visual acuity charts with tumbling E optotypes and English letter alphabets were used for assessment. An anterior segment examination using a portable handheld slit lamp and fundus imaging were carried out. Interviews and clinical eye examinations were done on different days to ensure that the participants had adequate rest between the assessments. The following two definitions were used for

distance VI based on the presenting visual acuity in the better eye:

1. Definition 1: a visual acuity threshold worse than 6/12 (mild VI or worse).
2. Definition 2: a visual acuity threshold worse than 6/18 (moderate VI or worse).

Both definitions are in line with recent definitions of VI.[24] Near VI (NVI) was defined as presenting binocular near vision worse than N8 among those with no VI for distance vision (presenting visual acuity of 6/18 or better in the better-seeing eye). N8 corresponds to the font size commonly used in the newsprint.

Other covariates

Trained field investigators collected data on personal and demographic information, such as age, gender and highest education level, in face-to-face interviews. The following covariates were included : age group (60–69, 70–79 and ≥80 years); gender (male or female); education: higher education (graduation and above), primary or secondary school only (1–12 years of education) or no formal education; the type of home: private (where the individual or their kin pay a monthly or annual user fee), subsidised homes (where the individual or their kin pay only a part of the fee and the remainder is supported from other funding sources), and free homes (where the individual does not pay and homes are supported by external funding) and self-report of diabetes and hypertension (present/absent).

Patient and public involvement

Patients and other members of the public were not involved in the study.

Data analysis

Statistical analyses were conducted using Stata V.14 (Stata Corp, College Station, Texas, USA). The prevalence of CI was calculated and presented with 95% confidence intervals. A Pearson χ^2 test was used to compare categorical variables, and the Student's t-test and ANOVA (Analysis of Variance) were used for continuous variables. In multiple logistic regression analysis, VI was used as an outcome variable, and its association with CI was assessed with the sociodemographic variables (age, gender and level of education) as covariates. The adjusted OR (odds ratio) with 95% confidence intervals have been presented. For all analyses, the statistical significance was set at p<0.05 (two-tailed); however, the exact p-values have been reported.

RESULTS

Characteristics of the participants

The mean age (±SD) of participants was 74.3 (±8.3) years (range: 60–97 years). There were 612 (63.4%) female participants, and 593 (61.5%) had attended at least some primary school. In terms of the type of home, 382 (39.6%), 425 (44.0%) and 158 (16.4%) were living in private, subsidised and free homes, respectively. Diabetes and hypertension were reported by 281 (29.12%) and 559 (59.7%) participants, respectively. In total, 459 (47.6) participants had VI using definition 1 (<6/18); 243 (25.2%) participants had VI using definition 2 (<6/12) and 355/722 (49.2%) participants had NVI (table 1).

The overall prevalence of CI was 26.9% (95% confidence intervals: 24.2 to 29.9; n=260). In a total of 459/965 (47.6%) participants who had VI for distance using the definition 1 (<6/12), 186 (40.5%; 95% confidence intervals: 36.0 to 45.1) participants had CI. Similarly, 243/965 (25.2%) participants who had VI using definition 2 (<6/18), 122 (50.2%; 95% confidence intervals: 43.7 to

Table 1 Characteristics of the study participants

Mean (SD) age in years	**74.3 (8.4)**	
Hindi mini-Mental Status Examination-Visual Impairment (HMSE-VI) scores—mean (SD)	**18.1 (3.9)**	
	n	%
Age group (years)		
60–69	284	29.4
70–79	387	40.1
80 and above	294	30.5
Gender		
Male	353	36.6
Female	612	63.4
Education level		
Higher education	196	20.3
School education	593	61.5
No education	176	18.2
Type of home		
Paid home	382	39.6
Subsidised home	425	44.0
Free home	158	16.4
Diabetes		
No	684	70.9
Yes	281	29.1
Hypertension		
No	406	42.1
Yes	559	57.9
Visual impairment (<6/12)		
No	506	52.4
Yes	459	47.6
Visual impairment (<6/18)		
No	722	74.8
Yes	243	25.2
Near visual impairment (n=722)		
No	367	50.8
Yes	355	49.2

Table 2 The effects of personal and demographic characteristics on cognitive impairment (multiple logistic regression analysis)

	Distance visual Impairment (<6/12)		Distance visual impairment (<6/18)		Near visual impairment (worse than N8)	
	Odds Ratio (95% Confidence intervals)	P value	Odds Ratio (95% Confidence intervals)	P value	Odds Ratio (95% Confidence intervals)	P value
Model 1—Crude Odds Ratio						
Cognitive impairment						
No	Reference		Reference		Reference	
Yes	3.98 (2.92 to 5.42)	<0.01	4.27 (3.12 to 5.83)	<0.01	2.44 (1.65 to 3.60)	<0.01
Model 2—adjusted for age, gender and education						
Cognitive impairment						
No	Reference		Reference		Reference	
Yes	3.09 (2.13 to 4.47)	<0.01	3.04 (2.13 to 4.35)	<0.01	2.12 (1.36 to 3.29)	<0.01
Model 3—adjusted for age, gender and education, type of home, diabetes and hypertension						
Cognitive impairment						
No	Reference		Reference		Reference	
Yes	3.16 (2.19 to 4.56)	<0.01	2.91 (2.00 to 4.25)	<0.01	2.13 (1.36 to 3.30)	<0.01

56.7) participants had CI. Of 355/722 (49.2%) participants who had NVI, 92 (25.9%; 95% confidence intervals: 21.4 to 30.8) participants had CI.

Association between VI and CI

The logistic regression analysis showed that the participants with VI for distance vision had higher odds for CI using both definitions (<6/12 and 6/18). Participants with VI had four times higher odds of having CI compared with those without VI. This association remained significantly high after adjusting for age, gender and education in model 1. The association remained significantly high after controlling for other covariates, including type of home, diabetes and hypertension, in model 2. Similarly, the participants with NVI had two times higher odds to have CI compared with those without NVI. This association persisted after adjusting for other covariates in models 1 and 2 (table 2).

Categories of VI and CI

The prevalence of CI varied from 14.6% among those with no VI to 60% among those with blindness. The mean HMSE-VI scores were lower among those with severe VI (one-way ANOVA; p<0.01) (table 3). The mean HMSE-VI scores were lower for those with VI caused due to cataract compared with other causes of VI (table 4).

DISCUSSION

CI was significantly associated with VI after adjusting for potential demographic and socioeconomic confounders. A dose-response relationship was observed, with a higher prevalence of CI in those with worse grades of VI. Half of the participants with VI, using the 6/18 definition, had CI. Though MMSE and HMSE are the most common tools to assess cognitive function, most studies have not excluded vision-dependent tasks.[17] A recent study that included a sample of participants from the Longitudinal Ageing Study in India presented its results after excluding vision-dependent tasks from a comprehensive cognitive test battery.[18] This study noted poorer cognitive function among those with VI, which is consistent with

Table 3 Prevalence of cognitive impairment and mean (±SE of the mean) Hindi mini-Mental Status Examination-Visual Impairment (HMSE-VI) scores with categories of visual impairment (VI)

	Number in the sample	Prevalence of cognitive impairment n (%)	Mean HMSE-VI score (±SE of the mean)
Visual impairment (VI) category			
No VI	506	74 (14.6)	19.5 (0.1)
Mild VI	216	64 (29.6)	17.5 (0.3)
Moderate VI	204	100 (49.0)	15.8 (0.3)
Severe VI	24	13 (54.2)	15.7 (1.0)
Blindness	15	9 (60.0)	14.7 (1.2)
Total	965	260 (26.9)	18.1 (0.1)
VI—6/12 Definition			
No VI	506	74 (14.6)	19.5 (0.1)
VI	459	186 (40.5)	16.6 (0.2)
VI—6/18 Definition			
No VI	722	138 (19.1)	18.9 (0.1)
VI	243	122 (50.2)	15.8 (0.1)

Table 4 Mean (±SE of the mean) of Hindi mini-Mental Status Examination-Visual Impairment (HMSE-VI) scores with causes of visual impairment.

Causes	Number (%)	Mean HMSE-VI score (±SE of the mean)
No visual impairment	722 (74.8)	18.9 (0.1)
Uncorrected refractive errors	76 (7.9)	16.2 (0.5)
Cataract	112 (11.6)	15.3 (0.4)
Other causes	55 (5.7)	16.1 (0.6)
Total	965 (100)	18.1 (0.1)

our findings.[18] Though there is a positive association of VI with the level of education and age, the association between VI and CI remained independent of these risk factors. NVI was also associated with CI after adjusting for other covariates. Similar findings are reported from a study conducted in the older populations in Israel.[30]

Several hypotheses could explain this strong and consistent association between CI and VI.[19 31 32] One hypothesis is attributed to the common pathway that affects the ageing brain and visual system, as shown in a few studies that investigated vision and cognition.[31 32] It is hypothesised that VI hinders social interactions, reduces physical activities and adversely affects the performance of vision-dependent tasks, resulting in cognitive decline and dementia.[17] Participation in cognitively stimulating activities and physical activity is shown to delay the onset of dementia.[33 34]

One out of every four elderly individuals living in homes for the aged in Hyderabad, India had CI. These findings are consistent with other studies that have reported the prevalence of CI among older adults in India, ranging from <5% to 44%.[9–11 35–38] However, those studies were conducted in community settings, as opposed to the homes for the aged included in this study. One study from Kerala that included a smaller subsample of elderly residents in homes for the aged centres reported a prevalence of 32.4% in paid homes and 42.7% in free homes compared with 21.9% in the community-dwelling elderly population.[39] Previous studies that investigated the prevalence of CI in India did not exclude participants with sensory impairments, which might have impacted the results and prevalence of CI.

The prevalence of CI increased with age in our study. Evidence from previous studies on the association between CI and older age, both from India and other countries, is equivocal.[17] The evidence also points to a positive association between gender and CI, both from India and other countries.[40 41] Women consistently have a higher prevalence of CI than men across studies.[40 41] In this study, the prevalence of CI among women was almost twice that of men. A higher prevalence of CI was observed among those with lower levels of education, which is consistent with the results from other studies conducted in India.[9–11] The education-cognition relationship is complex. Individuals with higher levels of education are likely to perform better on the cognitive test than those without any formal education. Moreover, individuals with higher levels of education are more likely to have more social interactions, cognitively active work lives and better socioeconomic status, slowing down the process of cognitive decline compared with their age-matched peers.[28 42]

The United Nations Decade of Healthy Ageing (2021–2023) provides the framework for the integrated care of older adults, including long-term care.[43 44] The research on late-life health and well-being is a cornerstone for achieving the goal of healthy and active ageing. The key is to identify the modifiable risk factors and design interventions to address them holistically. In line with this initiative, the current research investigated the relationship between two key public challenges that affect older adults in residential care to provide valuable insights into the provision of services. This study also highlights the need to screen for other dimensions of health and well-being such as cognition among older people seeking eye care and make appropriate referrals for services where needed.

Though several studies have investigated CI, only a few have described the relationship between CI and VI in India, and none has reported the association between CI and VI among the older population in residential care settings. There are no reports on NVI and CI in India. This study included a large sample of individuals from homes for the aged and an in-depth vision and eye health assessment, including the causes of VI. Unlike the previous studies done in India, we excluded the vision-dependent tasks from the HMSE to assess cognitive function independent of the severity of VI to provide a more realistic prevalence of CI. That said, the impact of VI on cognitive tests is not reported from India. Researchers from Singapore presented a vision-independent battery to assess cognitive function among the older people with VI.[45] To our knowledge, no publication has reported the HMSE-VI scores among the visually impaired population in India before this study.

This study had a few limitations. Participants with severe hearing loss did not complete the HMSE questionnaire, as it was difficult to communicate and elicit reliable responses. Moreover, those with mobility challenges or who were bedridden were not included. Therefore, we may have underestimated the prevalence of poor cognitive function and its association with VI. In addition to severity, the duration of VI could also impact cognitive function. However, this study could not assess the duration of vision loss. Given the cross-sectional design of the study, a causal relationship between VI and CI could not be established. Finally, the study included only individuals from homes for the aged in an urban region of India. Therefore, our results cannot be generalised to the population at large.

In conclusion, VI is associated with CI in older adults in residential care in Hyderabad, Telangana, India. As

a large proportion of VI is avoidable, interventions to address VI might cause a positive ripple effect on cognitive functions and improve the well-being of older people in residential care, though additional interventional research is warranted.

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Contributors SM conceived the idea, designed and conducted the study, analysed the data and wrote the manuscript. TRK assisted in data collection, clinical quality control and supervised the field activities. JRE, DB and DF reviewed earlier versions of the manuscript and provided intellectual inputs. All authors have reviewed the final version of the manuscript. SM bears primary responsibility for the final content of the manuscript and the accuracy of the data as a guarantor.

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Patient consent for publication Consent obtained directly from patient(s).

Ethics approval The study protocol was approved by the Institutional Review Board (IRB) of the Hyderabad Eye Research Foundation, L V Prasad Eye Institute, Hyderabad, India (LEC 08-16-073) and it adhered to the tenets of the Declaration of Helsinki. Written informed consent was obtained from each participant.

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