Discrepancies in Visual Impairment Prevalence: Comparing Self-Reports and Standard Tests in the Longitudinal Ageing Study of India

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DECLARATION:

Ethics approval and consent to participate

The Central Ethics Committee on Human Research (CECHR) under the Indian Council of Medical Research (ICMR) provided ethical approval for conducting the LASI survey. Analyses and methods were carried out under relevant guidelines and regulations. The survey agencies that conducted the field survey for the data collection have collected prior informed consent (signed and oral) for both the inter- views and biomarker tests from the eligible respondents under Human Subjects Protection

Consent for publication

Not applicable

Availability of data and materials

Data for this study were extracted from the first wave of the Longitudinal Ageing Study in India (2017-19) that is freely available in the public domain on request using the below link:

https://iipsindia.ac.in/sites/default/files/LASI_DataRequestForm_0.pdf

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Authors' contributions

Conceived and designed the research paper: RRS and SM; analysed the data: RRS and SM; Contributed agents/materials/analysis tools: RRS and SM; Wrote the manuscript: RRS, PM and SM; Refined the manuscript: PM, RRS and SM. All authors read, reviewed, and approved the manuscript.

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Competing of interests

The authors declare that there is no competing interest.

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Abstract:

Purpose: Self-reported measures of health are widely used and accepted for understanding the status of the respondents in a survey. However, due to potential biases, self-reported measures may fail to accurately capture the prevalence and severity of undiagnosed visual impairment (VI), underscoring the need for more objective diagnostic tools. This study aims to assess the inconsistency between self-reports and standard tests.

Design: The study used cross-sectional data from the first wave of the Longitudinal Ageing Study of India (2017-18).

Participants: 56,358 individuals aged 45 and above from 42,949 households were included in the study).

Methods: Reliability measures such as sensitivity, specificity and kappa statistics were used to examine the inconsistency between self-reports and standard tests. Further, multinomial logistic regression was used to identify the covariates that significantly affect (mis)reporting of VI.

Main outcome measure: Self-reported VI and measured visual acuity (VA) were the outcome variables.

Results: The study findings show that the prevalence of self-reported VI and measured VA was 23.2% and 35.9%, respectively. The overall sensitivity and specificity of self-reported VI was 52.1% (CI: 51.2% to 52.9%) and 67.2% (CI: 66.8% to 67.6%). The κ-coefficient exhibited a decent magnitude of 0.157 (95% CI: 0.149, 0.164), implying slight agreement and lack of concordance between self-reported VI and measured VA. The likelihood of reporting false negatives and false positives was significantly declining with increasing age. The relative risk ratio of reporting false positive and true negative reporting was increasing with increasing educational attainment. MPCE had a significant association with true negative reporting as individuals from the richest quintile were 1.3 times more likely than the poorest to report true negatives compared to their true positive counterparts.

Conclusion: The study confirms that the true prevalence of VI is likely underestimated via methods of self-reporting. The disparity in sensitivity and specificity across socio-demographic factors indicates the presence of inequality in the recognition and reporting of VI in different

segments. These findings highlight the need for tailored intervention through education and awareness programs to address the true burden of VI, minimize the barriers and enhance the overall quality of life of older adults in India.

Keywords: Visual Impairment, Self-report, Biomarker, Ageing, India

Introduction

Surveys use self-reported measures to efficiently gather subjective data directly from individuals about their thoughts, behaviours, and experiences (Fowler, F., 2014; Tourangeauet al.,2000). These measures are cost-effective, easy to administer, and allow for standardized data collection from large populations. However, self-reported data are criticized for potential biases, such as social desirability, recall inaccuracies, and the influence of question wording, which can affect the reliability and validity of the responses (Podsakoff et al., 2012; Althubaiti, A. 2016). Despite these limitations, self-reported measures remain essential for accessing personal and internal states that are otherwise difficult to measure objectively. Visual impairment (VI) refers to significant vision loss that affects daily activities, and self-reported measures can be problematic for those with undiagnosed VI (Onur and Velamuri., 2018). Individuals with undiagnosed VI may not recognize their impairment, leading to inaccurate or underreported data in surveys. Their subjective perception of what constitutes "normal" vision can skew responses, and factors like cognitive impairment or misunderstanding survey questions can further reduce the reliability of self-reports. Consequently, self-reported measures may fail to accurately capture the prevalence and severity of undiagnosed VI, underscoring the need for more objective diagnostic tools (van der Lijn et al., 2023).

Blindness and VI are a significant public health concern globally which lessen the economic, educational and employment opportunities, resulting in declining individuals' quality of life (Eckert et al, 2015; Frick et al., 2015; Frick and Foster., 2003; Li et al., 2022). A recent estimate of the Global Burden of Disease on blindness and vision impairment among 50 years and older reveals that 43.3 million people suffer from blindness and 259 million people have moderate and severe vision impairment in 2020 (Bourne et al., 2021), which imposed a substantial burden on healthcare systems (Yang et al., 2021).

In several nationally representative surveys on ageing, self-report measures of visual function have been incorporated. This indicator has a number of potential validity issues because responses reflect more than just measured visual acuity (Razavi, 2001). Previous studies have

highlighted the disparity between self-reported VI and objective measurements in different countries and populations (Bourne et al., 2012; Wu et al., 2016). For instance, a study conducted in 11 countries documented that self-reported VI underestimated the true prevalence compared to objective measurements (Bourne et al., 2012). Similarly, a population-based study conducted in China reported a substantial discrepancy between self-reported and objectively assessed VI estimates (Wu et al., 2016). Discrepancies between these two methods have been observed in various populations (Freeman et al., 2006; Whillans & Nazroo., 2014).

In the Indian context, a recent estimate from a population-based survey, which was conducted across the country among those aged 50 years and above using the Rapid Assessment of Avoidable Blindness (RAAB) version 6 methodology, indicates that the overall age-gender standardized prevalence of blindness was 1.99% and the prevalence of VI was 26.68% (Vashist et al., 2022). Another nationally representative study based on a tumbling E log MAR (Logarithm of the Minimum Angle of Resolution) chart for the vision-related measurements found that around 34% of the population aged 45 and above had low vision, while blindness prevalence was 1.63% (Singh and Maurya., 2022). The estimated net loss of gross national income as a result of blindness is INR 845 billion (Int$ 38.4 billion) (Mannava et al., 2022).

Previous research on VI in India has primarily relied on self-reported data focusing on specific regions or age groups (Marmamula et al., 2020; Murthy et al., 2005; Patel et al., 2021; Pattnaik et al., 2023). However, the use of standardised tests to validate self-reported measures remains limited (Neena et al., 2008). Many of the studies depended on self-reported measures, which are cheap and convenient for surveys in resource-constrained countries like India. There has been a growing critique of self-reported health measures in research (Subramanian et al., 2009; Bago D'Uva et al., 2011; Cullati et al., 2018; Onur and Velamuri., 2018; van der Lijn et al., 2023). Numerous studies have identified anchoring vignettes as a potential solution for correcting for the reporting heterogeneity in self-reported measures. Still, self-reported measures of health are widely used and accepted for understanding the status of the respondents in a survey. The most effective way to assess health is through direct measures, but due to greater expenses associated with conducting assessments (including time, money, interviewer/nurse training, and logistics), self-reported health assessments are frequently used in large-scale nationally representative surveys (Whillans and Nazroo; 2014).

In this context, it is crucial to investigate the inconsistency between self-reports and standard tests. Our study attempts to contribute to the limited empirical literature on the validity of self-

assessment of VI in low- and middle-income countries, which would help in effective planning and resource allocation.

Methods

Data

The study used data from the first wave of the Longitudinal Ageing Study of India (LASI), which was conducted in 2017-18. LASI is a large-scale nationally representative survey conducted across all the states and union territories of India among people aged 45 years and above and their spouses (irrespective of their age). LASI used a stratified clustered sampling technique to collect information on 73,396 individuals from 42,949 households. The detailed sampling strategy employed in the survey is mentioned in the LASI report (NPCHE., 2018). The effective sample size for the present study was 56,358 older adults and elderly aged 45 years and above.

Variable description

Outcome Variable

The LASI questionnaire was used to conduct face-to-face interviews with the respondents in the household. Self-reported data on VI was obtained by asking two questions, *"How good is your eyesight for seeing things at a distance, like recognizing a person across the street (or 20 meters away) whether or not you wear glasses, contacts, or corrective lenses?"* and *"How good is your eyesight for seeing things up close, like reading ordinary newspaper print whether or not you wear glasses, contacts, or corrective lenses?"*. The respondent had the choice to answer the question as "very good", "good", "fair", "poor" and "very poor". For the current study, the response variable was coded into binary. Those respondents who answered "poor" and "very poor" to these questions were considered as visually impaired; otherwise, no.

Further, a Visual Acuity (VA) test was conducted to measure the near and distance vision for each eye, irrespective of using spectacles or lenses among the respondents. The variable for VA was coded as "normal," "low vision," and "blindness." The low vision was characterized as either low near-vision (visual acuity equal to or poorer than 20/80 and equal to or better than 20/400 in the better eye) or low distance vision (visual acuity equal to or poorer than 20/80 ad/or better than 20/200 in the better eye). By taking the variables, low-near vision and low-distance vision, we have created a binary indicator of measured VA, where "1" represents "low vision" or "blindness" and "0" otherwise.

Key explanatory variables

Various individual, household and community level characteristics were used in the present study (Pattnaik et al., 2023; Singh & Maurya, 2022; Vashist et al., 2022; Whillans, & Nazroo, 2014). Individual level characteristics were age (45-54, 55-64, 65-74, and 75+), sex (male and female), education level (no education, less than 5 years, 5-9 years, and 10 years or more), and living arrangement (living alone, living with spouse and/or other, living with spouse and children, and living with children and/or other). Household level factors were religion (Hindu, Muslim, Christian, and Other), caste (scheduled caste (SC), scheduled tribe (ST), Other Backward Caste (OBC), and Others), and monthly per capita expenditure (MPCE) (richest, richer, middle, poorer and poorest). Community-level factors like place of residence (rural and urban) were considered. Health-related variables, like having any morbidity, were assessed through nine self-reported chronic diseases (hypertension, diabetes, cancer, lung disease, heart disease, stroke, bone-related disease, neurological/ psychiatric diseases, and high cholesterol). Based on these nine chronic diseases, a composite index was constructed and the variable any morbidity was coded into three categories (no morbidity, single morbidity and two or more morbidity). Health insurance coverage (yes/no) was considered. Smoking and use of tobacco were dichotomized as yes or no.

Statistical Analysis

LASI provides information on both self-reported and objective measures of VI. The accuracy of self-reported VI against the biometric data on VI (gold standard) was adjudged using diagnostic test statistics (**Figure 1**). As shown in Figure. 1, all the responses can be classified in the form of a 2x2 contingency table, as either a true positive (TP) (measured VA and self-reported VI), a true negative (TN) (measured normal/low VA and self-reported no VI), a false positive (FP) (measured normal VA and self-reported VI), or false negative (FN) (measured normal/low VA and self-reported no VI). The sensitivity and specificity of the self-reported VI were calculated. Sensitivity is the proportion of TP that is correctly identified by the self-report question, whereas the FP is the error in the self-report of VI. Specificity is the proportion of TN that are correctly identified, whereas FN is the corresponding error outcome. Kappa statistic is a measure of interrater agreement and was used to assess the degree of agreement between self-reported VI and measured VA. The value of κ can be divided as follows 0.01–0.20 as none to slight, 0.21–0.40 as fair, 0.41– 0.60 as moderate, 0.61–0.80 as substantial, and 0.81–1.00 as almost perfect agreement (McHugh., 2012). A categorical variable indicating the true and false positives and negatives was used as a dependent variable in a multinomial logistic regression model to identify the covariates that significantly affect (mis)reporting of VI. Relative risk

ratios were used for ease of interpretation. Stata software version 17.0 was used to calculate the sensitivity, specificity, and κ statistic, along with their 95% confidence intervals (CI).

Results

Figure 2 shows the prevalence of self-reported VI and measured VA in India. The prevalence of self-reported VI was 23.2%, whereas the prevalence of measured VI was 35.9%, indicating a 15 percentage-point (pp) difference in the estimates of the prevalence of VI from self-reported and measured responses.

Figure 3 presents the prevalence of self-reported VI and measured VA among older adults aged 45 years and above. The prevalence of self-reported VI and measured VA increases with the age of the individuals. The difference in estimates of measured and self-reported responses increases linearly with age.

The findings from sensitivity, specificity, and interrater agreement (κ) between self-reported and measured VI are presented in **Table 1**. The overall sensitivity of self-reported visual impairment was 52.1%, with a 95% confidence interval ranging from 51.2% to 52.9%. The sensitivity of self-reported VI increased with increasing age. The sensitivity of females (55.4%; 95% CI: 54.2, 56.5) was greater than their male counterparts (47.7%; 95% CI: 46.4, 49.0). The findings showed a negative correlation between educational attainment and the MPCE quintile with respect to the sensitivity of self-reported VI. The sensitivity of self-reported VI was found to be higher among individuals with no formal education, having two or more morbidities, belonging to the poorest quintile and rural residents. Further, the overall specificity of self-reported VI was 67.2%, with a 95% confidence interval ranging from 66.8% to 67.6%. Nevertheless, the κ-coefficient exhibited a decent magnitude of 0.157 (95% CI: 0.149, 0.164), implying slight agreement. The kappa statistic demonstrated an increasing pattern in relation to age, MPCE quintile, and multimorbidity. The low value of the κ-coefficient signified a lack of concordance between self-reported VI and objectively measured VA.

Figure 4 presents the state-wise variation in the prevalence of self-reported VI and measured VA among older adults aged 45 in India. The highest level of underreporting of VI can be seen in Karnataka, followed by Meghalaya and Delhi, and overreporting of VI can be seen in states like Sikkim, Jammu and Kashmir, and Madhya Pradesh.

Table 2 presents the sensitivity, specificity, and interrater agreement (κ) between self-reported and measured VI across states and union territories of India. There were significant differences in sensitivity and specificity across the Indian states and union territories. The sensitivity of

self-reported VI was highest in Delhi (64.6%; 95% CI: 56.6, 72.0%) and was the lowest in Sikkim (4.8%; 95% CI: 1.8, 10.2%). Almost half of the thirty-six states in India had sensitivity less than the national average of 52.1% (95% CI: 51.2, 52.9%). Sensitivity was found to be lower in some of the larger states which are economically rich and have a robust healthcare system like Maharashtra, Gujarat, etc. The κ -coefficients varied across the states of India, and the majority of the states of India had a very low agreement between self-reported and measured VI, where all the states had κ -coefficients less than the threshold of 0.20, and in the case of Meghalaya, it was found to be negative.

Figure 5 shows the estimated effects of the predictor variable (true positive) in terms of relative risk ratios from the multinomial regression model. The likelihood of reporting false negatives and false positives was significantly declining with increasing age. Females were less likely to report true negatives than their male counterparts; however, there was no significant effect of sex on false negatives or positive reporting. The education level of individuals had a significant effect on false positive and false negative reporting; For instance, the relative risk ratio of reporting false positive and true negative reporting was increasing with increasing educational attainment. MPCE had a significant association with true negative reporting as individuals from the richest quintile were 1.3 times more likely than the poorest to report true negatives compared to their true positive counterparts. Individuals having two or more morbidities were less likely to report false negatives and positives compared to true positives. Individuals with health insurance were 1.1 times more likely to report true negatives than individuals without health insurance, compared to the true positives. The individuals who use smoking and tobacco products were less likely to report true negatives compared to the true positives and individuals who do not use smoking and tobacco-related products.

Discussion

The present study is an attempt to assess the validity of VI measurement among older adults in India. We found a 15-percentage point (pp) difference in the estimates of the prevalence of self-reported VI and measured VA. Also, the low value of K-coefficient signifies low concordance between self-reported VI and measured VA.

In line with previous findings (Deme et al., 2024; Mactaggart et al., 2018; Patty et al., 2012; Singh and Maurya., 2022)., the study present study confirms that the true prevalence of VI is underestimated via self-reported measurement. The prevalence of measured VA was higher in an Indian setting, affecting approximately 35.9% (of people aged 45 and above; as per self-reported measures of VI, only 23.2% of older adults were having difficulties with vision. A previous small-scale study from India reported that 34.3% of study participants had VA, and 20% had self-reported VI among people aged 50 and above (Mactaggart et al., 2018). Another study conducted in Ethiopia reported a similar prevalence of VA in which authors used presenting VA and a cut-off point of 6/18 for defining VI (Deme et al., 2024). A study using Irish Longitudinal Study on Ageing data documented that overall subjective assessment of VI was more prevalent than objective measurement among the study population (Whillans and Nazroo., 2014). The study also found that self-reported VI had a 52.1% sensitivity and 67.2% specificity, suggesting that nearly half of the individuals with measured VA were not being identified by self-reported VI and one-third of individuals without VA might be incorrectly identified as having VI by self-reported measure. Previous studies reported a strong positive association between measured VA and self-reported VI (El-Gasim et al., 2013; Yip et al., 2014). Discrepancies between self-reported VI and measured VA were also documented in the Salisbury Eye Evaluation study, and the authors reported that black patients and those less educated had a higher likelihood of reporting discordant responses between VI and VA (El-Gasim et al., 2012). This discrepancy can be explained by the fact that self-reported VI is associated with components of visual functions other than VA, such as difficulties with contrast sensitivity, near vision, stereoacuity and visual fields, which are not measured by VA. Therefore, self-reported measures of VI can't take the place of VA assessment (El-Gasim et al., 2013; Yip et al., 2013). The observed low sensitivity also indicates that people with VI might be not aware of their disease or may not report it accurately. This emphasizes the need for older people to be better informed about aware of VI in order to early detection of VI and access to essential healthcare services. The study findings demonstrate that lower sensitivity between self-reported and measured VI in economically advanced states of India and have a robust public health outreach like Maharashtra and Gujrat (Priyadarshi et al., 2023; Das and Guha, 2024). The lack of awareness and knowledge related to these diseases might be the cause of low sensitivity in these states. Additionally, it might be difficult for an individual to evaluate themselves if they have VI in the early stages. Therefore, despite a vigorous amount of public health outreach, this study suggests creating awareness about the diagnosis and treatment of

this disease is indeed effective in reducing the burden of VI, especially among poor and migrant people.

The sensitivity, specificity, and interrater agreement (κ) between self-reported and measured visual acuity was significantly affected by a number of factors such as age, gender, wealth quintile, educational level, having health insurance and smoking and tobacco-using behaviour. The sensitivity of VI was lower among female than their male counterparts. The multinomial regression results show that FP and FN decreased with age, indicating a lack of self-judgement about their visual problems, which is consistent with the literature (El-Gasim et al., 2013; Klein and Klein, 2013). Being female and residing in rural areas were found to be an important predictor of being in TN. The study findings agree with previous studies (El-Gasim et al., 2012; Yip et al., 2013) that females and rural residents had higher sensitivity and were less likely to be in the TN category than TP.

The sensitivity declined with an increase in wealth quintile, educational attainment among urban residents and having health insurance. Multinomial results also reported a higher relative risk of TN among people from the richest wealth quintile, having more than 10 years of education and having health insurance compared to their reference category than TP. This finding highlights significant health inequalities experienced by older people into different wealth strata and educational categories. One mediating factor that is related to exposure and vulnerability is access to healthcare services. People in higher wealth strata and better educational attainment have better access to healthcare services and awareness about disease are more likely to adjudge their problems related to VI (Mactaggart et al., 2020; Solar and Irwin, 2010; Ulldemolins et al., 2012; Whillans and Nazroo., 2014). Further, the study finding indicates that People from the general caste had lower sensitivity compared to the scheduled caste, and the relative risk of TN was 1.11 times higher among the general caste than the scheduled caste compared to TP. This finding suggests social inequality has an impact on the identification and treatment of VI-related diseases (Ulldemolins et al., 2012; Whillans and Nazroo, 2014). Interestingly, the current study also observed that individuals with smoking behaviour and chewing tobacco were less likely to report their TN compared to TP, indicating an individual's judgement about their health status.

Although the present study uses a large-scale nationally representative sample from LASI which provides robust evidence on VI in India, in spite of that, this research has some inherent limitations. It is more difficult to establish causality due to the cross-sectional nature of the

data. Further, the longitudinal design of data could provide valuable insights pertaining to the burden and risk of VI. This study also acknowledges that the methodology for evaluating VI may have limitations, as some older adults might not be aware of their health condition or may not report it accurately owing to cognitive or social factors. On the other hand, people may misjudge their visual status, resulting in overreporting of VI. Therefore, it is essential to develop more advanced evaluation instruments to improve the accuracy of the burden of VI.

In conclusion, the current study confirms that the true prevalence of VI is likely underestimated via methods of self-reporting. The disparity in sensitivity and specificity across socio-demographic factors and regions indicates the presence of inequality in the recognition and reporting of VI in different sections of the population. These findings highlight the need for tailored intervention through education and awareness programs to address the true burden of visual impairment, minimize the barriers, such as the stigma associated with VI, and enhance the overall quality of life of older adults in India. The study also specifies the significance of ongoing research in this area to refine evaluation instruments and provide equitable access to vision care for all older adults.

Abbreviation

VI: Visual Impairment
TP: True Positive
TN: True Negative
FP: False Positive
FN: False Negative
VA: Visual Acuity
MPCE: Monthly Per Capita Expenditure

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