Risk factors for self-reported cataract symptoms, diagnosis, and surgery uptake among older adults in India: Findings from the WHO SAGE data

Authors: Sutapa Agrawal[1], Jasmine Fledderjohann[2]*, Shreeparna Ghosh[3]

1 Senior Consultant, Public Health Nutrition Epidemiology, New Delhi, India
2 Lancaster University, Lancaster, UK
3 Immunization Technical Support Unit-Ministry of Health and Family Welfare, John Snow India Private Ltd., New Delhi, India

*Corresponding author

Address for correspondence

Dr. Jasmine Fledderjohann
Department of Sociology
Lancaster University
Lancaster, LA1 4YN
United Kingdom
j.fledderjohann@lancaster.ac.uk

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Ethical Statement: Data for this study come from Wave 1 (2007-2008) of the cross-sectional WHO Study on Global Ageing and Adult Health (SAGE) for India. The data for our study are fully anonymised by WHO, and can be downloaded by registering through the WHO Data Archive website (http://apps.who.int/healthinfo/systems/surveydata/index.php/catalog/65).

The WHO SAGE study received human subject ethics council approval from research review boards local to each site, and from the WHO Ethical Review Committee. Written Informed consent was obtained prior to interview and examination. Our study is a secondary analysis of SAGE de-identified, publicly available data, and does not require ethics committee approval.

Authors' contributions: SA conceptualised the study and wrote the first draft. SG did the data analysis. JF provided important intellectual comments, suggestions and edits to the manuscript. All authors approve the final version of the paper.

Abstract

Objectives: Visual impairments have a substantial impact on the well-being of older people, but their impact among older adults in low- and middle-income countries is under-researched. We examined risk factors for self-reported cataract symptoms, diagnosis, and surgery uptake in India.

Methods: Cross-sectional data from the nationally representative WHO SAGE data (2007-08) for India were analysed. We focused on a sub-sample of 6,558 adults aged 50+, applying descriptive statistics and logistic regression.

Results: Nearly 1-in-5 respondents self-reported diagnosed cataracts, more than three-fifths (62%; n=3,879) reported cataract symptoms, and over half (51.8%) underwent surgery. Increasing age, self-reported diabetes, arthritis, low visual acuity, and moderate or severe vision problems were factors associated with self-reported diagnosed cataracts. Odds of cataract symptoms were higher with increasing age and among those with self-reported arthritis, depressive symptoms, low visual acuity, and with moderate or severe vision problems. Odds of cataract surgery were also higher with increasing age, self-reported diabetes, depressive symptoms, and among those with low visual acuity.

Conclusions: A public health approach of behavioural modification, well-structured national outreach eye care services, and inclusion of local basic eye care services are recommended.

Keywords: Older adults; cataracts; cataract symptoms; cataract surgery; risk factors; India

Introduction

Cataracts—a clouding of the eye lens—are the principal cause of blindness and visual impairment worldwide (Nirmalan et al., 2004). They are estimated to be responsible for 51% of all cases of blindness globally, impacting about 20 million people, disproportionately aged 50+ (Mariotti, 2012; Resnikoff et al., 2004). The prevalence of age-related eye diseases is assumed to be on the rise with increasing life expectancy (Laitinen et al., 2010). Approximately 90% of cases occur in low- and middle-income countries (LMICs), representing a substantial economic and public health burden (Resnikoff et al., 2004).

While it is possible to remove cataracts through a standard surgery, typically with high success rates, access to the surgical procedure remains a problem in many LMICs; many people remain blind due to an inability to access treatment (WHO, n.d.). Older persons living with unoperated cataracts are likely to face substantially diminished quality of life due to limited vision. Decreases in functional abilities sometimes attributed to other age-related processes may actually be associated with cataracts (Yawson et al., 2014). Efforts (such as removal of cataracts) to reduce modifiable health risks may result in a postponement of initial disability and a decrease in lifetime disability.

Previous research has documented a strong association between the development of age-related cataracts and diabetes, alcohol and tobacco use, and ultraviolet light exposure (DeBlack, 2003). Other factors inconclusively implicated include body mass index (Jacques et al., 2003) and postmenopausal decline in estrogen (Hennis et al., 2004). However, studies on the prevalence of and risk factors for cataracts have been conducted mainly in white populations in the United States, Australia, and Europe (Graw et al., 2011; Landers et al., 2010; Mares et al., 2010). Less is known about risks in LMICs, where the burden is highest (Vashist et al., 2011; Wu et al., 2010; Yawson et al., 2014).

Previous estimates of cataract prevalence in India range from 25% to upwards of 58% depending on the population under observation (Gupta et al., 2007; Sobti & Sahni, 2013; Vashist et al., 2011). However, most of the limited information available is from hospital- or clinic-based studies, which likely miss the most vulnerable groups due to selection bias. Despite the public health significance of cataracts in India, there is little population-based evidence on prevalence, risk factors, and treatment. To address this gap, in this paper we examine prevalence and risk factors for self-reported diagnosed cataracts, self-reported cataract symptoms, and cataract surgery uptake in a nationally representative population aged 50+ in India.

Materials and Methods

Data

All data for this study come from secondary data taken from Wave 1 (2007-2008) of the World Health Organization (WHO) Study on Global Ageing and Adult Health (SAGE) for India. Data are publicly available upon request from: https://www.who.int/healthinfo/sage/cohorts/en/index2.html. Briefly, in India respondents were interviewed face-to-face by the WHO SAGE team via a survey instrument on a broad range of topics including sociodemographics, health risk factors, chronic conditions, well-being,

healthcare utilization, and health insurance coverage. A physical examination was used to collect height, weight, waist circumference, and blood pressure. Details of the survey, including sampling framework, are provided elsewhere (Kowal et al., 2012; Naidoo, 2012). The SAGE survey collected a nationally representative sample of adults aged 50+ and a smaller comparative sample aged 18–49 years (4,717 men, 7,481 women) across six states (Assam, Karnataka, Maharashtra, Rajasthan, Uttar Pradesh and West Bengal). As our focus is on age-related visual impairments, we restricted the secondary data sample to men and women aged 50+ (n=7,150). We further restricted the sample to respondents for whom we did not have missing data on co-variates (n=6,558).

Independent Variables

In order to assess the risks associated with sociodemographic factors, we included several categorical variables from the SAGE data in our analysis: age (50–59, 60–69, 70+ years), sex, place of residence (rural, urban), marital status (currently married, not married), education (no education, primary school or less, secondary/high school, tertiary or higher), household income quintiles, and health insurance status. We also considered lifestyle and health factors, including ever smoking tobacco (yes=1), ever consuming alcohol (yes=1), daily fruit and vegetable intake (none/insufficient (<5 servings/day), sufficient (>=5 servings/day)), self-reported vision problems (none/mild, moderate, severe/extreme), and self-reported quality of life (good, moderate, bad). BMI values were classified into categories based on established WHO cut-offs (WHO 2000): underweight (<18.5 kg/m^2), normal (18.5-24.9 kg/m^2), overweight (25.0-29.9 kg/m^2), and obese (≥30 kg/m^2).

Together, these variables are either known correlates of sociodemographic gradients in public health broadly (e.g. education, place of residence, income) or potential risk factors for cataracts in particular (e.g. smoking, alcohol consumption, obesity). Smoking (Christen et al., 1996; Galor & Lee, 2011; Seddon et al., 1996; Thornton et al., 2005; Ye et al., 2012) and alcohol consumption (Cumming & Mitchell, 1997; Klein et al., 2003; Lindblad et al., 2007; Morris et al., 2004) are established risk factors for cataracts. Some literature also suggests the potential for fruit and vegetable consumption to reduce the risks of age-related eye diseases (Christen et al., 2005). The literature on obesity and cataract risks is more mixed, but is suggestive of a possible association that merits further investigation (Cheung & Wong, 2007).

We also examined risks associated with co-morbidity. Diabetes mellitus and stroke were assessed by SAGE through a self-reported diagnosis question: *"Have you ever been told by a health professional/doctor that you have (disease name)?"* Angina pectoris, arthritis, asthma, and chronic lung disease were derived from symptom-based questions, combined with a validated diagnostic algorithm (Arokiasamy et al., 2015). Hypertension and visual acuity were assessed by the WHO SAGE data collection team through a physical examination at the time of interview. The prevalence of hypertension was based on blood pressure (systolic, diastolic) measured three times on the right arm/wrist using an automated recording device while seated (WHO & International Society of Hypertension Writing Group, 2003). Following international guidelines (Parati et al., 2008; Pickering et al., 2005, 2008), an average of readings was used by the SAGE team. The first reading allowed the respondent to settle in and feel comfortable, and the second and third readings were then averaged (WHO, 2006). The limit for high

systolic blood pressure was 140 mm/hg or above, and for diastolic blood pressure 90 mm/hg or above; in the secondary SAGE data, we coded respondents as hypertensive if average systolic or diastolic blood pressure readings exceeded either of these thresholds or they reported current treatment for hypertension (Arokiasamy et al., 2015).

SAGE measured visual acuity in this study using a tumbling "E" logMAR chart. We categorised respondents as having low vision (0.01–0.25 decimal) if they had low near or distance vision in both eyes (Arokiasamy et al., 2015). Symptomatic depression items were assessed based on the World Mental Health Survey version of the Composite International Diagnostic Interview (Kessler & Üstün, 2004). Using the secondary SAGE data, we coded participants who indicated at least 4 of 10 depressive symptoms that lasted 2 weeks, most of the day, or all of the day as experiencing depression (Ayuso-Mateos et al., 2010). Respondents who responded positively to *'Have you been taking any medications or other treatment such as attending therapy or counselling sessions for depression during the last 12 months?'* were also coded as depressed for our analysis (Arokiasamy et al., 2015).

Dependent Variables

Our key outcomes of interest were dichotomous indicators of self-reported diagnosis of cataracts, cataract surgery, and cataract symptoms taken from the SAGE data. Respectively, the WHO SAGE team asked:

- *In the last 5 years, were you diagnosed with a cataract in one or both of your eyes (a cloudiness in the lens of the eye) by a healthcare professional?*
- *In the last 5 years, have you had eye surgery to remove this cataract(s)?*
- *In the last 12 months have you experienced any of the following:… cloudy or blurry vision? …vision problems with light, such as glare from bright lights, or halos around lights?*

Notably, SAGE Wave 1 in India included both operated and unoperated cataracts within the same question; it is therefore not possible to distinguish between diagnosed but previously removed cataracts and an unoperated cataracts. Additionally, because of the SAGE survey skip pattern, respondents who indicated that they had not been diagnosed with cataracts in the past 5 years were not asked about cataract surgery. Respondents who had not had a diagnosis could therefore still report on whether they had experienced symptoms, but are legitimately missing in our models predicting cataract surgery.

Statistical analyses

Chi-square tests of significance were used to examine the distribution of cataracts across independent variables. Logistic regression models were fit to determine factors associated with our dependent variables while controlling for other potential risk factors. Data were analysed using STATA version 14.

Ethics approval

The WHO SAGE study received human subject ethics council approval from research review boards local to each site, and from the WHO Ethical Review Committee (Kowal et al., 2012). Written Informed

consent was obtained prior to the WHO SAGE team's interviews and physical examinations of participants. Our study is a secondary analysis of this SAGE de-identified, publicly available data, and therefore does not require ethics committee approval.

Results

Figure 1 shows the percentage distribution of cases who self-reported diagnosed cataracts in the last five years preceding the survey, experienced cataract symptoms in the last 12 months, and/or had cataract surgery in the last five years in the WHO SAGE, India 2007-10, capturing the overlap in these categories. Almost three-fourths (71.6%) had cataract surgery with diagnosis but didn't have any symptoms while half (50.3%) of the respondents reported having a surgery with both diagnosis and symptoms. 56.8% reported only symptoms of cataract while 15.5% self-reported diagnosis only.

[Figure 1 here]

Table 1 gives the sample distribution and prevalence and bivariable associations of self-reported diagnosed cataracts, cataract symptoms, and cataract surgery uptake in older Indian adults by sociodemographic characteristics, lifestyle, and health-related factors. Just under one-fifth (18.7%) out of the total 6,558 older Indian adults (aged 50+) self-reported diagnosed cataracts, with higher prevalence reported in older age groups (from 10% in the 50–59 age group to as high as 32.7% in the ≥ 70 years group; p<.001). Respondents currently not in a marital union reported significantly (p<0.001) higher prevalence of cataracts (27.2%), compared to currently married (15.9%) respondents. Those with no education (19%), primary or less education (20.1%), or secondary education (18%) had a higher prevalence compared to those with tertiary or higher education (11.8%; p=0.013). Compared to those without these conditions, prevalence was significantly higher among those with hypertension (BP≥140/90mm/Hg) (21.5%; p<0.033), diabetes (32.5%; p<0.001), angina symptoms (26.9%; p<0.001), symptoms of arthritis (26%; p<0.001), asthma (22.9%; p=0.002), chronic lung disease (24.1%; p<0.001), depressive symptoms (23.6%; p<0.001), those with low visual acuity (20.9%; p<0.001), and those who reported severe/extreme vision problems (30.8%; p<0.001). Gender, place of residence, household income, health insurance status, tobacco and alcohol use, fruit and vegetable intake, BMI, history of stroke, and self-reported quality of life were non-significant predictors.

More than three-fifths of the sample (62%) reported cataract symptoms. Prevalence of cataract symptoms increased with age (p<0.001), and was higher among females (67.1%; p<0.001), people in a rural area (64.9%; p<0.001), those not in marital union (69.5%; p<0.001), those with no education (68.2%; p<0.001), and in the lowest wealth quintile household (67%; p<0.001). Prevalence was also higher among those who were underweight (67.1%; p<0.001), and who reported angina pectoris (75.8%; p<0.001), arthritis (72.8%; p<0.001), asthma (73.2%; p<0.001), chronic lung disease (77%; p<0.001), depressive symptoms (82.5%; p<0.001), low visual acuity (67.6%; p<0.001), severe/extreme vision problems (83.4%; p<0.001), and low quality of life (74.6%; p<0.001).

More than half the respondents (51.8%) reported that they had a cataract surgery in the last five years. Cataract surgery uptake also increased with age (37.8%-59.7% from age groups 50-59 to 70 and above; p<0.001), and was higher among those living in urban areas (55.6%; p<0.001), belonging to highest wealth quintile households (60.2%; p=0.035), who never consumed tobacco (56.3%; p<0.001) nor alcohol (53.9%; p=0.001), who consumed fewer fruits and vegetables (53.0%; p=0.007), with hypertension (53.8%; p=0.052), diabetes (69%; p<0.001), chronic lung disease (52.3%; p=0.008), no/mild vision problems (58.3%; p<0.001), and who self-reported a good quality of life (62%; p=0.001).

Table 2 provides results for the multivariable logistic regression analysis. Model 1 shows results predicting self-reported diagnosed cataracts. Controlling for all else, the risk of cataracts was greater in 60-69 years (AOR:1.90; 95% CI:1.61-2.25) and 70+ years (AOR:3.61; 95% CI:2.99-4.34) age groups compared to adults aged 50–59, with risk greatly increasing with age. The likelihood of reporting cataracts was lower among those who were currently married (AOR:0.81; 95% CI:0.69-0.96) than those not in marital union, and those with secondary education (AOR:1.54; 95% CI:1.05-2.26) compared to tertiary education. Older adults who reported diabetes (AOR:1.44; 95% CI:1.13-1.83), arthritis (AOR:1.42; 95% CI:1.22-1.65; p<0.0001), low visual acuity (AOR:1.64; 95% CI:1.39-1.94) or reported moderate (AOR:1,35; 95% CI:1.14-1.60; p<0.0001) or severe/extreme (AOR:2.13; 95% CI:1.79-2.53) vision problems had a higher risk for self-reported cataracts than those without these conditions.

Model 2 shows that, compared to those aged 50-59, risk of reporting cataract symptoms was higher among those aged 60-69 (AOR:1.14; 95% CI:1.01-1.30) and 70+ (AOR:1.62; 95% CI:1.38-1.91). Those in rural areas had a lower risk of reporting cataract symptoms (AOR:0.75; 95% CI:0.65-0.86), while those with no education (AOR:1.51; 95% CI:1.13-2.01) faced a higher risk compared to those with tertiary education. Controlling for all else, tobacco users (AOR:0.88; 95% CI:0.77-0.99) and those with hypertension (AOR:0.85; 95% CI:0.75-0.96) had a slightly lower risk. Risks were higher for those who reported angina (AOR:1.40; 95% CI:1.11-1.76), arthritis (AOR:1.50; 95% CI:0.1.31-1.71), asthma (AOR:1.24; 95% CI:1.01-1.53), depressive symptoms (AOR:2.12; 95% CI:1.71-2.63), low visual acuity (AOR:1.62; 95% CI:1.44-1.83), and moderate (AOR:2.72; 95% CI:2.38-3.11) or severe vision problems (AOR:3.67; 95% CI:3.13-4.32).

Results for cataract surgery are provided in Model 3. Odds for uptake of surgery were higher with increasing age (ages 60-69 AOR:2.11; 95% CI:1.53-2.93; ages 70+ AOR: 3.31; 95% CI:2.34-4.68) and among those with depressive symptoms (AOR:1.73; 95% CI:1.18-2.52). Those who used tobacco (AOR:0.75; 95% CI:0.57-1.00), consumed sufficient fruits and vegetables (AOR:0.62; 95% CI:0.41-0.92), had moderate (AOR:0.65; 95% CI:0.48-0.89) to severe/extreme vision problems (AOR:0.36; 95% CI:0.27-0.49), and reported moderate (AOR:0.74; 95% CI:0.56-0.98) or bad (AOR:0.53; 95% CI:0.33-0.83) quality of life had lower odds of uptake of cataract surgery.

Discussion

Worldwide, cataracts are a major cause of avoidable blindness; without appropriate planning, cataracts are likely to burden healthcare systems in LMICs as life expectancy increases (Sobti & Sahni, 2013). Our

results suggest India is not an exception to this trend. We found cataracts are highly prevalent among older adults in India, with approximately 1-in-5 people reporting a diagnosis. Even accounting for other risk factors, we found an increased risk of cataracts with increasing age and for individuals with other conditions, including diabetes, arthritis, depression, and lower visual acuity. These findings, which provide population-level results, are consistent with previous regional and hospital-based studies in India (Mukesh et al., 2006; Singh et al., 2019; Vashist et al., 2011).

Older adults living without a partner (separated/divorced/widowed) reported a higher prevalence of cataracts compared to married individuals. This may imply that older persons living alone are less likely to access healthcare services (Yawson et al., 2014), related to other social support factors. Older adults with visual impairments may have multiple disabilities, and would need more assistance (physical, social and economic) to access eye care services. Living alone may limit the availability of this assistance.

Persons with higher education, higher income, and health insurance all had a significantly higher risk of cataracts, similar to findings from a rural population of southern India (Nirmalan et al., 2004). Wealthier, more educated individuals may be better-able to access eye care services due to knowledge of services, ability to afford costs involved in seeking healthcare, and improved financial access to healthcare through the national health insurance scheme (Yawson et al., 2014). Conversely, individuals with less education may not seek preventive/appropriate eye care services. Improved literacy among the elderly may encourage timely visits to medical facilities for early diagnosis and treatment.

Prevalence of self-reported cataracts was also relatively higher in persons with other health-related factors such as diabetes, hypertension, angina, asthma, chronic lung disease, depressive symptoms, and low visual acuity. These findings agree with those in other studies in other LMICs that found similar associations (Mukesh et al., 2006; Nirmalan et al., 2004; Yawson et al., 2014).

Risk factors for symptoms and diagnosis differed somewhat across outcomes, possibly reflecting differences in health knowledge and healthcare access. For instance, respondents who had used tobacco had a lower prevalence of self-reported cataracts. One possibility is that individuals who smoke infrequently/not at all are more health-conscious, and are therefore more likely to visit physicians regularly. This would increase the risk of diagnosis without impacting the risk of cataracts overall, and would therefore result in a positive association seen here. Similarly, because questions regarding surgery were only asked of those with a diagnosis, these models include a group that has selected into healthcare access.

Although the SAGE data are now somewhat dated, they represent the most recent population-level data of this nature for the elderly population in India, and so remain an important source of data for documenting cataract risks at the population level. Cataracts account for a large portion of the burden of non-communicable diseases in this age group, but estimates for the prevalence of self-reported cataracts obtained from previous hospital-based/clinical data sources have varied widely (Gupta et al., 2007; Sobti & Sahni, 2013; Vashist et al., 2011). Undiagnosed cataracts going undetected in medical studies suggests the strong potential for a downward bias in previous estimates using medical data. At

the national level in India, there is limited nationally representative scientific data on prevalence of self-reported cataracts. The WHO SAGE data provide much-needed population level evidence on self-reported cataract prevalence, diagnosis, and surgery among older adults.

Our study provides critical insights into the vast heterogeneity of the problem of cataracts among older people within India. The SAGE data offer a novel opportunity to investigate pathways of interaction between sociodemographics, health behaviours, and self-reported cataract symptoms, diagnosis, and surgery uptake. As data from the longitudinal component of SAGE become available in the future, it will be possible to develop and test hypotheses that build from the results on the prevalence and correlates of self-reported cataracts presented here.

Using the WHO SAGE data, we were able to identify possible factors that contribute to vulnerability and resilience, with the aim of targeting public health programs toward those most likely to suffer from self-reported cataracts in India. Insights from our study may also be relevant to other low- and middle-income countries in which cataract studies to date have typically focused on national average statistics without identifying sociodemographic risk factors, or which have primarily relied on hospital- and clinic-based data.

Our study identifies sociodemographic groups at risk of having an unmet need for cataract surgery—crucially, this includes those who would be overlooked in data from medical settings. While the specific prevalence of cataracts and population composition may feasibly have shifted somewhat since the SAGE data were collected, changes in population composition in terms of sociodemographics are traceable through other national-level data sources, even where cataract prevalence itself cannot be tracked. The unique insights into sociodemographic risk factors our findings provide can thus be used in combination with more recent sociodemographic data to identify areas of the country where health systems might face particular challenges. Our findings also indicate the need for policymakers to address gaps in the health care system in the form of unmet need.

A public health approach of behavioural modification (for modifiable and preventable risks, e.g. obesity) may improve the eye health of older persons in India. Our findings suggest that greater engagement with the healthcare system is associated with greater rates of diagnosis. For older adults, a holistic approach to clinical practice, in which physicians screen for a range of age-related conditions (e.g. cataracts) during visits for specific illnesses, may reduce the risk of undiagnosed cataracts, and may encourage treatment, foster a higher quality of life, and reduce risks of co-morbidity.

Limitations

Previous work has primarily focused on particular regions or hospital-based samples, and may therefore suffer from selection bias. Our study uses large, nationally representative data from India, a middle-income country experiencing increasing non-communicable disease risk (Oyebode et al., 2015). A key strength of our approach is that we were able to examine risks for populations who may not seek care (for various reasons, potentially including structural barriers to accessing care) and so would be omitted

samples from medical settings. As a result, we were able to shed light on risks for an under-represented population.

However, our measure of cataracts relies on self-reported diagnosis which may result in underestimation of prevalence rates compared to measured rates (Andresen et al., 2005). It is possible that there are sociodemographic differences in both access to physicians and other health risks. Thus, increased prevalence may potentially imply improved access to healthcare rather an increased disease burden. To address this concern, we also examined self-reported symptoms of cataracts. Taking into account the possible bias introduced by disease prevalence derived from self-reported physician diagnosis (Allotey et al., 2014; Basu & King, 2013; Hosseinpoor et al., 2012; Levesque et al., 2013), WHO SAGE incorporated a number of alternate methods of estimating disease – using a mixture of self-reported diagnosis cum validated symptom reporting-based diagnostic algorithms, and objective health measurements criteria (Arokiasamy et al., 2015; Kowal et al., 2012; Naidoo, 2012). These measures point to the robustness and validity of the self-reported diagnosis measure used here.

It is possible that recall bias and respondents' baseline level of knowledge about ocular conditions could impact both on accurate recollection of diagnosis, and also on self-reporting of symptoms. This concern could likewise apply to other self-reported health conditions, such as diabetes. Linking self-reports to hospital data for diagnosis and health conditions could help to mitigate this risk, but was not possible using the anonymized SAGE data.

However, the SAGE team recognized population-specific risks to reliability and validity, and took every reasonable measure to mitigate these risks (WHO, 2006). Specifically, where respondents were unable to respond for themselves, either due to physical or mental limitations on their capacity to respond, proxy respondents were invited to respond where possible. The team also used cards with written prompts to provide standardized clarification on any concepts with which respondents might have struggled. SAGE interviewers were trained to identify and address a range of population-specific challenges (e.g. difficulty understanding the question, misinterpretation of the question, digression from the topic, providing incomplete or unclear information) in order to minimize the risk of bias.

Previous research suggests that the use of symptom-based and criterion-based measures of diseases from population surveys can be a viable option for tracking disease prevalence. A study by Vellakkal et al. (2013) based on WHO-SAGE data revealed that the socioeconomic patterning of non-communicable disease (NCD) prevalence differs markedly when assessed by standardized criteria versus self-reported diagnoses, indicating likely under-diagnosis and under-reporting of diseases among the poor. Another study (Vellakkal et al., 2015), also using SAGE data, showed that socioeconomic inequalities in NCD prevalence tend to be artefactually positive when using self-report measures compared with symptom-based or criterion-based diagnostic criteria, with greater bias occurring in low-income countries. The authors concluded that using standardised, symptom-based measures, as is the WHO SAGE practice, provides more valid estimates of NCD inequalities.

Thus, although there is a risk of bias, this risk has been addressed to the greatest extent possible, and is balanced against the significant benefit of a large sample from a representative population survey (as noted above). This is especially beneficial for highlighting the experiences of groups with limited healthcare access, who may face a particularly high risk of unoperated cataracts, but who would be omitted from hospital- and clinic-based samples.

In a similar vein, we found strong evidence of co-morbidity, with higher prevalence of cataracts among those with chronic conditions such as diabetes, arthritis, and depression. Rather than this representing a causal link, it is possible that individuals with other conditions may interact with healthcare professionals more frequently, and may be therefore be more likely to receive care for and diagnosis of a range of health problems, including cataracts.

It was not possible to distinguish between cataracts which had been surgically removed and unoperated cataracts. While not problematic for estimating prevalence, it is likely that some sociodemographic groups are at increased risk of unoperated cataracts arising from limited access to healthcare. Our analysis, however, provides information on the prevalence of self-reported diagnosed cataracts among older persons across India, and will serve as a useful starting point for further investigations.

Conclusion

Cataracts remain a major public health problem in India, particularly among older adults and those living without a partner. Risk modification through primary prevention and health promotion efforts may contribute to reduced risk at the population level. Likewise, behavioural modification, including through public health campaigns, are key efforts to limit the burden of cataracts in India. Well-structured national outreach eye care services for rural residents and inclusion of basic eye health services at sub-district health levels of India's primary healthcare structure are needed. Routine clinical screening for a range of age-related conditions such as cataracts may increase diagnosis, treatment, and overall quality of life.

Conflict of interest: None to declare

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Table 1 Sample distribution and prevalence of self-reported diagnosed cataracts, cataract symptoms and cataract surgery uptake in older adults (50 and above) by socioeconomic and demographic characteristics and health related factors in India, WHO-SAGE Wave 1, 2007-2010.

Characteristics	Sample distribution %[n]	Self-reported diagnosed cataracts %[n=6558]	Chi-square P value	Cataract symptoms %[n=6557]	Chi-square P value	Cataract surgery %[n=1293]	Chi-square P value
Total	100.0[6558]	18.7		62.0		51.8	
Age groups			<0.001		<0.001		<0.001
50-59	44.1[2939]	10.0		55.6		37.8	
60-69	30.3 [2234]	19.5		61.2		51.1	
70 and above	25.6 [1385]	32.7		73.8		59.7	
Sex			0.801		<0.001		0.080
Male	50.5 [3303]	17.0		56.9		48.5	
Female	49.5 [3255]	20.4		67.1		54.5	
Place of residence			0.075		<0.001		<0.001
Urban	31.2 [1676]	18.3		55.4		55.6	
Rural	68.8 [4882]	18.9		64.9		50.2	
Marital status			<0.001		<0.001		0.200
Currently married	74.9 [4861]	15.9		59.4		51.2	
Not in marital union	25.1 [1697]	27.2		69.5		52.8	
Education			0.013		<0.001		0.506
No education	51.6 [3364]	19.0		68.2		55.2	
Primary school or less	24.9 [1674]	20.1		59.8		46.7	
Secondary/high school	18.4 [1195]	18.0		53.2		49.8	
Tertiary or higher	5.2 [325]	11.8		41.1		48.3	
Household income quintiles			0.349		<0.001		0.035
Q1 (Lowest)	18.1 [1062]	16.4		67.0		44.2	
Q2	19.3 [1218]	18.2		63.6		49.8	
Q3	18.7 [1206]	17.7		64.7		42.5	
Q4	19.6 [1407]	18.4		58.8		56.9	
Q5 (Highest)	24.2 [1627]	21.8		57.7		60.2	
Health insurance status			0.866		0.074		0.431
Without insurance	96.1 [6252]	18.7		62.4		52.5	
With insurance	3.9 [306]	18.8		50.9		34.3	
Tobacco ever use			0.775		0.278		<0.001
Yes	54.4 [3448]	18.2		61.6		47.9	
No	45.6 [3109]	19.3		62.3		56.3	
Ever alcohol intake			0.391		0.119		0.001
Yes	15.4 [1039]	18.9		61.9		40.5	
No	84.6 [5519]	18.7		62.0		53.9	
Daily fruits or vegetable intake			0.672		0.411		0.007
No or insufficient (<5 servings/day)	90.8 [5858]	18.8		62.2		53.0	
Sufficient (>=5 servings/day)	9.2 [700]	18.0		59.8		40.6	
Measured BMI status			0.573		<0.001		0.627
Normal (18.5-24.9kg/m^2)	47.5 [3205]	17.5		59.1		50.9	
Underweight (<18.5kg/m^2)	39.3 [2240]	19.6		67.1		49.9	
Overweight (≥25.0 kg/m^2)	13.2 [922]	19.4		55.7		58.2	
Hypertension			0.033		0.092		0.052
BP<140/90mmHg	72.4 [4575]	17.9		63.2		50.9	
BP≥140/90mmHg	27.6 [1879]	21.5		58.8		53.8	
Diabetes			<0.001		0.864		<0.001
No	92.9 [6080]	17.7		62.0		49.5	
Yes	7.1 [478]	32.5		61.6		69.0	
Stroke			0.431		0.233		0.018

No	98.0 [6410]	18.6		61.8		51.8	
Yes	2.0 [147]	22.3		71.2		52.4	
Angina pectoris			<0.001		<0.001		0.439
No	91.7[6042]	18.0		60.7		51.1	
Yes	8.3 [516]	26.9		75.8		57.1	
Arthritis			<0.001		<0.001		0.132
No	75.5[4975]	16.3		58.5		53.2	
Yes	24.5[1581]	26.0		72.8		49.0	
Asthma			0.002		<0.001		0.090
No	88.7[5805]	18.2		60.5		52.7	
Yes	11.3[753]	22.9		73.2		45.7	
Chronic lung disease			<0.001		<0.001		0.008
No	83.8[5515]	17.7		59.0		51.7	
Yes	16.3[1043]	24.1		77.0		52.3	
Depression			<0.001		<0.001		0.564
No	87.6[5835]	18.0		59.1		52.1	
Yes	12.4[722]	23.6		82.5		50.0	
Low visual acuity			<0.001		<0.001		0.066
No	30.2 [2055]	12.5		47.4		62.4	
Yes	69.8 [4350]	20.9		67.6		49.1	
Self-reported vision problem			<0.001		<0.001		<0.001
None/mild	54.0 [3440]	14.1		47.4		58.3	
Moderate	24.4 [1690]	18.2		75.1		49.5	
Severe/extreme	21.6 [1424]	30.8		83.4		46.0	
Self-reported quality of life			0.114		<0.001		0.001
Good	35.8 [2180]	19.0		53.2		62.0	
Moderate	53.3 [3638]	18.5		65.2		47.7	
Bad	10.9 [729]	19.0		74.6		38.7	

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564 **Table 2** Factors associated with self-reported diagnosed cataracts in older adults (50 and above) in India,
565 WHO-SAGE Wave 1, 2007-2010.

Characteristics	Model 1		Model 2		Model 3	
	Self-reported diagnosed cataracts (n=6217)		Cataract symptoms (n=5031)		Cataract surgery (n=1185)	
	Adjusted OR[95%CI]	P value	Adjusted OR[95%CI]	P value	Adjusted OR[95%CI]	P value
Age groups						
50-59	1		1		1	
60-69	1.90 [1.61-2.25]	<0.001	1.14 [1.01-1.30]	0.040	2.11 [1.53-2.93]	<0.001
70 and above	3.61 [2.99-4.34]	<0.001	1.62 [1.38-1.91]	<0.001	3.31 [2.34-4.68]	<0.001
Sex						
Male	1					
Female	0.91 [0.76-1.09]	0.301	1.13 [0.97-1.31]	0.106	1.12 [0.80-1.58]	0.498
Place of residence						
Urban	1		1		1	
Rural	0.91 [0.77-1.08]	0.264	0.75 [0.65-0.86]	<0.001	0.74 [0.55-1.01]	0.057
Marital status						
Not in marital union	1		1		1	
Currently married	0.81 [0.69-0.96]	0.013	1.00 [0.87-1.16]	0.966	1.02 [0.76-1.37]	0.907
Education						
No education	1.27 [0.86-1.90]	0.233	1.51 [1.13-2.01]	0.005	1.62 [0.75-3.49]	0.219
Primary school or less	1.47 [1.00-2.16]	0.052	1.25 [0.94-1.65]	0.125	1.07 [0.51-2.26]	0.854
Secondary/high school	1.54 [1.05-2.26]	0.028	1.13 [0.86-1.50]	1.374	1.22 [0.58-2.56]	0.606
Tertiary or higher	1		1		1	
Household income quintiles						
Q1 (Lowest)	1		1		1	
Q2	1.11 [0.87-1.41]	0.396	1.00 [0.82-1.21]	0.802	1.24 [0.81-1.91]	0.322
Q3	1.02 [0.80-1.31]	0.848	1.01 [0.83-1.22]	0.959	1.01 [0.65-1.56]	0.967
Q4	1.18 [0.93-1.51]	0.173	0.98 [0.80-1.19]	0.871	1.38 [0.89-2.15]	0.146
Q5 (Highest)	1.26 [0.98-1.63]	0.071	0.99 [0.80-1.21]	0.885	1.28 [0.81-2.01]	0.285
Health insurance status						
Without insurance	1		1		1	
With insurance	1.010 [0.79-1.52]	0.573	1.23 [0.95-1.61]	0.121	0.79 [0.43-1.45]	0.446
Tobacco ever use						
Yes	0.91 [0.78-1.06]	0.234	0.88 [0.77-0.99]	0.042	0.75 [0.57-1.00]	0.049
No	1		1		1	
Ever alcohol intake						
Yes	1.22 [1.00-1.49]	0.052	1.08 [0.92-1.28]	0.332	0.79 [0.55-1.14]	0.208
No	1		1		1	
Daily fruits or vegetable intake						
No or insufficient (<5 servings/day)	1		1		1	
Sufficient (>=5 servings/day)	0.97 [0.77-1.21]	0.780	1.04 [0.87-1.25]	0.652	0.62 [0.41-0.92]	0.018
Measured BMI status						
Normal (18.5-24.9kg/m^2)	1		1		1	
Underweight (<18.5kg/m^2)	0.96 [0.82-1.12]	0.584	0.99 [0.87-1.13]	0.695	1.07 [0.80-1.41]	0.654
Overweight (≥25.0 kg/m^2)	1.06 [0.86-1.31]	0.578	1.01 [0.85-1.19]	0.915	0.99 [0.67-1.46]	0.963
Hypertension						
BP<140/90mmHg	1		1		1	
BP≥140/90mmHg	1.07 [0.93-1.25]	0.348	0.85 [0.75-0.96]	0.010	0.96 [0.73-1.25]	0.743
Diabetes						
No	1		1		1	
Yes	1.44 [1.13-1.83]	0.003	1.10 [0.88-1.37]	0.402	1.28 [0.84-1.96]	0.254
Stroke						
No	1		1			
Yes	1.06 [0.68-1.64]	0.811	1.10 [0.74-1.62]	0.647	2.31 [0.97-5.46]	0.057

Angina pectoris						
No	1		1		1	
Yes	1.20 [0.95-1.52]	0.135	1.40 [1.11-1.76]	0.005	0.89 [0.58-1.34]	0.567
Arthritis						
No	1		1		1	
Yes	1.42 [1.22-1.65]	<0.001	1.50 [1.31-1.71]	<0.001	0.77 [0.59-1.01]	0.063
Asthma						
No	1		1		1	
Yes	0.90 [0.71-1.13]	0.356	1.24 [1.01-1.53]	0.045	0.87 [0.58-1.33]	0.529
Chronic lung disease						
No	1		1		1	
Yes	1.16 [0.94-1.42]	0.164	1.14 [0.95-1.37]	0.163	0.79 [0.55-1.13]	0.196
Depression						
No	1		1		1	
Yes	1.20 [0.97-1.49]	0.088	2.12 [1.71-2.63]	<0.001	1.73 [1.18-2.52]	0.005
Low visual acuity						
No	1		1			
Yes	1.64 [1.39-1.93]	<0.001	1.62 [1.44-1.83]	<0.001	0.90 [0.66-1.23]	0.496
Self-reported vision problem						
None/mild	1		1		1	
Moderate	1.35 [1.14-1.60]	<0.001	2.72 [2.38-3.11]	<0.001	0.65 [0.48-0.89]	0.007
Severe/extreme	2.13 [1.79-2.53]	<0.001	3.67 [3.13-4.32]	<0.001	0.36 [0.27-0.49]	0.000
Self-reported quality of life						
Good	1		1		1	
Moderate	0.96 [0.82-1.12]	0.612	1.12 [0.99-1.27]	0.074	0.74 [0.56-0.98]	0.038
Bad	0.85 [0.66-1.10]	0.227	1.11 [0.89-1.39]	0.345	0.53 [0.33-0.83]	0.006

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Figure 1. Percentage distribution of overlapping cases for self-reported diagnosed cataracts, symptoms, and surgery, WHO SAGE, India 2007-10.