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ORIGINAL ARTICLE

Piloting targeted glaucoma screening: experiences of eye care services in Ganjam district, Odisha state, India

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Background: The number of patients with visual impairment and blindness from glaucoma is rapidly increasing with wide-ranging impacts for individuals and societies. However, the disease often goes undiagnosed for a long time, especially in low- and middle-income countries where healthcare services are limited. This paper presents the results of a pilot programme, which integrated targeted glaucoma screenings of people aged ≥40 y in community-based eye care services in the Ganjam district of Odisha state, India.

Methods: Using routine programme data, descriptive statistics were produced for the characteristics of patients participating in the screening programme and the rate and uptake of glaucoma referrals. Bivariate analysis was used to examine associations between patient characteristics, clinical risk factors and glaucoma diagnosis.

Results: Out of 23 356 individuals aged ≥40 y screened for glaucoma over a period of 18 mo, 2219 (9.5%) were referred and 2031 presented for further examination. Among them, almost half (n=968, 48%) were diagnosed with glaucoma, representing a screening to diagnosis conversion rate of 4.14% (95% CI 3.9 to 4.4%). A positive diagnosis of glaucoma among suspects was associated with female sex, age >60 y, visual impairment, vertical cap-to-disc ratio ≥0.6:1, intraocular pressure ≥30 mmHg and shallow anterior chamber ($p<0.001$).

Conclusions: The importance of targeted screening for glaucoma using simple referral criteria to identify patients at high risk of vision loss who can benefit from treatment is critical to slow the progression of the disease and the prevention of blindness. Further studies assessing costs of the targeted screening, the role of technology in improving programme effectiveness and efficiency and the longer term compliance with treatment are needed to support glaucoma policy frameworks, guidelines and clinical practice.

Keywords: community-based programme, glaucoma, India, screening.

Introduction

The number of patients with visual impairment and irreversible blindness from glaucoma is rapidly increasing.[1] The disease can stay asymptomatic and undiagnosed for a long time and until a very advanced stage. Therefore, its full magnitude is difficult to estimate. This is particularly true in low- and middle-income countries (LMICs) with limited eye care infrastructure as many patients do not have access to regular eye health check-ups.[2,3] The WHO estimated that in 2020, 6.9 million people lived with moderate to severe visual impairment or blindness from glaucoma, but the actual number of people experiencing diagnosed or undiagnosed glaucoma could be as high as 76 million.[4] Projections published by Tham et al. in 2014 suggested that by 2040, the number of people with glaucoma worldwide would increase to nearly 112 million.[5] In its late stages, glaucoma has a profound effect on the patient's functioning and quality of life.[6] Most patients experience defects in central and near vision, which affects their ability to read, walk, recognise faces and drive.[7] Patients with glaucoma are also at a high risk of developing depression.[6,8] The direct and indirect costs of glaucoma are significant and extend to the patients, their families, the healthcare system and society at large.[9–11]

Glaucoma is usually caused by fluid building up in the front part of the eye, which increases intraocular pressure (IOP) and gradually damages the optic nerve, which connects the eye to the

brain.[1] Age, gender, family history, health status and race have been shown to be associated with the risk of the disease.[1,12] High IOP is a major risk factor for loss of vision from glaucoma and the only one that is modifiable. Evidence from epidemiological studies and clinical trials have shown that effective control of IOP reduces the risk of optic nerve damage and slows disease progression.[13–16] Therefore, early diagnosis and treatment of glaucoma are critical for managing IOP and preventing severe loss of vision.[12]

Glaucoma diagnosis includes multiple tests ranging from simple eye examinations and measurements of visual acuity (VA) and IOP to more complex assessments of anterior chamber (AC) angle structures, fundus and optic nerve examination and visual field charting to look for characteristic glaucomatous changes. However, these tests are very challenging in low-resource settings, as the number of facilities that have glaucoma-trained staff and equipment is limited; they tend to be located in large urban centres that are unreachable for the majority of patients. Patient demand for services in such settings is also low due to the lack of education and awareness and the inability to pay for eye consultations and treatment.[17]

In India, studies published during 2000–2020 estimated the prevalence of glaucoma at 2.3% to 4.7% with variations by location and population subgroups. Studies also noted that >90% of glaucoma patients were unaware of their condition at the time of the diagnosis.[18–23] Global estimates suggest that India accounts for around 13% of all glaucoma cases in the world.[24] Although India's 12th Five-Year Plan of the National Programme for Control of Blindness and Visual Impairment recognises glaucoma as a priority disease, it suffers from a lack of clear objectives, strategies and actions.[25] Facility-based studies show that the majority of glaucoma patients are diagnosed at an advanced stage and that there are challenges in both detecting and treating the disease.[20,26–27] In a recent review of the glaucoma situation in India, Senjam argued that in resource-limited settings like India, mass community screenings or glaucoma case finding was not feasible. The author suggested that targeted opportunistic screening programmes that operated at different levels of the system would be more appropriate.[28] The growing burden of glaucoma and the significant numbers of patients presenting with irreversible vision loss calls for developing and implementing effective, accessible and inexpensive glaucoma care pathways appropriate for India and other LMICs. In 2019, the WHO South-East Asia Office conducted a workshop with the aim of developing guidelines for the effective screening and management of glaucoma in the region. These guidelines are currently under development. Nevertheless, the evidence to advocate for the roll-out of targeted screening continues to be limited and more studies to assess its feasibility, acceptability, effectiveness and efficiency are urgently needed.

In this paper, we present the results of a pilot programme, which integrated targeted glaucoma screening in community-based eye care services in the Ganjam district of Odisha state, India. We used routine programme data to explore the enrolment and characteristics of patients participating in the screening programme, the rate and uptake of glaucoma referrals and the prevalence and distribution of different types of glaucoma among those who were routinely screened.

Methods

Study setting and intervention

Ganjam is a coastal district in Odisha state in eastern India with a population of >3.5 million people. It is a predominantly rural district (78%) spread across 22 blocks. The district has 124 public and 17 private health facilities but the ratio of doctors, nurses and hospital beds to the population is lower than WHO-recommended levels.[28]

The pilot was funded by Allergan's Keep Sight initiative and implemented in partnership with Sankara Eye Hospital located in Ganjam. The hospital is a 50-bed private not-for-profit facility, which provides services for all segments of the population using a sliding pricing structure with subsidised or free services for those who cannot pay. The hospital has a comprehensive community outreach eye care programme and clinical glaucoma service.

Prior to the pilot, no specific glaucoma screening was done at the community level and the number of glaucoma patients presenting to the facility with glaucoma was relatively small. They were primarily walk-ins or referrals from other hospitals that could not provide glaucoma assessments. Within the hospital, all ophthalmologists performed comprehensive examinations for outpatient cases including tests for glaucoma such as IOP and disc assessment. Any case who appeared 'suspect' for glaucoma was referred to the specialised glaucoma clinic for further evaluation such as gonioscopy and visual field assessment. However, these referrals were based on the judgement of the referring ophthalmologist and were not standardised. Also, there was no mechanism to follow up these referrals to assess the compliance to the advice and subsequent final diagnosis. The pilot aimed to strengthen the existing care pathways and introduce glaucoma interventions at different levels of service delivery including community-based interventions.

The intervention included the development of a tool to identify glaucoma suspects at high risk of vision loss. The tool included assessments of any family history of glaucoma, IOP, AC depth and optic disc assessment. To make the tool more applicable for community settings, clinical data were entered in a number of predefined categories (Figure 1). As we focused primarily on patients at risk of vision loss from glaucoma, referral cut-off points previously used by the hospital were simplified. The guidelines developed by this project recommended referring patients for further glaucoma examination if they had one of the following risks: (1) IOP≥30 mmHg, (2) vertical cup-to-disc ratio (CDR)≥0.6:1 or (3) shallow AC on oblique flashlight test.[29]

The screening was implemented as an add-on to the patient examination pathway at the outpatient department of the base hospital, at two vision centres located in the district and at outreach camps organised by the hospital within their catchment zone (villages within 10–15 km from the facility). The screening took place from October 2019 to March 2021. The target group was patients aged ≥40 y. At the hospital, glaucoma screening was conducted in a dedicated area where all individuals who agreed to participate were directed to. In addition to the patients, their accompanying persons were also invited to be screened for glaucoma, provided they were aged ≥40 y. At the screening camps, a health worker collected data on each patient's

Name			Block				Contact no.			
SCREENING										
History			Tests		RE	LE	Examination		RE	LE
Age (Yrs)	<40		Distance VA	>6/18			Lens	Clear		
	40-60			6/18 -3/60				Cataract		
	> 60			<3/60				Operated		
Family H/o Glaucoma or blindness due to unknown cause	No		Near VA	>N8			Anterior Chamber	Deep		
	Yes			<N8'				Shallow		
	Not Sure							Not sure		
High BP	No		IOP (mm Hg)	16-21			C:D ratio	<0.6		
	Yes			22-30*				0.6-0.7		
	Not Sure			>30				>0.7		
Steroid use or long term use of unknown eye drops	No		Pupil	Normal			Assymetry	<0.2		
	Yes			Abnormal				>0.2		
	Not Sure			Not sure				N/A		
Others			Any other findings				Referral	No		
								Yes		

Figure 1. Glaucoma-screening data collection tool used in the pilot.

demographics and personal and family history. A team of three trained optometrists provided the following examinations for each case:

(1) presenting VA for distance and near;
(2) lens status;
(3) AC depth;
(4) Optic disc assessment.

AC depth was assessed using the oblique flashlight method,[30] where a grade 1 AC depth (i.e. iris shadow reaching the pupil margin) was regarded as shallow AC. Vertical CDR was assessed on fundus photographs taken with a non-mydriatic fundus camera (FORUS Tri-Netra, Forus Health, Bangalore, India). IOP was measured using the iCare rebound tonometer (iCare TA01i, Helsinki, Finland), which presents an average of six consecutive readings. The findings from the worse affected eye (i.e. higher IOP, higher CDR or lower AC depth) were used to categorise the case as 'suspect for referral'.

Participants were also asked about the history of glaucoma in their first-degree relatives and about the use of steroid eye drops for >6 wk. However, these data proved to be difficult to collect accurately and the data were subsequently removed from the analysis.

In addition to applying the referral guidelines, the screening optometrists exercised their own clinical judgement. For example, they referred patients where they suspected that visual impairment might be related to glaucoma but other clinical criteria were absent. This was particularly common in the base hospital, where examination in the glaucoma clinic was organised onsite and patients did not incur extra time or costs related to travel.

Based on the findings of the screening, individuals categorised as 'suspect for referral' were advised to visit the glaucoma clinic at the hospital for a more detailed assessment, which included gonioscopy, visual field assessment and consultation with the glaucoma specialist (SD), who made the final diagnosis of glaucoma and advised the management plan.

All ophthalmologists at the hospital participating in the pilot were trained on diagnosis and management of glaucoma using an online course recognised by the International Council of Ophthalmology. All optometrists and other healthcare staff were trained on the objectives and protocols of the screening by the glaucoma specialist from the base hospital (SD). We did not conduct any tests to assess interobserver variability in this pilot.

Data collection and analysis

Data were extracted retrospectively from facility records. Data from the screening records included patient demographics, family and personal history, VA, IOP, AC depth and CDR. Data extracted from glaucoma clinic records included gonioscopy findings, visual field assessment and glaucoma specialist notes, which included vision at the time of the diagnosis, comorbidities, the type of glaucoma diagnosed and the treatment offered.

Hospital records were linked using the medical record number. Outreach referrals were linked using camp ID numbers recorded in the screening sheets and passed to the hospital. Individuals directly presenting to the glaucoma clinic, referred by other

facilities outside the pilot screening programme or those already diagnosed with glaucoma were excluded from the analysis.

Data were analysed using STATA version 16. Descriptive statistics were used to describe the characteristics of patients presenting for the screening and those diagnosed with glaucoma. The χ^2 test was used to examine the bivariate relationships between clinical risk factors as explanatory variables and glaucoma diagnosis as an outcome variable.

For the purpose of this paper, the screening to diagnosis conversion rate was calculated as follows:

$$\text{Number of patients with confirmed glaucoma diagnosis} / \text{number of patients screened for glaucoma} \times 100$$

For the purposes of this paper, we are distinguishing between four types of glaucoma based on the findings documented by the glaucoma specialist:

'Open-angle glaucoma' is defined as cases that have characteristic optic disc and visual field changes with no evidence of angle closure on gonioscopy.

'Closed-angle glaucoma' is defined as cases where clear gonioscopy evidence of closure of the AC angle is seen along with optic disc or visual field changes.

'Other glaucoma' cases include where the specialist could identify findings suggestive of other types of secondary glaucoma, such as neovascular glaucoma, pseudoexfoliation and phacolytic glaucoma.

'Glaucomatous optic atrophy' were cases with advanced/end-stage glaucoma changes in the optic disc and the inability to perform the visual field test due to very poor vision.

Results

During the 18 months of the pilot, 23 356 individuals aged ≥40 y were screened for glaucoma; 58.7% (n=13 707) were men and the majority (78%) were aged 40–60 y. Due to restrictions imposed during the COVID-19 pandemic, most patients (n=18 670, 79.9%) were screened at the base hospital and only 4686 patients could be screened in the community settings (outreach camps and vision centres).

Based on the referral guidelines and clinical judgement, 2219 individuals (9.5%) across all sites were referred for further examination as glaucoma suspects and 2032 of them (91.6%) attended the referral. The majority of glaucoma suspects were men (n=1385, 62.4%) and aged <60 y (n=1696, 76%); >70% of them (n=1557) had good vision (VA>6/18).

The referral rate from the base hospital was almost twice the referral rate from the community settings (1958/18 670 [10.5%] compared with 261/4686 [5.6%]) and the uptake of referrals made by the hospital was also much higher (1880/1958 [96%] compared with 152/261 [58%]).

For those referred from the community settings, there were no statistical differences in the uptake of referrals by sex but individuals with VA>6/18 and those aged <60 y were less likely to take up the referral than people with visual impairment or those aged >60 y (p<0.001) (Table 1).

Table 1. Association between patient characteristics and the uptake of glaucoma referral from the community settings

	Uptake of referrals		
	n	%	p value
Sex			
Male	102/178	57.3	–
Female	50/83	60.2	0.654
Age			
>40 to <60 y	79/167	47.3	–
>60 y	73/94	77.7	<0.001
Distance VA			
>6/18	92/183	50.3	-
<6/18–3/60	31/45	68.9	–
<3/60	29/33	87.9	<0.001

Among the 2032 glaucoma suspects presenting for further examination, almost half (n=968, 47.6%) were diagnosed with glaucoma. This represented a screening to diagnosis conversion rate of 4.1% (95% CI 3.9 to 4.4%); >56% of all patients with confirmed glaucoma (n=545) were male and 74.1% were aged 40–60 y. In the bivariate analysis, female sex, age >60 y and visual impairment among glaucoma suspects were associated with a positive glaucoma diagnosis.

All 2219 glaucoma suspects referred for further examination had records of IOP measured at the time of the screening. Data on CDR and AC depth were available for 2191 (98.7%) and 1895 (93.5%) of referred patients, respectively. Looking at the clinical criteria for referral, 1175 out of 2219 referred patients (52.9%) had at least one of the three criteria used in the screening guidelines (i.e. IOP>30 mgHg; CDR>0.6:1 or shallow AC). CDR>0.6:1 was present in 746 referred individuals with data (34.1%), including 562 individuals where it was the sole risk factor for referral. High IOP (>30 mmHg) was recorded in 232 (10.5%) of referred patients, including 113 individuals where it was the sole criterion. Shallow AC was present in 197 referred patients with data (9.5%), including 108 individuals where it was present alone. The distribution of the three risk factors among patients who presented for further examination was similar to that among the referred glaucoma suspects (Table 2).

Among patients diagnosed with glaucoma, 540 individuals with data (56.4%) had CDR>0.6:1 at the time of the screening; 187 individuals (19.3%) had IOP>30 mmHg and 156 individuals (18.4%) had shallow AC. In the bivariate analysis, a positive diagnosis of glaucoma was associated with the presence of any of the three factors at the time of the screening (Table 3).

Overall, 74.6% of patients with one of the three referral risk factors at the time of the screening were subsequently diagnosed with glaucoma. This proportion increased to 91.5% in those with two risk factors and 100% in those with all three risk factors.

More than half (58.8%) of all patients diagnosed with glaucoma had open-angle glaucoma (n=570); 31% (n=294) had angle closure glaucoma; 5% (n=41) had others (e.g. normal tension glaucoma, neovascular glaucoma, pseudoexfoliation,

Table 2. Presence of risk factors used as criteria for referral in different groups of patients with available data

Risk factor (alone or in combination with other factors)	In patients referred*	In patients presenting for examination*	In patients diagnosed with glaucoma*
CDR>0.6	746/2191 (34.1%)	680/2005 (33.9%)	540/957 (56.4%)
IOP>30 mmHg	232/2219 (10.4%)	220/2032 (10.8%)	187/968 (19.3%)
Shallow AC	197/2075 (9.5%)	182/ 1895(9.6%)	156/850 (18.4%)

*The denominator includes patients with records of the risk factor in question.

Table 3. Associations of patient characteristics and confirmed glaucoma diagnosis

	Glaucoma		No glaucoma		
	n	%	n	%	p value
Sex					
Male	545	43.3	715	56.8	
Female	423	54.6	349	45.2	<0.001
Age					
>40 <60 y	717	45.5	860	54.5	
>60 y	251	55.2	204	44.8	<0.001
Distance VA					
>6/18	659	43.9	844	56.2	
<6/18–3/60	202	59.2	139	40.8	<0.001
<3/60	107	56.9	81	43.1	
IOP (mmHg)					
16–21	579	60.1	871	39.9	
22–30	202	55.8	160	44.2	
≥30	187	85.0	33	15.0	<0.001
CDR					
<0.6	417	31.5	908	68.5	
≥0.6	540	79.4	140	20.6	<0.001
AC depth					
Deep	694	40.5	1019	59.5	
Shallow	156	85.7	26	14.3	<0.001

phacolytic) and 6.5% (n=63) had glaucomatous optic atrophy in one eye.

Almost a third of patients with confirmed glaucoma were either blind (n=107, 11%) or had moderate-to-severe vision impairment (MSVI; VA < 6/18 but ≥3/60) (n=202, 20%) in their better eye. Coexisting unoperated cataract was present in 10% of cases (n=99) and another 42 patients (4.3%) had previous operations for cataracts in one or both eyes. Other significant retinal pathologies were identified in 78 cases (4%) and uncorrected refractive errors were diagnosed in 287 cases (12%).

The flowchart of patient screening, referral and diagnosis is shown in Figure 2.

Trabeculectomy surgery was performed alone in 110 cases and combined with cataract surgery in 99 cases. Laser peripheral iridotomy was offered to 137 patients and 622 patients needed medical management, either as standalone or in conjunction with other eye care treatments.

Discussion

In this study, we used data from the community-based and hospital-based targeted screening of people aged ≥40 y and found that 4.1% of those screened and subsequently examined had glaucoma; 2.4% had open-angle glaucoma, 1% had angle closure glaucoma, 0.2% had secondary glaucoma and 0.3% had glaucomatous optic atrophy.

Our results are broadly comparable with other South Asia studies that integrated glaucoma screening in other eye care services, although these studies differ in their target populations, screening approaches and definitions used. For example, a study conducted in Nepal in 2009–2010 and published in 2019 recruited patients aged ≥50 y through cataract outreach camps. In this study, patients were referred as glaucoma suspects based on shallow AC, IOP>20 mmHg, abnormal frequency doubling technology test, CDR>0.7:1, asymmetric CDR>0.2:1 and optic disc abnormalities. But the prevalence of glaucoma among the people screened (3.4%) was similar to our findings.[31] A study from upper Assam, India, published in 2017, targeted patients aged >40 y who were recruited from a hospital setting. Patients were referred for further examination based on IOP>21 mmHg measured with non-contact tonometry and then rechecked with a Goldmann applanation tonometer. The estimated prevalence of glaucoma among those screened in this study (2.2%) was slightly lower.[24] While population-based surveys are not strictly comparable with facility-based studies, they suggest similar levels of glaucoma burden in the population. For example, a population-based study in Central India conducted in 2001 and published in 2008 estimated the prevalence of glaucoma in people aged ≥35 y at 3.7%.[32] A more recent study conducted in eastern India in 2011–2013 and published in 2016 estimated the prevalence of glaucoma among people aged ≥40 y at 3.2% in urban areas and 2.7% in rural areas.[33] This evidence suggests that the burden of undetected glaucoma in the population is substantial, and opportunistic targeted screening integrated into broader eye care services can play an important role in detecting unknown cases, referring them for treatment and thus preventing deterioration and irreversible loss of vision.

With regard to clinical indicators, the available literature suggests that referrals of glaucoma suspects, particularly those at early stages of the disease, should be based on a combination of tests, as none of them individually have a positive predictive value that is high enough to be used for community-based screening.[34] In this programme, we focused largely on identifying patients at risk of vision loss from glaucoma and used three referral indicators (IOP>30 mmHg, CDR≥0.6:1 and shallow AC). Our data suggest that these indicators were reasonably accurate in predicting

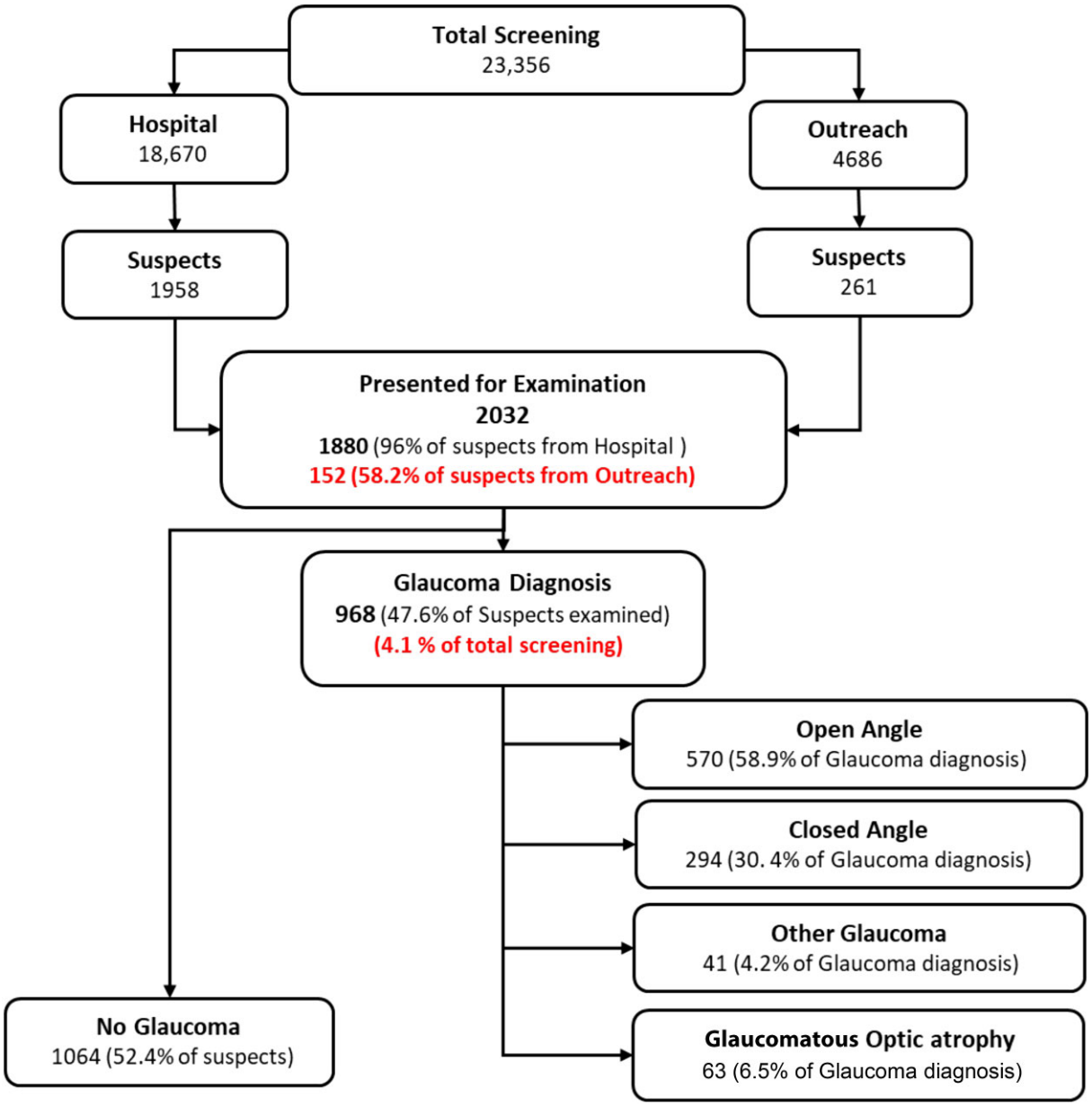

Figure 2. The flowchart of patient screening, referral and diagnosis process.

glaucoma. Each of the three indicators was associated with glaucoma diagnosis in the bivariate analysis and 74% of patients who had one of the three risk factors was diagnosed with glaucoma. The finding suggests that this combination of clinical indicators is suitable for targeted screening programmes aiming to identify patients at a high risk of vision loss from glaucoma.

We do not dispute that identifying patients with glaucoma at very early stages of the disease would be most beneficial from the clinical perspective, but in this pilot we tried to balance out the comprehensiveness of the clinical assessment with the realities of community-based programmes in LMICs. The use of multiple tests to increase the accuracy of screenings would be desirable. However, in settings similar to the one where we conducted our pilot, this is not a viable option unless low-cost portable technology becomes easily available. In addition, patients in similar contexts experience multiple barriers in accessing healthcare services and the uptake of referrals and treatment at early stages of the disease in such settings is likely to be low. The focus of community-based screening on simple referral criteria to identify patients at more advanced stages of glaucoma but who can still benefit from treatment seems to be a reasonable compromise in such geographies. In our study, nearly 90% of patients diagnosed with glaucoma were deemed to benefit from treatment, which confirms the public health significance of this approach. Interestingly, in 42 cases of patients who had been previously operated on for cataracts, glaucoma had not been detected. This

suggests that the current system in this setting does not have the capacity to identify glaucoma patients during routine eye examinations and the integration of additional simple tools like the one piloted in our programme can bring significant added value.

An interesting observation in our analysis was the gender distribution of patients screened and diagnosed with glaucoma. Men represented the majority of patients recruited for screening (>58%) and diagnosed with glaucoma (>56%). This is consistent with the study in Upper Assam, where 73% of all patients diagnosed with glaucoma during the hospital-based screening were men.[24] Although there is no known biological relationship between the incidence of glaucoma and sex, women may be more disadvantaged in the opportunities for an early diagnosis due to their limited access to eye care services, which is documented in many LMICs.[35,36] Therefore, screening programmes need to put specific measures in place to ensure that women are aware of screening services and that they are run in an accessible and acceptable way to women. Also, more research on how to facilitate women's access to both screening and eye examination services will be beneficial.

There are a number of limitations to our study that need to be taken into account when interpreting our findings and planning future screening programmes and research. First, this study was based on the secondary analysis of data collected by the pilot and we were limited by the completion and accuracy of records available. For example, 1.2% of records missed data on CDR and 6.5% missed data on AC depth. Future screening programmes and research need to build mechanisms for regular data checkups to ensure that all screening data are complete, accurate and correctly linked to diagnosis and treatment records. Second, two factors that showed associations with glaucoma diagnosis in previous research, family history and steroid use,[37] proved difficult to assess in our programme. In addition, we did not have information on patients' education, socioeconomic status or residency and cannot make any conclusions on the associations of these with a positive diagnosis, either independently or in combination with other factors. Future research on how to better collect these data accurately and on how to use this information in combination with other risks is needed. Furthermore, as described in this paper, one of the key purposes of the pilot was to test the feasibility of the targeted glaucoma screening close to where people live. Unfortunately, due to the restrictions imposed by the COVID-19 pandemic, we were not able to fully assess the potential of the screenings in the community settings, such as vision centres and outreach camps. The number of these activities during the pandemic was limited and the number of patients referred was relatively small. The uptake of referrals from the community was also relatively low, particularly among patients who were younger and had normal vision. It is possible that the uptake of referrals in our pilot was partly influenced by COVID-19 and people's unwillingness to travel far from their communities during the pandemic. However, low rates of the uptake of referrals from community settings have been previously reported in other studies,[38] which is largely due to the long distance to hospitals and the cost of transport. Future research should give particular attention to the question of the referral uptake and better understanding of the profile of patients who do and do not take up the referrals.

Our study relied on secondary data and, therefore, we could not assess the impact of the integration of the additional tests on staff workload, screening time and costs. We also do not know to what extent patients diagnosed with glaucoma will comply with the treatment prescribed and future check-ups, particularly in the contexts where the costs of treatment and follow-up visits may not be available from the public or charity-funded sources and patients have to cover them out of their own pocket. It is critical that future screening programmes collect data on the uptake of treatment and clinical follow-ups.

Finally, in this pilot, we did not assess intraobserver variation among the programme screeners; nor did we formally assess sensitivity and specificity and predictive values of our screening tool. Collecting these data in future pilots will be very important to maximise the effectiveness of screening programmes, as this will have implications for their sustainability and taking them to scale.

In conclusion, glaucoma is a growing public health problem in India and across the globe. The importance of targeted screening should not be underestimated. Community-based programmes and eye examinations of patients presenting for regular eye check-ups can play a critical role in the detection of the disease early on and the prevention of severe vision loss. Further studies assessing the costs of the targeted screening, the role of technology in improving programme effectiveness and efficiency and longer term compliance with treatment will be needed to support glaucoma policy frameworks, guidelines and clinical practice.

Authors' contributions: SB and ES conceived and designed the study; SB and SD supported collection of the data; BG and SB conducted the data analysis; SB prepared the first draft of the manuscript; ES and SD critically revised the manuscript for intellectual content and also provided comments on subsequent drafts and approved the final version of the manuscript.

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Competing interests None.

Ethical approval Because the data used in this paper are routinely collected programme data without any identifying information, ethical clearance was not required.

Data availability: Data available upon reasonable request.

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