Knowledge, Willingness, and Preferences of Glaucoma Patients on Telemedicine and Vision Centres in South India

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ABSTRACT

Introduction: Glaucoma, a leading cause of irreversible blindness, affects 80 million people globally, is projected to surpass 111 million by 2040. In India, limited availability of ophthalmologists, especially in rural areas, limits glaucoma care. Telemedicine bridges this gap by enabling remote consultations, reducing travel-related barriers and improving access to specialist services. A tertiary eye care centre in South India operates over 100 vision centres (VCs), providing primary eye care through telemedicine. However, evidence regarding glaucoma patients' acceptance remain limited, particularly in low and middle-income countries.

Objective: To evaluate glaucoma patients' knowledge, perceptions, and preferences regarding telemedicine, particularly through VCs.

Methodology: This analytical, cross-sectional study included patients aged 18 years or older with stable glaucoma (well-controlled intraocular pressure, no change in medications in past one year) who had attended three or more glaucoma clinic visits. After obtaining demographic and clinical details, a validated questionnaire was administered. The collected data were then analysed.

Result: Among 246 participants, 82 (33.33%) were aware of telemedicine. Despite limited awareness, 203 (82.52%) participants expressed willingness to use telemedicine for follow-up appointments. 164 (66.67%) preferred video calls for virtual appointments. VC model was the most preferred telemedicine approach for 190 (77.24%) participants.

Conclusion: Glaucoma patients demonstrated moderate awareness but a positive attitude toward both telemedicine and VCs for follow-up care. Enhancing the capabilities of VCs is essential, as they are the preferred for follow-up visits and can optimise long-term glaucoma management.

Key words: Glaucoma; remote care; telemedicine; teleophthalmology; vision centres.

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INTRODUCTION

Glaucoma is the leading cause of blindness worldwide; it is projected to surpass 111 million by 2040 (Tham et al., 2014). The rapidly ageing population, is expected to further increase this burden (Venkataraman et al., 2020). Prevention of vision loss depends on early diagnosis, intraocular pressure (IOP) control, and regular follow-up. Access to eye care professionals remains limited. In 2024, approximately 27,000 ophthalmologists were registered with the All-India Ophthalmological Society, with one ophthalmologist/46,000 people. Sub-speciality glaucoma care is predominantly urban-centric. Major follow-up barriers include travel distance, expenses, and lack of an escort (Killeen et al., 2020).

Telemedicine has emerged as a promising solution (Rhodes et al., 2019), defined as remote health care delivery from a distance using electronic technology (National Cancer Institute, 2011), it enables specialist access in underserved regions. A tertiary eye care centre in south India operates over 100 permanent eye care facilities known as vision centres (VCs) (Muralikrishnan et al., 2022), and provides refraction, slit lamp bio-microscopy, applanation tonometry, and fundus photography. Examinations are performed by a trained ophthalmic assistant with optometrist-level skills, followed by real-time teleconsultation with ophthalmologists at base hospitals thereby addresses accessibility. During the COVID-19 pandemic, VCs were less affected than secondary and tertiary centres in maintaining patient care (Muralikrishnan et al., 2022).

While teleophthalmology show promise, stakeholder's perspectives- particularly in asymptomatic conditions like glaucoma remain underexplored. Studies from Ethiopia (Belachew et al., 2023), the United States (Klee et al., 2023; Ladin et al. 2021; Camacho-Leon et al.,2022) show promising western/upper-middle-income evidence. Virtual Glaucoma Clinics (VGCs) report high acceptance (Azzopardi et al., 2023; Gunn et al., 2022; Court et al., 2015; Ali et al., 2017) yet low- and middle-income countries glaucoma data remain limited.

The authors aimed to address this gap by evaluating glaucoma patients' knowledge, perceptions, preferences, and predispositions towards telemedicine and VC based follow-up.

METHODOLOGY

The study protocol received approval from the Institutional Ethics Committee (Reference number: AEH/PDY/EC/OA/148/2023; Dated: 2023 April 21) and was registered with the clinical trial registry of India (CTRI/2023/05/052941). Written informed consent was obtained from all participants and the study adhered to the tenets of the Declaration of Helsinki.

This analytical, cross-sectional study was conducted from 2023 June to 2023 July after ethical clearance. A consecutive sampling technique was used. Patients with stable glaucoma, attending the glaucoma services at Aravind Eye Hospital, Puducherry, India during the study period were invited to participate until the required sample size was achieved. Stable glaucoma was defined as well-controlled IOP, with no change in antiglaucoma medications (AGM) for at least one year or more, requiring periodical six monthly follow-ups. Patients aged 18 years or older, diagnosed with primary glaucoma, secondary glaucoma or glaucoma

suspects (disc suspect and ocular hypertension) on periodical review, with a minimum of three previous visits at the base hospital were included. Patients with any acute or intractable glaucoma and ocular comorbidities including proliferative diabetic retinopathy (PDR), age-related macular degeneration (ARMD), retinal detachment, non-glaucomatous optic nerve pathologies were excluded.

Upon checking in for their appointment, patients provided demographic details including age, gender and address. Information on distance travelled, cost to reach the hospital, need for vacation days from work, and amount of wages lost were obtained. Socio-economic status (SES) was assessed using the modified Kuppuswamy index scale for the year 2022, which is based on the education and occupation of the head of family, along with the family's monthly income (Sood et al., 2022). Documented clinical data included best corrected visual acuity, duration and severity of glaucoma, ophthalmic diagnosis, and current as well as past treatment details. Glaucoma severity was analysed on the level of eye (total 481 eyes), while other variables were analysed on the level of patient (n=246). It was categorised using the cup-to-disc ratio (CDR) as per the Canadian guidelines: mild (CDR <0.65), moderate (CDR 0.7 to 0.85), and severely glaucomatous (CDR >0.9) (Sihota et al., 2018). Given the lack of reliable field test for all participants on the day of recruitment, severity grading relied on the CDR. A validated questionnaire was administered to patients by a well-experienced study coordinator in the local language (Tamil), to assess the participant's knowledge and preference for telemedicine and VCs. Patients who were not familiar with the telemedicine were educated about it and their queries on telemedicine/VC were clarified before administering the questionnaire.

A structured questionnaire was developed in English before the commencement of the study and translated into Tamil. Its validity was assessed through a pilot study with 20 participants. The questionnaire comprised of multiple sections, beginning with questions on access to telephone and/or internet and patient's awareness of telemedicine and video conferencing. The following questions concentrated on perceived advantages and concerns regarding telemedicine with the responses recorded on a five point Likert scale ranging from "Strongly Agree" to "Strongly Disagree". The subsequent sections explored participants' willingness to use telemedicine and their preferred mode of consultation. One section focused only on Vision Centres, assessing awareness, satisfaction and the perceived benefits. The full questionnaire used in this study is available as Appendix (Supplementary material).

Continuous variables were presented as mean (SD), and quantitative variables as frequency (percentage). Associations between demographic details and knowledge, awareness, or willingness were analysed using Chi-Square test/Fisher's Exact test. Data normality was checked using the Kolmogorov-Smirnov test. Univariate and multivariate logistic regression analysis assessed relationship between various independent and dependant variables. The odds ratio with 95% confidence intervals were reported. A p-value of less than 0.05 was considered statistically significant. All the statistical analyses were performed using STATA software version 17.0 (Texas, USA).

A pilot study involving 20 participants validated the questionnaire. Cronbach's alpha (α value) assessed internal consistency for questions on telemedicine's advantages, concerns, willingness, and awareness about vision centres, with an α value above 0.7 confirming validity. The sample size, calculated using the pilot study results with a 5% precision, 80% power and 95% confidence interval was 246.

RESULTS

The baseline characteristics of the 246 study participants are depicted in (Table 1). The mean age was 57.73 years (± 9.86) and 122/246 respondents (49.59%) were males. On average, patients travelled 58.39 km (± 43.61) to attend appointments, incurring an average expense of INR 328.41 (± 576.90) including travel and food. Patients lost an average income of INR 908.44 (± 964.94) due to attending appointments. The socio-economic status using the Modified Kuppuswamy index scale, revealed that 143 (58.13%) of patients belonged to the upper lower class (IV), followed by 48 (19.51%) in the lower middle class (III) and only seven (2.85%) in the upper class (I). The mean duration of diagnosis was 5.62 years (± 4.50). In terms of glaucoma severity (eye-based analysis), of the 481 eyes examined, 295 (61.3%) had mild glaucoma, 133 (27.6%) had moderate glaucoma, and 53 (11.0%) had severe glaucoma.

Table 1: Baseline characteristics of the Study Participants

Characteristics		**Mean ±SD (Min – Max)**
Age (in years): (n=246 patients)		57.73 ± 9.86 (19 – 81)
Gender: (n=246 patients)	Male, n (%)	122 (49.59)
	Female, n (%)	124 (50.41)
Average Distance Travelled (in km): (n=246 patients)		58.39 ± 43.61 (2 – 180)
Cost of the Appointment (in INR.): (n=246 patients)		328.41 ± 576.90 (20 – 4000)
Amount of wages lost (in INR.): (n=32 patients)		908.44 ± 964.94 (20 – 5000)
Socio-economic Status, n (%): (n=246 patients)	Upper (I)	7 (2.85)
	Upper middle (II)	32 (13.01)
	Lower middle (III)	48 (19.51)
	Upper lower (IV)	143 (58.13)
	Lower (V)	16 (6.50)
UCVA: (n=492 eyes)	Median (IQR)	6/12 (6/6-6/18)
	{Log MAR}	{0.3 (0-0.48)}
BCVA: (n=492 eyes)	Median (IQR*)	6/6 (6/6-6/6)
	{Log MAR}	{0(0-0)}
Duration of diagnosis (in years): (n=490 eyes)		5.62±4.50 (0.34 – 26)
Severity, n (%): (n=481 eyes)	Mild (CDR <0.65)	295 (61.3)
	Moderate (CDR 0.7-0.85)	133 (27.6)
	Severe (CDR >0.9)	53 (11.02)

*IQR – Inter-quartile range, CDR- cup to disc ratio

Among the 246 surveyed patients, 134 (54.47%) possessed both mobile phone and internet access at home, 98 (39.84%) had only phone access without internet, and 14 (5.69%) lacked both. About one-third, 82 (33.33%) of the patients were aware of telemedicine. Most of the respondents 51 (20.73%), regarded telemedicine as a method where trained ophthalmic personnel conduct examinations, and the patient connects with a specialist via telephone or video call.

Uni-variate and Multivariate logistic regression analyses were performed to identify the association between telemedicine awareness and various baseline characteristics (Table 2). On both univariate (OR=0.11, 95% CI-0.01 to 0.88, p=0.038) and multivariate analysis (OR=0.076, 95% CI-0.07 to 0.76, p=0.028), the patients in the lower SES group had significantly lower odds of telemedicine awareness as compared to the upper SES category. For the regression analysis, the better eye's visual acuity was used. No significant association was found between the other baseline characteristics and telemedicine awareness, in both univariate and multivariate analyses.

Table 2: Uni-variate and Multivariate logistic regression between telemedicine awareness and baseline characteristics

Variables		Univariate		Multivariate	
		OR (95% CI)	**p-value**	**OR (95% CI)**	**p-value**
Age category (in years)	20-30	Ref.		Ref.	
	30-40	0.25(0.01-8.56)	0.442	0.2 (0.004-9.16)	0.41
	40-50	0.56(0.03-9.66)	0.690	0.25 (0.01-6.1)	0.399
	50-60	0.44(0.03-7.29)	0.567	0.24 (0.015-5.39)	0.373
	Above 60	0.38(0.02-6.26)	0.497	0. 19(0.008-4.3)	0.299
Gender	Male	Ref.		Ref.	
	Female	0.66(0.38-1.15)	0.142	0.74(0. 39-1.4)	0.359
Socio-economic status	Upper	Ref.		Ref.	
	Upper middle	0.66(0.13-3.45)	0.624	0.62 (0.11-3.52)	0.512
	Lower middle	0.25(0.05-1.28)	0.096	0.28 (0.05-1.58)	0.151
	Upper lower	0.30(0.06-1.41)	0.127	0.31 (0.06-1.6)	0.164
	Lower	0.11(0.01-0.88)	**0.038***	0.07 (0.007-0.76)	**0.028***
Distance travelled for reaching hospital (in kms)		0.99(0.99-1.01)	0.873	0.99(0.98-1.04)	0.811
Cost of reaching hospital (in INR)		1.00(0.99-1.00)	0.788	1.00(0.99-1.01)	0.953
UCVA		0.94(0.42-2.07)	0.872	0. 0.78(0. 31-1.94)	0.604
Diagnosis duration		0.99(0.93-1.06)	0.885	0.99 (0.93-1.06)	0.972
CDR severity	Mild	Ref.		Ref.	
	Moderate	0.61(0.30-1.25)	0.177	0.64(0.31-1.31)	0.2228
	Severe	0.70(0.32-1.49)	0.352	1.83(0. 75-4.45)	0.180

p-value is statistically significant; BCVA is omitted from the multivariate analysis due to collinearity.

Regarding the advantages of telemedicine, a majority of participants, more than 60% (includes percentage of participants “strongly agree” and “agree”), agreed that telemedicine improves access from remote regions, provides faster contact with health care provider, reduces waiting time at the clinic, leads to cost reduction, and eliminates the need to take vacation days from work (Figure 1).

The different statements and the percentage of the participants who agreed that the statement was a concern (Figure 2). More than 50% of the participants chose either "strongly agree" or "agree" regarding the provided concerns. The concerns used were that patients would feel or miss the absence of direct contact with a health care provider (n=169, 68.7%), some complaints would go unaddressed (n=154, 62.6%), they might have a lesser understanding of disease (n=165, 67.08%), they might not receive the same quality of care (n=154, 62.61%), and that using devices and technology might pose challenges for them (n=211, 85.78%).

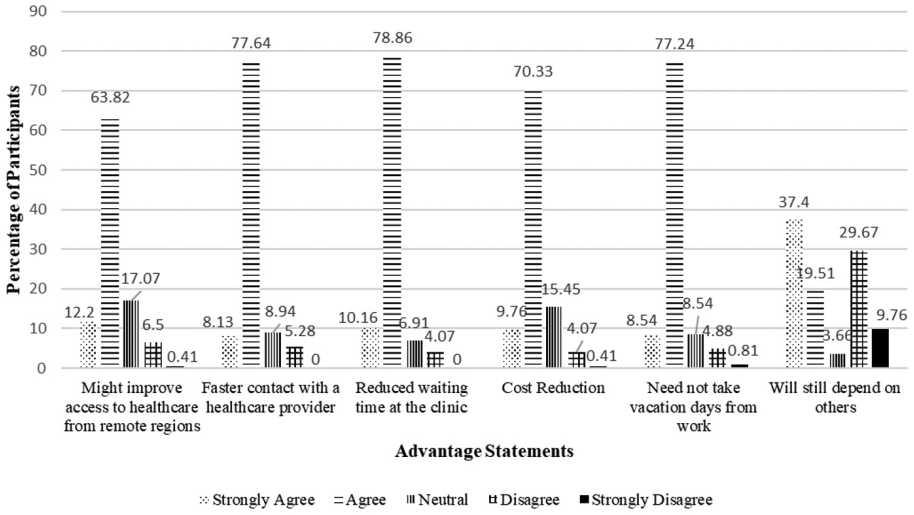

Figure 1: Participant perceptions on the advantages of telemedicine.

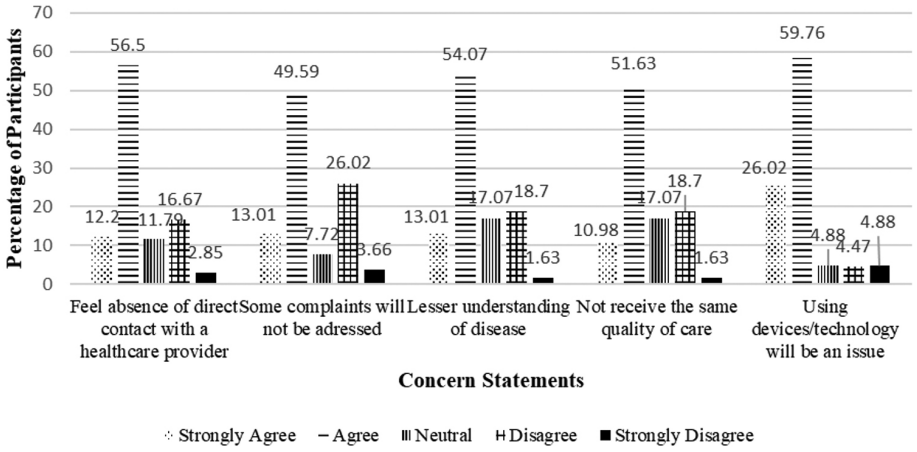

Figure 2: Participant perceptions on the concerns regarding telemedicine.

Approximately 203 (82.52%) patients expressed willingness to receive diagnosis, intervention, and follow-up through telemedicine, with 187 (76.02%) indicating a willingness to pay for the services. 164 (66.67%) patients preferred video calls for virtual appointments. Half of the patients (n=123, 50%) acknowledged a change in their perception of telemedicine following the COVID-19 pandemic.

Regarding the various types of telemedicine, 190 (77.24%) of patients favoured the VC model, 46(18.70%) preferred the virtual clinic model where an ophthalmic technician conducts the examination and sends data to a specialist, and only 9(3.66%) favoured a self-test at home using appropriate devices with data sent to a specialist .

The results of univariate and multivariate logistic regression analyses between telemedicine preference and the baseline characteristics have been tabulated (Table 3). There was no significant association (p >0.05) between any of the independent variables with the outcome variable.

Table 3: Uni-variate and Multivariate logistic regression between telemedicine preference and characteristics.

Variables		Univariate		Multivariate	
		OR (95% CI)	p-value	OR (95% CI)	p-value
Age category (in years)	20-30	Ref.		Ref.	
	30-40	1.5(0.05-40.63)	0.574	0.49 (0.014-16.6)	0.697
	40-50	0.69(0.04-11.96)	0.803	0.22(0.010-4.89)	0.343
	50-60	0.78(0.05-12.86)	0.863	0.33 (0.017-6.79)	0.480
	Above 60	0.92(0.06-15.19)	0.956	0.4 (0.019-8.13)	0.553
Gender	Male	Ref.		Ref.	
	Female	1.54(0.93-2.55)	0.094	1.79 (1.00-3.21)	0.050
Socio economic status	Upper	Ref.		Ref.	
	Upper middle	0.58(0.11-3.04)	0.522	0.47 (0.083-2.68)	0.399
	Lower middle	0.58(0.12-2.89)	0.510	0.45 (0.08-2.47)	0.365
	Upper lower	0.70(0.15-3.24)	0.647	0.56 (0.11-2.87)	0.489
	Lower	0.25(0.04-1.63)	0.148	0.17 (0.023-1.34)	0.094
Distance travelled for reaching hospital (in kms)		1.00(0.99-1.00)	0.590	1.00 (0.99-1.009)	0.86
Cost of reaching hospital (in INR.)		1.00(0.99-1.00)	0.147	1.00 (0.99-1.00)	0.365
UCVA		0.92(0.45-1.89)	0.821	0.80 (0.36-1.76)	0.586
Diagnosis duration		0.96(0.91-1.02)	0.247	0.96 (0.90-1.02)	0.198
CDR severity	Mild	Ref.		Ref.	
	Moderate	0.99(0.56-1.73)	0.981	1.04(0.55-1.95)	0.893
	Severe	0.63(0.29-1.32)	0.220	0.69(0.29-1.64)	0.408

Ref-Reference category; *- Omitted from the model due to collinearity Bolded p-value is statistically significant (p <0.05)

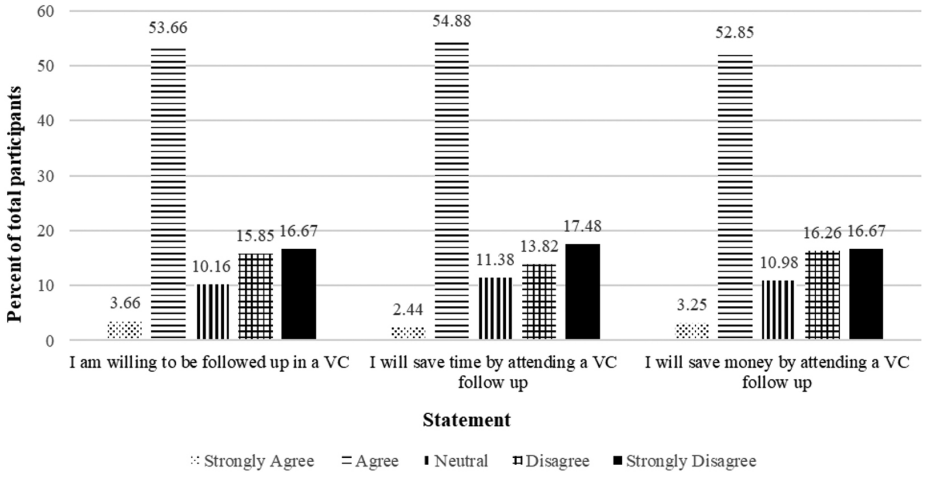

Figure 3: Participant opinions on vision centres for follow-up.

About 121 (49.19%) of patients were familiar with the Vision Centres (VC) within the system. Among them, 49 (19.92%) had visited a VC, and of those, 38 (77%) rated the examination conducted by the VC technician and the teleconsultation as "Good". The authors observed that a significant portion, 141 (57.32%), expressed willingness to be followed up in the VC by choosing “strongly agree” or “agree” (Figure 3). This is primarily because most of them did not require an escort (n=178, 72.36%) to visit the VC. Additionally, majority of participants agreed or strongly agreed that they would save both time (n=141, 57.32%) and money (n=138, 56.1%) by opting for follow-up care at the VC (Figure 3).

DISCUSSION

Our study indicates that a majority of the study participants with stable glaucoma are willing to opt video-based telemedicine for their follow up appointments, with preference for the vision Centre model over virtual clinic or self-testing at home. Telemedicine is presently employed in ophthalmology for diabetic retinopathy (Ramasamy et al., 2021) and retinopathy of prematurity (ROP) (de Campos-Stairiker et al., 2023) but, it’s use in glaucoma care is still evolving. User attitudes are crucial in facilitating its adoption. This study found nearly 83% willing to use telemedicine, with around 66% preferring video consultations.

Glaucoma requires lifelong follow-up to preserve vision and quality of life, but patient loss to follow up remains a challenge, with nearly one-third of the patients dropping out even in developed countries. (Killeen et al., 2020; Williams et al., 2023) Barriers include the travel distance, travel expenses and lack of escort (Killeen et al., 2020). This study reveals that telemedicine has the potential to overcome these issues, with 70% reporting no need for escorts if using VCs and most agreeing it saves time and money. Nearly 80% rated VC services as good.

In our study, approximately one-third (33.33%) of the patients had knowledge on telemedicine. A similar study by Rhodes et al., (2019), focused on patients' perceptions of telemedicine, researchers focused on older glaucoma patients (≥60 years), around half of whom were African and the other half of European descent. Although the demographics of the participants are different from our study, our results align with that of Rhodes et al., with a similar rate of awareness on telemedicine at around 30%. In the same study, about 40% were willing to receive a remote medical diagnosis and around 30% were neutral. If we consider those who answered neutrally as being potentially persuadable to receive a remote diagnosis, the percentage of individuals willing to be screened through telemedicine is similar between Rhodes' study and current study, both at around 70%. This suggests a broad willingness to utilise telemedicine for glaucoma screening and follow up care, regardless of geographic and demographic differences.

Notably, the authors found no difference between genders in the awareness of telemedicine and associated technologies. This shows that women in Southern India are equally aware as men of the technologies mentioned in current study. Telemedicine was preferred by the participants as they were less likely depend on others for escort and transport and they could save both money and time. There was a noticeable difference in knowledge between the socio-economic classes, so it is integral that when implementing telemedicine screening methods, the authors consider the lack of knowledge and accessibility between the lower socio-economic classes and the higher ones. The study by Rhodes et al., (2019) provided a heavy framework for present study, but cannot fully be applied to India due to differences in socio-economic culture, average age of glaucoma patients, and a difference in race and education rates.

Previous studies, like the one by Killeen et al., (2020), have explored barriers to glaucoma treatment in South India, focusing on adherence. This study found that 93% of their study participants were non-adherent to glaucoma medication, and about half were late for follow-up. Common barriers to adherence included difficulty in obtaining drops, being busy, and expenses. Additionally, many missed appointments because of distance and having no escort. These findings highlight that multiple factors contribute to glaucoma treatment barriers, and distance is not always the main cause. Patients' negligence with medicine is also a commonality. However, present study has shown that a majority of the participants were willing to have their follow-up appointment at a VC closer to them, addressing some of the barriers. While telemedicine might not be able to solve all the issues surrounding the adherence to anti glaucoma medications, which is an educational issue, based on available evidence the authors believe that utilizing telemedicine in VCs can greatly reduce common barriers to glaucoma treatment adherence.

Respondents expressed concerns about using telemedicine, including missing direct contact with health care providers, potentially having some complaints go unaddressed, possibly having a lesser understanding of their disease, not receiving the same quality of care, and facing challenges with devices and technology. The greatest concern (82.78%) was about using devices/technology, possibly due to the

older age group and lower education levels. Nonetheless, 82.52% were willing to use telemedicine for glaucoma follow-up care, as its advantages, such as reduced dependence on escorts and saving time and money, outweighed these concerns.

The strengths of present study lie in its execution with a substantial sample size of patients at a tertiary care centre, encompassing patients with a variety of conditions from simple to more complex, adding depth to the findings. Some of the patients had access to both VC with telemedicine facilities and in-person examinations at the base hospital. They would have a comprehensive understanding of the advantages and disadvantages of both approaches.

There are certain limitations to our study. It exclusively focuses on the South-Indian population, potentially restricting the generalisability of findings to the rest of the world. Additionally, the assessment of glaucoma severity relied solely on the CDR, which might impact the strength of the association between glaucoma severity and willingness towards telemedicine. Although fields were not uniformly available for all the study participants on the day of recruitment, stable patients were carefully selected based on the recent fields. As the questionnaire was administered by a study coordinator, interviewer bias may have influenced responses due to perceived expectations and phrasing of explanations. Moreover, participants may have provided some socially desirable answers giving rise to response bias. In future studies, these biases can be minimised by using a self-administered anonymous questionnaire.

CONCLUSION

The findings of this study sheds light on the knowledge, preferences, and predispositions of glaucoma patients towards telemedicine for follow-up care, addressing a critical gap in literature. While awareness of telemedicine among the participants was limited, a significant percentage expressed willingness to adopt it. Socio-economic status influenced telemedicine awareness while, gender was not found to be a significant determinant of telemedicine preference. Patients perceived the advantages of telemedicine, such as improved accessibility and reduced waiting time, but also expressed concerns such as challenges in using technology and lack of direct contact with health care providers. Furthermore, Vision Centres were well accepted with high satisfaction and preference for follow up visits.

The consensus among participants regarding the advantages of telemedicine, especially the vision Centres, underscores its potential to revolutionise follow up care for stable glaucoma patients. As telemedicine continues to evolve, it is crucial to understand and address patient perspectives to ensure its successful integration into mainstream health care. Our findings provide valuable insights to consider decentralizing care for stable glaucoma patients, potentially addressing the barriers to follow-up and facilitate high risk follow-up at tertiary care Centres. However, further research is needed to assess the quality of care and patient satisfaction with the telemedicine services.

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