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Glaucoma

Making better use of patients' time: feasibility of performing self-administered vision assessments in waiting rooms

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BACKGROUND: Patients often spend significant time in clinic waiting rooms. This study assessed the feasibility of using this "wasted" time to perform self-administered vision assessments directly within the waiting area.
METHODS: Glaucoma patients attending routine appointments were asked to complete either a pen-and-paper (SpotChecks) or digital (PopCSF) contrast sensitivity (CS) test. Ambient illuminance, background noise, and crowd levels were recorded to assess potential environmental confounds. Test durations and patient feedback were recorded. Visual-Functioning Index-7 (VF-7) and Pelli-Robson CS (reference) test results were collected for comparison.
RESULTS: Of 173 patients approached, 155 (89.6%) agreed to participate, and 151(97.4%) participants completed testing before their appointment (77/78 pen-and-paper; 74/74 digital). Environmental factors had no significant impact (all $P > 0.05$). Median completion times were 3.0 {2.6–4.5} minutes (pen-and-paper) and 2.5 {2.0–3.5} minutes (digital). Age did not impact the pen-and-paper test duration ($P = 0.944$) but weakly correlated with the digital test duration ($r_{digital} = 0.27$, $P = 0.020$). Functional CS scores correlated with Pelli-Robson reference measurements ($r_{pen\text{-}and\text{-}paper} = 0.81$; $r_{digital} = 0.62$), age ($r_{pen\text{-}and\text{-}paper} = -0.58$; $r_{digital} = -0.37$), logMAR visual acuity ($r_{pen\text{-}and\text{-}paper} = -0.42$; $r_{digital} = -0.44$), and visual field mean deviation scores ($r_{pen\text{-}and\text{-}paper} = -0.54$; $r_{digital} = -0.63$). Both tests were highly acceptable to patients (> 80% on all questions). Visit durations were longer for participants (109 vs 88 min, $P = 0.007$), but this was attributed to consenting and related research activities rather than the tests themselves.
CONCLUSIONS: This proof-of-concept study demonstrates that it is feasible for patients to self-administer portable vision tests in clinic waiting rooms. Using CS as a representative example, this approach may enable additional data collection, potentially improving patient management, clinic flow, and/or patient satisfaction.

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INTRODUCTION

Ophthalmology patients often spend considerable time sitting in waiting rooms. For example, one audit in Ohio, USA, found that ophthalmology patients spend on average 80–106 min in waiting rooms [1]. Similarly, Moorfields Eye Hospital (the UK's largest specialist eye centre) advises patients that: *"Depending on the number and type of tests you require, you might need to stay at the hospital or clinic for up to two or three hours"* [2]. These waiting times are only likely to increase as populations age. In the UK, ophthalmology is already one of the busiest outpatient services, and the number of appointments is projected to rise from 7.5 million in 2022 to 9.0 million (a 20% increase) by 2030 [3–5].

Long waiting times are strongly associated with patient dissatisfaction [6–8], but are conventionally seen as a necessary burden. However, we argue that they also present an opportunity, as this time could potentially be used to perform productive, clinically relevant activities. Previous research has explored whether this waiting time could be used to collect quality-of-life questionnaire data or deliver general and ocular health education [9–12]. In ophthalmology, waiting room time has been used to test patients with diabetic macular oedema on tablet-based simulations of everyday tasks such as facial discrimination and visual search [10]. The present study aimed to assess the feasibility of conducting quick, self-administered functional vision tests directly within clinic waiting rooms.

Contrast sensitivity (CS) was selected as an illustrative measure for this initial pilot. Since, unlike visual acuity, CS is not already routinely assessed, it might provide additional useful information as noted in previous literature [13, 14]. CS tests are also less dependent on stimulus viewing distance, making them a

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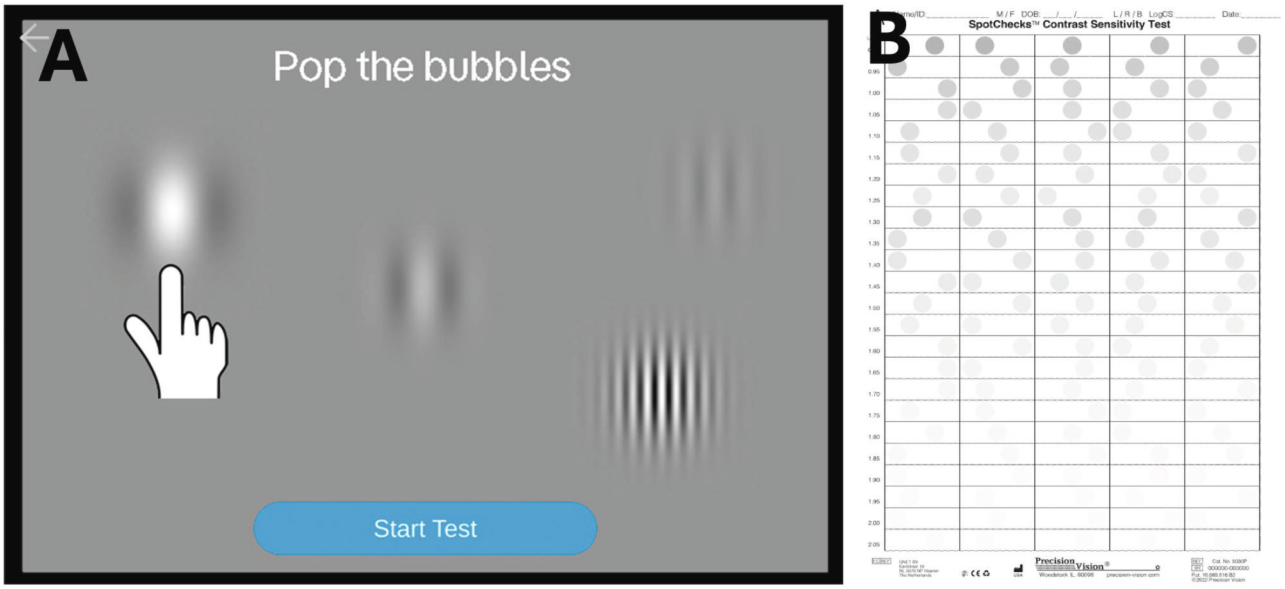


Fig. 1 Images of the digital and pen-and-paper CS measures. A Digital (PopCSF) test **B** Pen-and-paper (Spotchecks) test.

pragmatic choice to use in spaces with a constrained floor area. Additionally, early changes in CS have been reported within glaucoma patients [15–22], as well as across a range of other ophthalmic conditions including central serous chorioretinopathy [23], optic neuritis [24], cataracts [25], AMD [26, 27], diabetic retinopathy [28], retinitis pigmentosa [29] and amblyopia [30], making it a potentially useful tool for diagnosis and patient monitoring [20, 23, 24]. CS has also been proposed as a functional endpoint in glaucoma clinical trials, including neuroprotection research, where standard automated perimetry may lack sufficient sensitivity to detect early functional change [31–33]. Note, however, that this study is not designed to evaluate the clinical utility of CS testing or its impact on glaucoma management. The present study focused on the feasibility of self-administered vision testing in waiting rooms in general, rather than the specific benefit/utility of CS testing.

A glaucoma clinic was chosen for this study because glaucoma services are among the busiest outpatient services (20% of all outpatient ophthalmology services [34]), and so any efficiency gains would have a sizeable impact.

METHODS

Ethics

This study was approved by the UK Health Research Authority (Reference number: #24/PR/0038 Research Ethics Committee 24/WS/0012) and adhered to the tenets of the Declaration of Helsinki. Informed consent was collected from all participants.

Recruitment: participants

The clinic and its workflow. Data were collected between May and August 2024 at the Moorfields Eye Centre at Bedford Hospital (South): a busy tertiary eye department in suburban south-east England containing various sub-speciality clinics running in parallel. All testing was performed in the virtual glaucoma clinic. This technician-led clinic lasts four hours, operates three times a week, and typically sees ~87 patients/week (~ 29 per clinic). The waiting room has a seating capacity for ~70 people. (see Supplemental Figure S1 for photographs of the waiting room). Patients attending the clinic routinely undergo eye health history taking, distance visual acuity assessments (Thomson Test Chart, Thomson Software Solutions, UK), IOP measurement (Ocular Response Analyser, Reichert Technologies, New York, USA), visual field assessments (Humphrey Field Analyser, Zeiss, California, USA), and Optical Coherence Tomography (OCT, Topcon Medical Systems, Oakland, USA, and Carl Zeiss Meditec AG, Germany).

Study inclusion criteria. Patients were screened for study eligibility a day before their appointment by the on-site research nurses (Authors RW and BR). Inclusion criteria were broad and consisted of: (a) suspected or confirmed glaucoma; (b) attending a routine follow-up appointment; (c) visual acuity of 6/18 in at least one eye; and d) the ability to provide informed consent. The better eye (in terms of visual acuity) was selected for the study, and the fellow eye was patched. The better eye was chosen to reflect the closest approximation of the patient's real-world functional vision for the purposes of this initial feasibility study. If both eyes had equal visual acuity, the eye was chosen at random.

Study protocol

Overview. Participants were randomly assigned to one of two functional CS tests to complete directly within the waiting room (i.e., patients remained seated in the chair they had originally selected upon entering the clinic). Randomisation was performed using a random number sequence generated in Microsoft Excel (RAND function, Microsoft Corporation, Redmond, USA). Half were given a pen-and-paper CS test: Spotchecks (Precision Vision, Woodstock, Illinois, USA). The other half were given a digital, tablet-based CS test: PopCSF (Irida Health, London, UK). Details of both tests are given below. In both cases, participants were encouraged to wear their habitual near-vision spectacles during testing.

In addition, in order to check that the self-administered CS test was completed successfully, all participants were also asked to perform a Pelli-Robson CS assessment [35] at a 1 m distance for comparison (the Pelli-Robson chart being the closest available "reference measure" for CS). Participants were questioned about their vision and its impact on their vision-related quality of life, using the Visual-Functioning Index-7 (VF-7) questionnaire [36]. The VF-7 questionnaire was chosen because it was quick to administer (7 questions) and asked questions about activities impacted by loss of contrast sensitivity (driving, for example). Unlike the CS tests, these additional tests (Pelli-Robson, VF-7) were completed not in the waiting room itself, but in a small annex nearby (due to the need for privacy and a 1 m viewing distance).

At the end of the session, participants were also asked to rate the acceptability of the functional CS test using a custom survey comprised of nine questions (see Supplemental Material S2).

PopCSF (The digital test). PopCSF (Fig. 1A) is a gamified tablet-based functional CS test, described previously elsewhere [37–39]. In brief, the test displays Gabor patches ("bubbles") composed of black-and-white

Table 1. Clinical and demographic information of the participants based on their current visit.

	Total (%) (*N* = 151)	Pen-and-Paper (*N* = 77)	Digital (*N* = 74)
Sex			
Female	78 (52)	37 (27)	41 (25)
Male	73 (48)	40 (26)	33 (22)
Age (years)			
40–49	3 (2)	2 (1)	1 (1)
50–59	7 (5)	5 (3)	2 (1)
60–69	36 (24)	16 (11)	20 (13)
70–79	54 (36)	27 (18)	27 (18)
80–89	40 (26)	20 (13)	20 (13)
≥90	11 (7)	7 (5)	4 (3)
Glaucoma diagnosis of the tested eye			
Open-angle glaucoma	42 (28)	20 (13)	22 (15)
Angle-closure glaucoma	19 (13)	10 (7)	9 (6)
Glaucoma suspect	42 (28)	23 (15)	19 (13)
Awaiting diagnosis	22 (15)	12 (8)	10 (7)
Ocular hypertension	23 (15)	10 (7)	13 (8)
All other types of glaucoma	3 (2)	2 (1)	1 (1)
Ethnicity			
White/Caucasian	109 (72)	59 (39)	50 (33)
Indian	4 (3)	1 (1)	3 (2)
Black	3 (2)	2 (1)	1 (1)
Not specified	32 (21)	15 (10)	17 (11)
Mixed	1 (1)	0 (0)	1 (1)
East Asian	2 (1)	0 (0)	2 (1)
Glaucoma severity (HPA classification*)			
No visual field damage	53 (35)	26 (17)	27 (18)
Borderline	23 (15)	13 (9)	10 (7)
Mild	30 (20)	16 (11)	14 (9)
Moderate	25 (17)	14 (9)	11 (7)
Severe	15 (10)	5 (3)	10 (7)
Unreliable VF report	5 (3)	3 (2)	2 (1)
Glaucoma stability			
Stable	132 (87)	68 (45)	64 (42)
Unstable	18 (12)	8 (5)	10 (7)
Awaiting review	1 (1)	1 (1)	0 (0)

***HPA classification** – Hodapp-Parrish-Anderson Criteria for glaucoma classification.

gratings of variable spatial frequency and contrast, presented against an isoluminant grey background. Participants were asked to "pop" these Gabor patches by pressing them. No strict viewing instructions were imposed (viewing distance was corrected for in near-real time using the tablet's integrated near-infrared distance sensor). The test was performed on an Apple iPad Pro 2 11" (Apple Inc., Cupertino, CA, USA). The primary outcome measure was the observer's contrast sensitivity function, from which we extracted the peak (G_{max}) expressed in units of log CS, for consistency with SpotChecks.

Spotchecks (The pen-and-paper test). Spotchecks (Fig. 1B) are a successor to a previously described CS test called "CamBlobs" [40]. Spotchecks have been validated in children and healthy adults [39, 41, 42], though formal validation in a glaucoma clinic population has not yet been conducted. It consists of a single sheet of A4 paper containing dots of decreasing contrast. Patients are asked to mark the dots using a pen, and their sheet is scored based on the number of dots correctly identified. The primary outcome measure is LogCS score, for which a higher score is better, and a normally sighted person aged between 50 and 84 would be expected to score around 1.8 LogCS [41].

Patient assessment-of-test acceptability

After testing, participants were asked to rate the acceptability of their randomly assigned test (PopCSF or SpotChecks) and of their overall waiting room testing experience, using a nine-item survey using a five-point Likert scale (5=strongly agree, see Supplemental Material S2 for the complete survey).

Impact of the clinic's human and non-human environment

Ambient illuminance in lux (Aoputtriver AP-881D; Zhuhai, Guangdong, China), auditory noise levels in dB_{SPL} (Type 2236 Sound Level Meter; Bruel and Kjaer, Denmark), and the number of other people in the waiting room were recorded to assess the possible impact of these environmental factors on the task. We also compared the total time taken for their visit ("visit duration") of participants and non-participants, who had similar arrival times and visit durations, using timestamps from the reception desk. Non-participants were defined as patients in the clinic who were not recruited into the study, either due to declining to participate or not being approached due to limited research personnel.

Statistical analysis

Analyses were performed using a combination of Microsoft Excel (Microsoft Corporation, Redmond, USA), GraphPad Prism Version 10.3.0 (GraphPad, Boston, USA), and R version 4.1.2 (R Foundation for Statistical Computing, Vienna, Austria). The sample size was not formally calculated as the study was planned as a pilot/feasibility study with unknown effect sizes. Completion rates and patients' clinical and demographic information (sex, ethnicity, age, diagnosis type, disease severity, and stability) were tabulated and compared between CS measures using independent-samples t-tests or one-way ANOVAs, as appropriate. Differences in environmental factors (illuminance, noise, crowd) were compared using the Mann-Whitney *U* test or the Kruskal-Wallis *H* test. The functional CS scores and clinical parameters were correlated using Pearson's correlation test. Visit durations were tested for statistical significance using the Mann-Whitney *U* test. Acceptability proportions were compared using percentages and compared statistically using the Chi-square test. Statistical significance was set at $P < 0.05$. In appropriate cases of multiple comparisons, statistical significance was adjusted using the Bonferroni correction method to avoid the risk of Type I error inflation.

RESULTS

Participant profiles

Clinical and demographic data for all participants are given in Table 1. Most (69%) participants were 70 years or older, half (52%) were female, and most (72%) identified as White. At the time of their clinical appointment, most patients either had a diagnosis of primary open-angle glaucoma (28%) or were glaucoma suspects (28%); 35% did not show visual field damage, and 87% were considered stable by their consulting ophthalmologist.

Feasibility: completion rates

A total of $n = 173$ patients were approached, of whom $n = 155$ (89.6%) agreed to participate. Patients (10.4%) declined to participate due to several factors, including difficulty hearing, limited understanding of English, mobility concerns (i.e., consent took place in a separate room for ethical concerns), and undisclosed personal preferences.

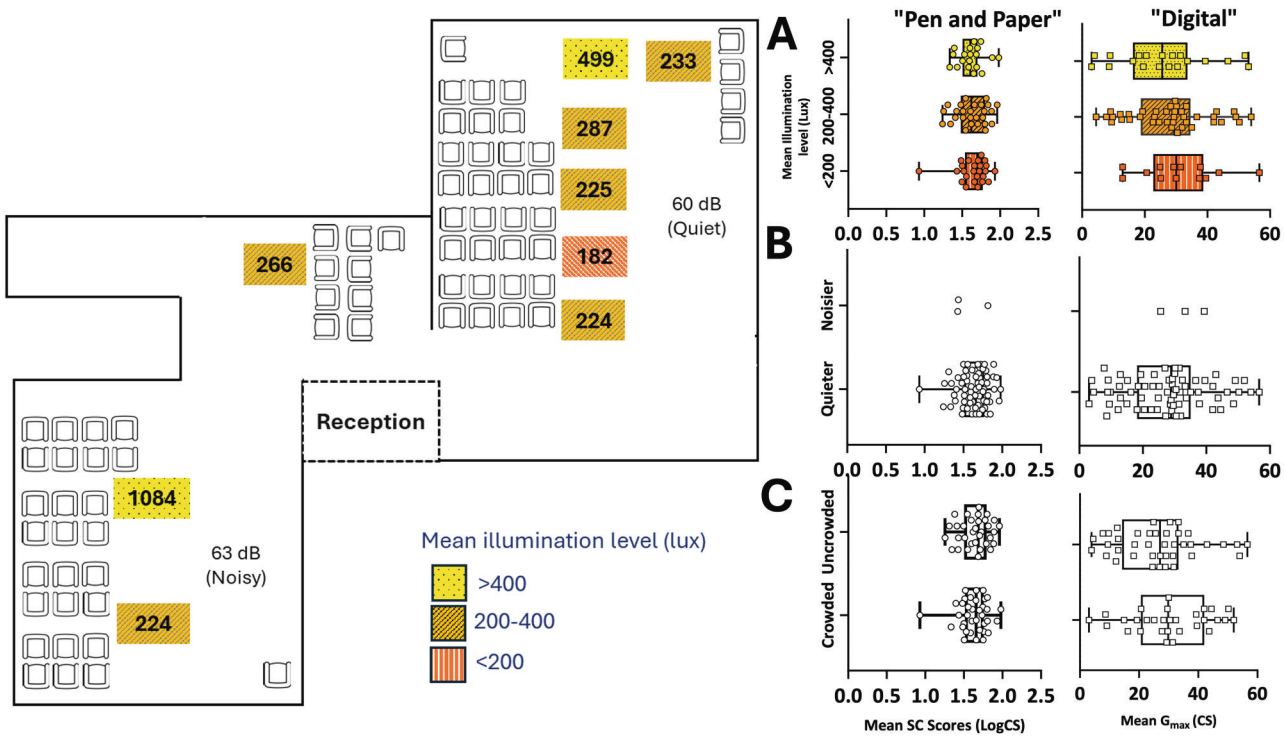


Fig. 2 Resilience of the pen-and-paper (SpotChecks) and digital (PopCSF) functional CS test to differences in illuminance levels, auditory background noise, and crowd size (number of other patients in the room). A Illuminance: The waiting room was divided into three zones: Zone 1 (< 200 lux), Zone 2 (200-400 lux), Zone 3 (> 400 lux). **B** Background Noise: Most patients underwent testing on the right side of the waiting room, which had a mean noise level of 60 decibels. **C** Crowdedness: The number of people in the waiting room was recorded each time a patient performed the functional CS test. The waiting room was considered "crowded" when there were more than the mean (nine people) during the test.

Of the $n = 155$ participants who agreed to participate, 151 (97.4%) successfully completed their assigned CS test. Specifically, 77/78 (98.7%) completed the pen-and-paper test, 74/74 (100%) completed the digital test, and 3 participants were called into their scheduled appointment before either CS test could be assigned. The one participant who failed to complete the pen-and-paper test did so due to limited comprehension of spoken English, which meant that they struggled to understand the test instructions.

Feasibility: demographic factors

Table 1 presents the clinical and demographic information of the participants based on their current visit. No group differences in mean CS scores were observed between participants based on their sex (Mann-Whitney U test; $P_{pen\text{-}and\text{-}paper} = 0.163$, $P_{digital} = 0.072$), ethnicity (Kruskal-Wallis H Test; $P_{pen\text{-}and\text{-}paper} = 0.378$, $P_{digital} = 0.381$), or stability of their condition (Mann-Whitney U test; $P_{pen\text{-}and\text{-}paper} = 0.663$, $P_{digital} = 0.793$).

However, as one would expect, differences in mean CS scores were noted between participants based on their age (Kruskal-Wallis H Test; $P_{pen\text{-}and\text{-}paper} < 0.001$, $P_{digital} = 0.026$), glaucoma severity (Kruskal-Wallis H Test; $P_{pen\text{-}and\text{-}paper} < 0.001$, $P_{digital} = 0.005$), and diagnosis type (glaucoma, glaucoma suspect, etc.) (Kruskal-Wallis H Test; $P_{pen\text{-}and\text{-}paper} = 0.690$, $P_{digital} = 0.006$), though the latter only reached statistical significance for the digital test. No further adjustments were made for age, type of glaucoma, or disease severity, as this feasibility study was not designed or powered to assess the influence of these variables on CS outcomes.

Feasibility: resilience to environmental factors

We investigated the effects of illuminance, noise, and crowd levels in the waiting room to understand the potential impact of environmental factors on test performance. As shown in Fig. 2A, B, C, none of these environmental factors had any significant impact on group mean log CS score, either for the pen-and-paper test or digital test (all $P \geq 0.232$; see Supplemental Table S3 for statistics). There was also no difference in group mean CS scores based upon the time of day (morning versus afternoon, $P = 0.462$).

Feasibility: correlation with the standard clinical tests

Figure 3 shows the correlations between each of the two CS tests and various other factors, such as the Pelli-Robson test, participant age, mean deviation scores (a visual field metric relevant in glaucoma), and distance logMAR visual acuity. The Pelli-Robson test, age, visual acuity in LogMAR, and mean deviation (in decibels) showed a statistically significant relationship with the two tests individually. The pen-and-paper test ($r_{pen\text{-}and\text{-}paper} = 0.81$, [$CI_{95}$: 0.71,0.88], $P < 0.001$) correlated significantly more (z-statistic=2.36, $P = 0.018$, Fisher's r-to-z test) with the Pelli-Robson than the digital test ($r_{digital} = 0.62$, [CI_{95}: 0.45,0.74], $P < 0.001$). However, this effect ceased to be statistically significant after using Bonferroni correction to correct for multiple ($n = 4$) comparisons ($P > 0.0125$). Non-overlapping 95% confidence intervals and non-significant Fisher's r-to-z results across the other parameters (Age, VA, and MD) indicated no significant differences between the correlation coefficients of the two tests (all $P > 0.05$).

Feasibility: patient acceptability

Patient feedback was largely positive. Most participants found both tests enjoyable (pen-and-paper/digital: 82%/81%) and understood the tests well (99%/96%). When questioned about their experience in the waiting room, most felt comfortable (87%/92%) doing the tests in the waiting room and found it to be a beneficial use of their time (97%/95%).

For 4 of 5 acceptability questions, there was no significant difference in the between-subject ratings for the two tests (all

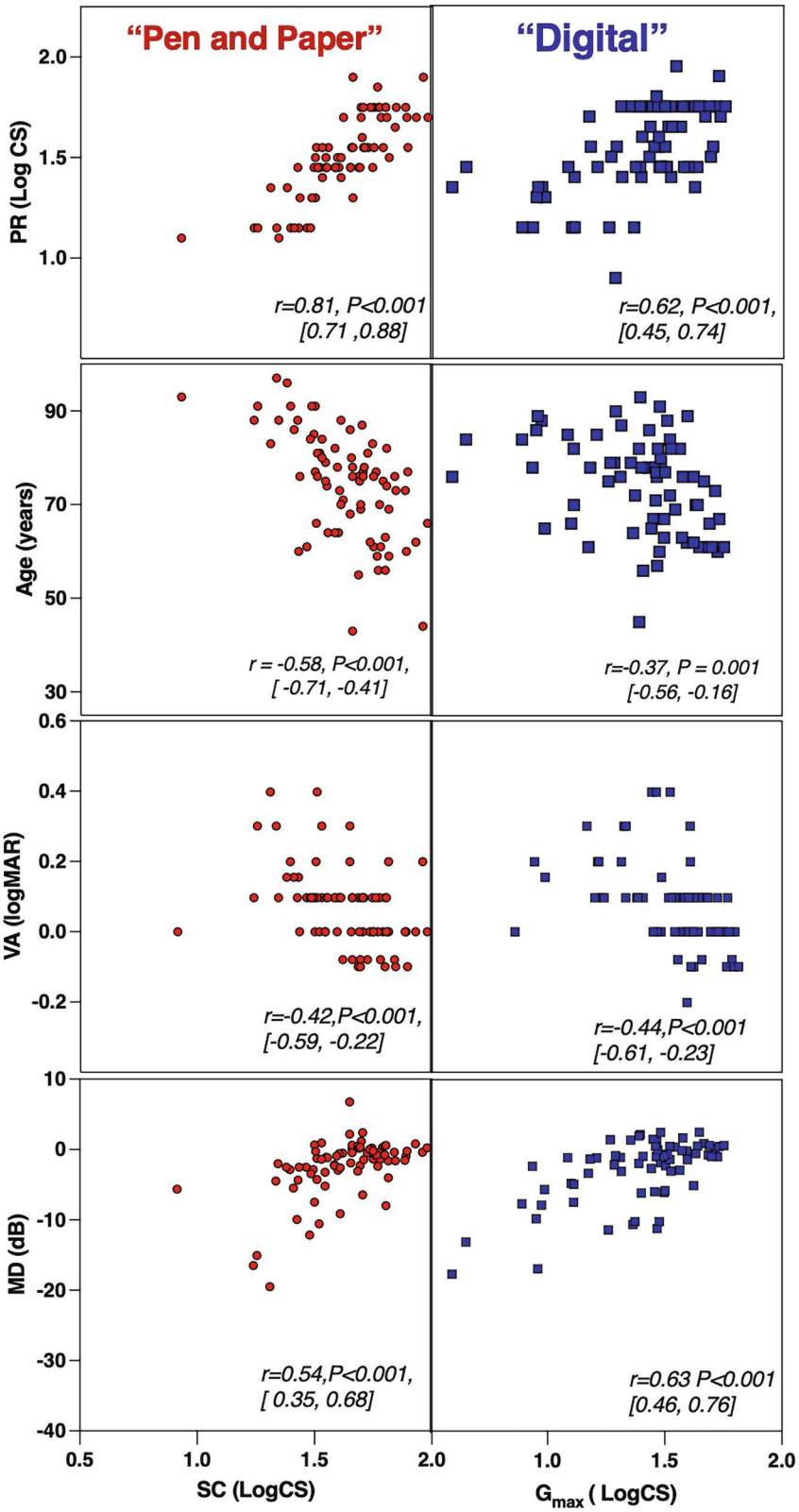


Fig. 3 Correlations between the two waiting-room tests (pen-and-paper test and the digital test) and the current contrast sensitivity measure, the Pelli-Robson (PR) contrast sensitivity test, distance letter acuity (logMAR), age (years), and the visual field loss measure (Mean deviation [MD]). Numbers show the Pearson's rho coefficient(r), their 95% confidence intervals in square brackets and their respective p-values.

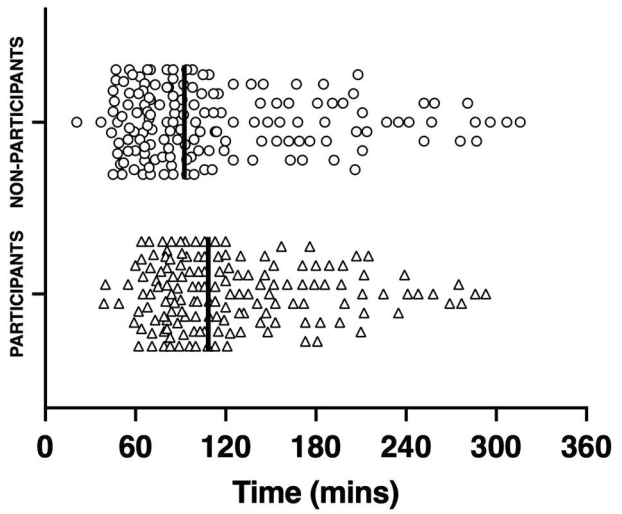


Fig. 4 Total time spent in the clinic (visit duration) by study participants (triangles,109 min) and non-participants (circles, 88 min). Vertical black lines show the median time for each group. As described in the main text, the total time spent by the two groups differed significantly ($P = 0.007$, Mann-Whitney U test).

$P > 0.05$, Chi-square). However, for the "ease to perform the test" statement, participants were more likely to agree that the pen-and-paper test was easy to perform (96%) than digital test users (84%, $P = 0.011$, *Chi-square test*, odds ratio: 4.79,[1.41,16.34]).

No adverse events were encountered for either test. Several patients anecdotally reported that they enjoyed speaking to someone and that the CS assessments were a welcome diversion. See Supplemental Fig. S4 for the graphical presentation of this data.

Time costs

Including time taken to explain how the test works, median {IQR} completion times were 3.0 {2.6–4.5} mins for the pen-and-paper (Spotchecks) test, and 2.5 {2.0–3.5} mins for the digital (PopCSF) test. Completion times for both were associated with visual-field mean deviation, logMAR visual acuity, and Pelli-Robson contrast sensitivity (all $P > 0.05$). Age did not influence the pen-and-paper test duration ($P = 0.943$). However, it showed a weak yet significant association with the digital test duration ($r_{digital} = 0.27$, [0.05, 0.47], $P = 0.020$). Based on linear regression ($r^2 = 0.07$, *Slope* = 0.84, *Y-Intercept* = 70.16, $P = 0.020$), test duration increased approximately 1 second/year, with an 80-year-old patient typically taking ~17 s (13.8%) longer compared to a 60-year-old patient.

To understand the potential impact of waiting-room testing on clinic flow, we analysed the total time of the patient's visit. Figure 4 shows the median visit duration for both participants (109 min {IQR = 83.5–153}) and for patients who attended the clinic without participating in the study, i.e., non-participants (93 min, {IQR = 67–154}). This difference was statistically significant ($P = 0.007$), indicating that participants spent a longer duration in the clinic than non-participants. Retrospectively, after excluding the time taken for these research-related activities (consenting, the VF-7 questionnaire, the Pelli-Robson test, and the post-study patient assessment of test acceptability survey), there was no difference ($P = 0.562$, Mann-Whitney *U* test) between the median visit duration of non-participants (93 min, {IQR = 67–154}) and participants (Median=90 min, {IQR = 67–132}).

DISCUSSION

Summary of the study

This pilot study investigated the feasibility of utilising otherwise "wasted" time in ophthalmology waiting rooms to have patients self-administer additional vision testing. The results showed that both pen-and-paper and digital contrast sensitivity (CS) tests were quick (2.5–3 mins), could be feasibly completed by most patients (97.4% completion rate), were acceptable to patients (> 80% positive feedback on all questions), and were relatively resilient to anticipated variations in illuminance, noise levels, and clinic crowdedness (all $P > 0.05$). Encouragingly, the tests correlated with various demographic and clinical parameters, such as age, Pelli-Robson contrast sensitivity, visual acuity, and visual field mean deviation, suggesting the data may be clinically meaningful; this is different from being clinically valuable.

Conversely, 2.6% of participants were unable to complete the test (primarily due to a lack of time prior to the appointment), and 11.4% of patients in the waiting area declined to participate, in part for reasons relating to language barriers that might also have impeded their ability to do the tests. These are important feasibility barriers that would need to be carefully considered; however, such cases are also encountered in regular clinics where the data is indeterminate or unobtainable. The financial costs associated with these tests were also not trivial and would need to be carefully considered (*see 4.4. Financial Costs*, below).

Comparisons with previous findings

The current study used CS testing as a representative example; however, a similar protocol could be applied to other productive uses of waiting time, such as condition-specific awareness or patient education initiatives. Several healthcare-related studies have shown that time spent waiting for routine appointments can be utilised to benefit both patients and clinicians [9–11, 43]. Within Ophthalmology, waiting time has been used in a study to educate patients about eye conditions [12], specifically about glaucoma; however, the US-based study did not find any positive impact of that exercise on patient satisfaction [12]. Their study was conducted in the waiting rooms of general eye clinics and did not specifically target glaucoma patients. This suggests that patient satisfaction from an 'intervention' in the waiting area may depend on various factors, including the clinical setting, patient demographics, and the nature of the intervention.

Beyond ophthalmology, Spoladore et al. (2024) conducted a systematic review of "smart" waiting rooms, which included studies that focused on enhancing the waiting room experience and on pre-visit data acquisition, such as collecting vital-sign measurements (e.g., blood pressure, heart rate) in waiting areas. This review concluded that it was feasible to use waiting rooms as a data collection point, consistent with our present results. In particular, they found no significant safety or workflow barriers. However, they did acknowledge the organisational and integration hurdles, which is partially consistent with our study, as we had no safety, integration or organisational concerns, but our patients did take longer, ultimately impacting workflow [44]. Similarly, studies performed in paediatric, obstetric, and general hospital populations have shown that testing in waiting rooms is feasible, fast, and acceptable to patients, provided patients receive adequate guidance [45–47]. We compared our CS test results with routine clinical data, such as visual acuity, MD, etc., to look for their clinical relevance in our sample of glaucoma patients. Both CS tests showed a similar but somewhat weaker correlation with visual acuity than those reported by Hawkins et al. ($r = 0.57$), who measured CS using the Pelli-Robson test in glaucoma patients [15]. Both CS tests also showed a moderate correlation with MD, in agreement with existing literature on how CS is well associated with field defects in glaucoma patients [15, 48–50]. While these findings suggest that these novel CS tests may capture clinically relevant information, the present study was designed only to assess feasibility (not utility), and further work is needed to determine how such results would inform clinical decision-making in routine practice.

Impact of the tests on clinical efficiency and wait times

Hospital visit durations are often a measure of the efficiency of the hospital and significantly influence patient satisfaction [8] and patient anxiety [51]. However, our participants did spend longer on average in the clinic than non-participants, which raises concerns about efficiency. Patient-perceived waiting times are strongly correlated with the actual calculated waiting times but have a greater impact on patient satisfaction [52, 53]. Luo and Chu et al. also highlight how interactive or health-related tasks can help improve the waiting experience [54, 55]. In reality, while it may not be possible to eliminate waiting time in clinics, converting passive waiting into brief, meaningful activities like quick vision tests may enhance patients' care.

Financial costs

Hypothetically, we estimated that if one were to implement the digital tests and pen-and-paper tests in UK clinics routinely in the same way that they were administered in the present research study, this would cost the health service approximately £29,512 (digital) and £58,682 (pen-and-paper) per clinic. As detailed in Supplementary Table S5, these costs were mostly due to staffing. Thus, in the present study, although the functional CS tests themselves were self-administered, a healthcare professional distributed the test, explained the procedure, and was available in case the patient had questions or experienced any difficulties. If, however, the tests could be administered entirely autonomously without the need for a designated health-care professional, the costs drop by 53% for the pen-and-paper test (£2.07/patient) and by 93% for the digital test (£0.13/patient). Against this, however, patients specifically expressed that part of what they enjoyed about the testing was having someone to speak to while they waited. Note that the financial analysis presented is specific to the CS testing example and should be interpreted accordingly, rather than as a generalised cost model for all waiting room interventions.

Limitations and future research

The study design was intended to be pragmatic and reflective of real-world conditions. Anecdotally, however, the clinic waiting room selected was relatively quiet and orderly. A multicentre trial would be required to generalise to other ophthalmology referral clinics, and it would not be reasonable to generalise to other clinical settings, such as general emergency clinics (which often experience excessive noise, a lack of comfort and safety, and inadequate staff assistance when required [56–59]). The current study tested one eye only. However, future studies might consider testing both eyes (monocularly or binocularly) to reflect real-world conditions. The current study also did not adjust for potential confounding variables, including age, type of glaucoma, disease severity, and visual acuity. Future studies should be appropriately powered to assess the influence of these factors on CS outcomes in a waiting room setting.

The current study was also not designed to assess the clinical value of CS testing, and further testing is needed to determine whether its implementation in routine care would meaningfully impact patient care. In addition, future research could focus on patient groups beyond glaucoma, identify the specific tests that provide the most valuable information for clinicians, systematically evaluate the impact of such testing on patient satisfaction, and/or conduct a comprehensive cost-benefit analysis.

CONCLUSIONS

Testing in a waiting room using simple tests, like these functional CS tests, is feasible and can provide potentially valuable clinical data while patients wait for their appointments. These were acceptable to patients in a glaucoma clinic and could potentially support decision-making. Pursuing these tests incurs high costs for the clinic; therefore, careful consideration, especially in terms of staff availability and resource assessment, is crucial before implementation. If integrated well into the clinical workflow, performing similar quick tests may provide a way to provide additional data and potentially increase patients' satisfaction.

SUMMARY

What is known about this topic

- Patients often spend significant time in waiting rooms for their appointments. This "wasted" time is also a major source of patient dissatisfaction.

What this study adds

- Time in clinic waiting rooms could be feasibly used to collect additional contrast sensitivity data using two portable tests.
- Variations in light, noise, and crowding in the waiting room had no significant impact on the test results.
- Tests were quick to administer and produced results that correlated well with standard clinical tests.
- Patients had a strong willingness to participate; those recruited showed high acceptability of both the novel tests.

DATA AVAILABILITY

Anonymised data are available upon request.

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AUTHOR CONTRIBUTIONS

Rathore: Data collection, data analysis, study design, preparation of the original manuscript draft, editing the subsequent revisions, and submission of the manuscript. Founti: Study design, data collection, and manuscript review. Rethi: Data collection. Wulandari: Data collection. Raja: Data collection. Scott: Ethical approval and study support. Jayaram: Ethical approval and study support. Crabb: Study design, funding acquisition, and project supervision. Jones: Study design, data analysis, manuscript editing and review, and project supervision.

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COMPETING INTERESTS

The authors declare no competing interests.

ETHICAL APPROVAL

The study was approved by the Research Ethics Committee (REC) of the West of Scotland Research Ethics Service (Reference number: #24/WS/0012) and the Health Research Authority (Reference number: #24/PR/0038) at Bedfordshire NHS Trust.

ADDITIONAL INFORMATION

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