VRCare - Improving Diagnostic Eyecare Experience - An investigative Study

Yuvaraj Kumaresan*
National University of Singapore
Singapore

Aryan Arora†
University of Illinois at Urbana-Champaign
USA

Bhojan Anand‡
National University of Singapore
Singapore

Abstract

We present VRCare, a VR-based eye screening tool enabling remote, self-guided vision assessments for colour blindness, visual field, myopia, and contrast sensitivity. A user study with 33 participants evaluated usability, comfort, and perceived effectiveness. Participants rated the system highly for intuitiveness (4.45/5), ease of use (4.48/5), and comfort (4.27/5), with 91% willing to reuse the tool. Lower confidence in diagnostic accuracy (3.76/5) and reports of mild discomfort highlight the need for clinical validation and ergonomic refinement. Overall, findings demonstrate VR's potential for accessible vision screening outside clinical settings.

CCS Concepts

• **Human-centered computing** → **Virtual reality**.

Keywords

Virtual reality, Colour blindness, Field of vision, Myopia, Contrast sensitivity, Visual impairment, Diagnostic eye care

1 Introduction and Related Works

Over 2.2 billion people live with vision impairment, with at least 1 billion cases preventable or untreated [11]. Early screening for myopia, visual field loss, contrast sensitivity, and color blindness remains limited by specialist shortages, high costs, and access barriers. Virtual reality (VR) offers controlled 3D stimulus presentation, immersion, and portability, making it a promising platform for vision screening.

Existing tools are mostly non-VR or focused on training and education (e.g., NGENUITY®, ARTEVO®) [2, 3, 5]. We present **VRCare**, a proof-of-concept VR system integrating four tests—refraction, perimetry, contrast sensitivity, and Ishihara plates. Unlike prior approaches, VRCare is self-guided, runs on consumer headsets, and targets remote use. While clinical validation is future work, feasibility is demonstrated alongside known limitations (e.g., false positives, lack of monocular control).

*Both authors contributed equally to this research.
†Both authors contributed equally to this research.
‡Project supervisor

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Recent studies support VR's potential: VR perimetry has shown accuracy comparable to SAP with better tolerance [4, 9], while contrast sensitivity tests using optokinetic responses achieved strong reliability [10]. Other systems (e.g., VR-SFT [8], VisionaryVR [1]) focus on clinical diagnostics or simulation but face hardware constraints.

VRCare differs by prioritizing early, accessible screening. It lowers barriers to preliminary testing, encouraging users to seek professional evaluation when issues are detected.

2 VR System Design & Implementation

2.1 System Architecture

VRCare was built in Unity for the Meta Quest 3 with modular diagnostic tests (myopia, visual field, contrast sensitivity, color vision) managed by a central controller. This enables extensibility and streamlined data collection.

2.2 UX Design Principles

Design prioritized comfort and low VR sickness. Following Sensory Conflict Theory [6], users remain seated with no artificial motion. Based on Postural Instability Theory [7], tasks use central stimuli and stable fixation to limit movement. Lightweight rendering and stable frame rates reduce latency and artifacts.

2.3 Diagnostic Modules

Four immersive tests were implemented: **Field of vision:** detect peripheral deficits via randomized stimuli. **Myopia:** Snellen-style E-chart with adjustable clarity. **Contrast sensitivity:** letters with varying contrast (Pelli-Robson). **Color vision:** VR-adapted Ishihara plates estimating red–green deficiencies.

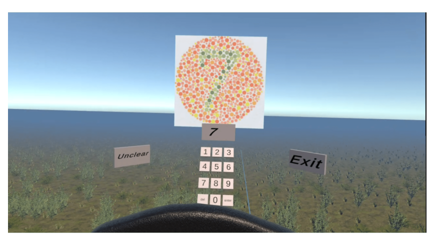

Figure 1: Color Vision Test

2.4 Visualization & Iterations

Simulated impairment views (e.g., color blindness) support awareness. Iterative testing added an "Unsure" option, clearer instructions, simplified inputs, and minimal visuals for comfort.

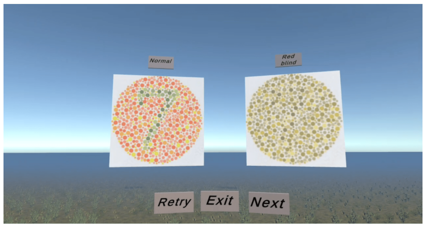

Figure 2: Color Vision Visualization

3 Evaluation Methods

We conducted a two-part user study with 33 participants at NUS during the 26th STePS event. A pre-survey collected demographics and VR familiarity, while a post-survey assessed usability, comfort, and perceived effectiveness via 5-point ratings and open feedback. Two team members facilitated and observed sessions. For three participants who recalled eyeglass prescriptions, myopia readings were compared against tool estimates for preliminary validation.

Participants were 66.7% aged 20–29, 18.2% aged 30–39, and 15.2% aged 40+. Gender distribution was balanced (51.5% male, 45.5% female, 3% undisclosed). Prior VR experience varied: 36.4% novices, 33.3% occasional, 30.3% frequent users.

4 Results

Average ratings (mean ± SD) were: Intuitiveness 4.45 ± 0.63, Ease of Use 4.48 ± 0.58, Clarity 4.35 ± 0.66, Feedback Usefulness 4.23 ± 0.72, Confidence in Accuracy 3.76 ± 0.97, and Comfort 4.27 ± 0.76. Users highlighted ease of use and intuitiveness, but showed lower trust in accuracy, reflecting the need for clinical validation.

For myopia, VR estimates closely matched recalled prescriptions: −2.00D vs −2.50D, −4.50D vs −4.75D, and −3.00D vs −3.25D. Deviations were within 0.5D, suggesting the tool provides reasonable approximations though not precise diagnostics.

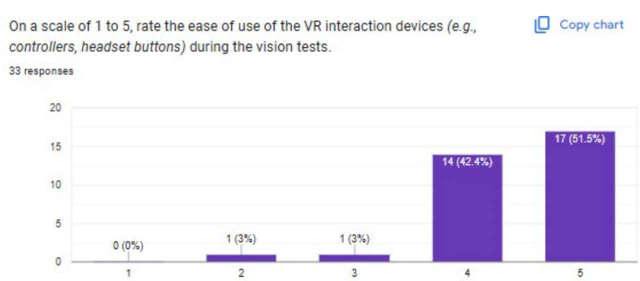

Figure 3: Ease of use distribution

4.1 Qualitative Feedback

Open-ended feedback highlighted areas for refinement. Users suggested clearer instructions (e.g., bold text, diagrams, voice-overs), simpler interactions (fewer clicks, larger keyboard), and improved UI design (higher contrast, consistent textures). Some requested extended tests and clearer result explanations. About 24% reported mild discomfort (eye strain, dizziness, or headset–glasses fit issues), though no severe problems occurred. Minor technical glitches (e.g., boundary view leak) were noted.

5 Acceptance and Limitations

Overall acceptance was high: 91% would reuse the tool, citing ease of use and comfort. Hesitancy (9%) stemmed from limited accuracy and preference for traditional exams. Limitations include modest diagnostic precision (e.g., myopia in 0.5D steps), small sample size (33 participants), and reported discomfort, highlighting the need for clinical validation and ergonomic refinements. We acknowledge that the test was done in an informal environment and further testing is required in controlled clinical settings with diverse patient populations to rigorously evaluate performance and reliability.

6 Conclusion

VRCare demonstrates feasibility as a self-guided, VR-based eye screening tool. While diagnostic accuracy and ergonomics require further work, strong usability ratings and positive reception underscore VR's potential for accessible, remote eye care.

Acknowledgments

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.1 Task survey links

https://docs.google.com/forms/d/e/1FAIpQLSf0XtZijZJW-xGjbCEGqqxP8_uT99D_tC6Xk989Uyj9u_3-IA/viewform
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