Exploring the Potential of Augmented Reality and Virtual Reality as a Diagnostic Tool for Glaucoma Screening in Ophthalmology

Author: Krishnika Vetrivel, Kings College London

KING'S College LONDON

Introduction

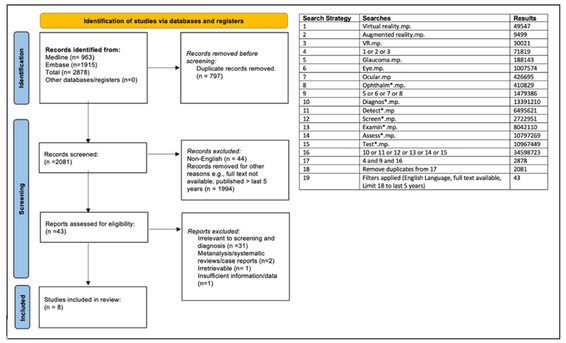
Glaucoma is one of the leading causes of irreversible blindness globally. Early detection is crucial. Yet, half of Glaucoma cases remain undiagnosed. The prevalence of glaucoma is projected to increase by almost 50% over the next 20 years. The burden of glaucoma care will therefore continue to grow. As a result, the demand for the provision of glaucoma care will likely exceed capacity. Current models of care are unsustainable. Hence, there is a need to look toward innovation in order to address the mismatch between capacity and demand. Whilst previous reviews have primarily focused on the application of virtual reality/ augmented reality (VR/AR) in Ophthalmology for education, surgical training and treatment, the potential of this technology as a diagnostic or screening tool is limited in current literature.

Aims: This review aims to provide an overview of the current state of research by exploring four key areas: limitations of existing screening tools, benefits and challenges of VR, the integration of VR with telemedicine and artificial intelligence (AI) for Glaucoma diagnosis, and future directions.

Scan the QR to find out more!

Methodology

A comprehensive search for original publications was conducted using the Medline and Embase databases. The initial search yielded 2878 studies, from which 8 relevant studies were identified. Publications' bibliography and cited references were also checked to ensure that all relevant articles were identified in this review. Original findings that adhered to the following criteria were included: regarding the use of VR or AR in diagnosis and screening in Glaucoma, English language, full-text available and published in the last five years. The included studies had a varying risk of bias and applicability, according to the QUADAS-2 evaluation. Specific keywords and Boolean operators were shortlisted.



Search Strategy	Searches	Results
1	Virtual reality.mp.	49547
2	Augmented reality.mp.	9499
3	VR.mp.	30021
4	1 or 2 or 3	71819
5	Glaucoma.mp.	188143
6	Eye.mp.	1007574
7	Ocular.mp	426695
8	Ophthalm*.mp.	410829
9	5 or 6 or 7 or 8	1479386
10	Diagnos*.mp.	13391210
11	Detect*.mp	6495621
12	Screen*.mp.	2721951
13	Examin*.mp.	8042110
14	Assess*.mp.	10797269
15	Test*.mp.	10967449
16	10 or 11 or 12 or 13 or 14 or 15	34598723
17	4 and 9 and 16	2878
18	Remove duplicates from 17	2081
19	Filters applied (English Language, full text available, Limit 18 to last 5 years)	43

Figure 1. Modified PRISMA flow chart depicting study identification and selection as well as search strategy used in Ovid and Embase databases.

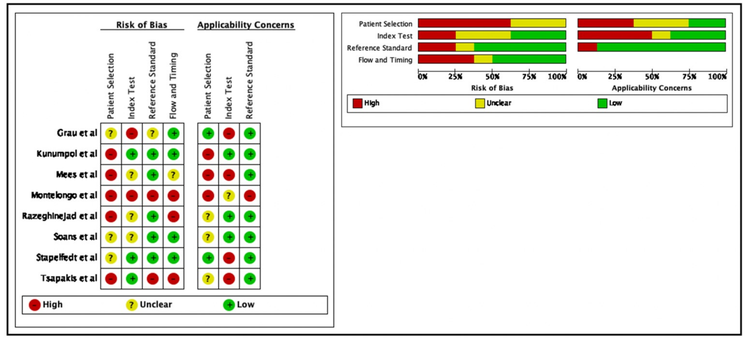


Figure 2. Risk of Bias and applicability concerns graph made using Revman software: judgements about each domain presented across included studies.

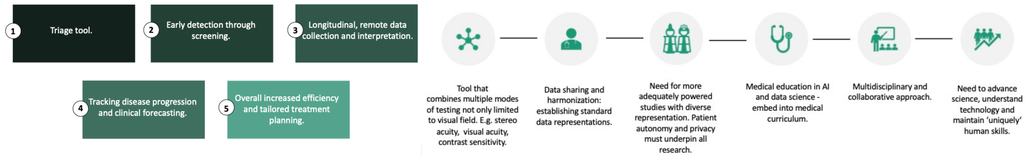
Results

VR offers advantages such as enhancing accessibility, improving disease management and reducing wait times. Integrating telemedicine and VR with AI offers the potential for remote collection of patient data, early disease detection, clinical forecasting, disease progression tracking, and optimized treatment planning. Nevertheless, potential limitations that hinder its incorporation into clinical practice include medico-legal considerations, data privacy concerns, unclear ground-truth, marketing- driven heterogeneity, underrepresentation of certain patient populations in AI models, limited external validation of studies and the 'black box' phenomenon.



Discussion

Glaucoma assessment is data rich. The diagnosis and follow-up of glaucoma are complex processes involving vast amounts of data, particularly with the extensive use of imaging modalities. This makes glaucoma a natural fit for the application of VR and AI. Future studies should investigate the accuracy and applicability of AR/VR in diagnosing glaucoma across diverse patient groups, including paediatric cases, encompassing different types and severity levels. VR and AI holds potential for streamlining Glaucoma diagnosis but necessitates collaboration, transparency and further research before seamless integration into clinical practice. Crucially, patient autonomy and privacy should underpin all research. Although these technologies have shown the potential to redefine the delivery of eye care, it should be regarded as a tool to aid clinicians instead of replacing them. In conclusion, the adoption of VR and AI into healthcare models may alleviate the existing limitations of access and timely management of patients with glaucoma globally.



References
1.Soh Z, Yu M, Betzler BK, Majithia S, Thakur S, Tham YC, et al. The global extent of undetected Glaucoma in adults. Ophthalmology. 2021;128(10):1393–404.
2.Camara J, Neto A, Pires IM, Villasana MV, Zdravevski E, Cunha A. A comprehensive review of methods and equipment for aiding automatic Glaucoma tracking. Diagnostics. 2022;12(4):935.
3.Li J-PO, Liu H, Ting DSJ, Jeon S, Chan RVP, Kim JE, et al. Digital Technology, Tele-Medicine and Artificial Intelligence in Ophthalmology: A global perspective. Progress in Retinal and Eye Research. 2021;82:100900.