

# BMJ Open Portable devices for diagnosis and monitoring of glaucoma: a scoping review protocol

Farouk Garba <sup>1,2</sup> Fatima Kyari,<sup>1,3</sup> Winifred Nolan,<sup>1,4</sup> Matthew J Burton,<sup>1</sup> Iris Gordon,<sup>1</sup> Jennifer R Evans,<sup>1</sup> Victor H Hu<sup>1</sup>

**To cite:** Garba F, Kyari F, Nolan W, *et al.* Portable devices for diagnosis and monitoring of glaucoma: a scoping review protocol. *BMJ Open* 2024;**14**:e082375. doi:10.1136/bmjopen-2023-082375

► Prepublication history and additional supplemental material for this paper are available online. To view these files, please visit the journal online (<https://doi.org/10.1136/bmjopen-2023-082375>).

Received 21 November 2023  
Accepted 31 January 2024



© Author(s) (or their employer(s)) 2024. Re-use permitted under CC BY-NC. No commercial re-use. See rights and permissions. Published by BMJ.

<sup>1</sup>Faculty of Infectious and Tropical Diseases, London School of Hygiene and Tropical Medicine, International Centre for Eye Health, London, UK

<sup>2</sup>Department of Ophthalmology, College of Medical Sciences, Ahmadu Bello University, Zaria, Kaduna, Nigeria

<sup>3</sup>Department of Ophthalmology, College of Health Sciences, University of Abuja, Abuja, Nigeria

<sup>4</sup>NHRI Biomedical Research Centre, Moorfields and UCL Institute of Ophthalmology, London, UK

## Correspondence to

Dr Farouk Garba;  
[farouk.garba@lshtm.ac.uk](mailto:farouk.garba@lshtm.ac.uk)

## ABSTRACT

**Introduction** Glaucoma is the leading cause of irreversible blindness in the world. The need to diagnose glaucoma early in its natural history before extensive sight loss occurs cannot be overemphasised. However, glaucoma is largely asymptomatic in the early stages of the disease making it complex to diagnose clinically and requires the support of technology. The objective of this scoping review is to determine the nature and extent of the evidence for use of portable devices in the diagnosis of glaucoma.

**Methods** We will consider studies conducted in all healthcare settings using portable devices for the detection of all type of adult glaucoma. We will also include any systematic reviews or scoping reviews, which relate to this topic. Searches will be conducted in MEDLINE, Embase, CENTRAL on the Cochrane Library and Global Health databases, from their inception to the present. Reference lists from publications identified in the searches will also be reviewed. Two authors will independently screen titles and abstracts, followed by full-text screening to assess studies for inclusion. Any disagreements will be discussed and resolved with a third author. Tables accompanied by narrative descriptions will be employed to discuss results and show how it relates to review questions.

**Ethics and dissemination** Ethical approval is not required in this review. Only published and publicly accessible data will be used. We will publish our findings in an open-access, peer-reviewed journal and develop an accessible summary of results and recommendations.

## INTRODUCTION

Glaucoma is a disease of public health importance, ultimately resulting in irreversible blindness.<sup>1</sup> It is characterised by a progressive optic neuropathy with loss of vision, which is asymptomatic until the advanced stages of the disease. Elevated intraocular pressure (IOP) is the only treatable risk factor in glaucoma, and it is an important parameter in the diagnosis and monitoring of the disease.<sup>1</sup> Recent projections predict 111.8 million people will have glaucoma by the year 2040, and African and Asian populations are expected to be disproportionately affected.<sup>2 3</sup> In the recent *Lancet Global Health* Commission on

## STRENGTHS AND LIMITATIONS OF THIS STUDY

- ⇒ This scoping review will determine the nature and extent of published literature on the use of portable devices in the diagnosis of glaucoma.
- ⇒ This will be a comprehensive review, with no time, language or geographical restriction.
- ⇒ Available studies may not be globally representative.

global eye health, glaucoma was reported to have caused blindness in 3.61 million people (uncertainty interval (UI) 2.81 to 4.42 million) and moderate or severe vision impairment in a further 4.13 million (UI 3.24 to 5.18 million).<sup>4</sup>

The diagnosis of glaucoma usually requires specialist equipment, especially when trying to detect and confirm the presence of early asymptomatic disease. Resourcing primary and secondary healthcare facilities in low-resource settings with expensive high-tech equipment is challenging, particularly when it comes to eye care. Additionally, highly trained health workers are needed to operate such devices. In contrast, portable devices are used in remote areas during ophthalmology outreach programmes and screening exercises.<sup>5</sup> Their compact, low maintenance and battery-operated characteristics make them more suitable in areas where bulky high-tech equipment is not available or difficult to transport. Tests using portable devices such as the Eyecatcher perimeter, icare tonometer, portable fundus cameras and more have shown promising results when compared with conventional equipment in eye care.<sup>5–10</sup>

In high-income countries, portable devices are now being used to monitor glaucoma by assessing IOP at home using devices such as the icare HOME.<sup>11</sup> The possibility of remote visual field assessment by patients using portable, easy-to-operate devices has also been demonstrated in some studies.<sup>7 8</sup> However, the situation is different in low-income and

middle-income countries (LMICs), where the initial diagnosis of glaucoma is challenging due to lack of specialised diagnostic equipment and personnel.

The primary healthcare (PHC) system has been adopted universally in LMICs, with the aim of addressing basic health needs in the community.<sup>12</sup> It serves as the first point of care for individuals with conditions needing treatment and/or referral for further management, providing health education on common diseases in communities and basic rehabilitation services if required.<sup>13</sup> In the World report on vision, the WHO calls on countries to place a renewed emphasis on incorporating primary eye care (PEC) services into PHC.<sup>14</sup> This is being increasingly implemented worldwide, with varying effect in different regions. In South Asia, PEC services are often provided by local non-governmental organisations through networks of PEC facilities, staffed by qualified eye care workers, provided with relevant equipment. However, in many sub-Saharan African countries, such as Nigeria, there is a lack of PEC centres in most regions. The few available centres are often donor driven or initially run by NGOs before handing over to the State, and they lack basic equipment and expertise to screen, diagnose and or manage glaucoma.<sup>4 14 15</sup> Equipping PHCs with portable devices which are reliable and easy to operate in the detection of glaucoma could make a great impact in identifying people with glaucoma and refer appropriately for further management in specialised centre before blindness ensues.

Individuals with advanced glaucoma are challenging to manage, as stringent IOP control is required to prevent visual field progression and loss of vision.<sup>16</sup> Primary open-angle glaucoma tends to present with more severe visual field defects in African origin populations, and particularly in West African populations, compared with Caucasian populations.<sup>17 18</sup> Hence, vigorous treatment needs to be instituted. Treatment options include long-term daily eye-drops, surgery, laser or combined therapy to lower the IOP.<sup>18 19</sup> In the LMIC context, the cost of long-term glaucoma treatment is relatively high and many patients cannot afford it and have no medical insurance cover. Therefore, glaucoma treatment and the frequent follow-up appointments are often paid out of pocket.<sup>3</sup>

The task of preventing vision loss from progressing to end-stage glaucoma is difficult for the health system, the patient and caregivers. Individuals with advanced disease have poor vision and usually need family members or friends to accompany them to the hospital, requiring them to take time off from work. Earlier diagnosis helps to mitigate some of these issues, as it provides for more time to explore treatment options. The diagnosis of glaucoma is not straight forward, as both structural and functional changes of the optic nerve head have to be considered and IOP readings sometimes need to be taken at more than one sitting.

Considering the challenges highlighted above in making the diagnosis of glaucoma in LMICs, the use of portable devices may play an important role in its earlier detection. These devices could be used in community

health centres and could serve as a screening tools. Glaucoma cases detected could then be promptly referred to specialised centres for further investigations and management. Known or suspected cases could also periodically have their IOP checked (this being the only modifiable risk factor in management of glaucoma) and possibly visual fields to check for progression of the disease in these community health centres if these portable devices are available.

A preliminary search of MEDLINE was conducted and no current or underway systematic reviews or scoping reviews on this topic were identified. The objective of this scoping review is to assess the nature and extent of the literature in which portable devices have been used in the diagnosis/detection, management and monitoring of glaucoma.

### Review questions

We aim to answer the following questions:

1. What is the extent of published literature on the use of portable devices in the detection/ diagnosis and monitoring of glaucoma?
2. What is the range of reported specificity and sensitivity of these portable devices in detecting/diagnosing and monitoring glaucoma?
3. What can we learn from authors' reflections on the use of these portable devices?

### METHODS

This proposed scoping review will be conducted in accordance with the Joanna Briggs Institute methodology for scoping reviews and reported according to the relevant Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guideline.<sup>20 21</sup>

The protocol will be registered with the Open Science Framework before starting the review.

### Eligibility criteria

In this review, we will include studies:

- Where portable devices have been used in any health-care setting to detect or diagnose glaucoma in adults. Portable devices here are defined as devices that are hand held, battery operated, compact, easy to transport with minimal storage space requirement. Examples include; icare tonometer, tonopen, Perkins applanation tonometer, handheld fundus camera, portable visual field analysers.
- Studies conducted in all parts of the world including all ethnic groups will be considered in this review.

### Exclusion criteria

- Studies in children will be excluded from this review.

### Types of studies

This scoping review will consider both experimental and quasi-experimental study designs including randomised controlled trials, non-randomised controlled trials, before-and-after studies and interrupted time-series

studies. In addition, analytical observational studies including prospective and retrospective cohort studies, and cross-sectional studies will be considered for inclusion. This review will also consider descriptive observational study designs including case series and descriptive cross-sectional studies for inclusion. Qualitative and systematic reviews that meet the inclusion criteria will also be considered. Text and opinion papers will be excluded in this scoping review.

### Search

The search strategy will be run by an experienced information specialist (IG). The searches will be run without date or language restrictions. Grey literature (eg, government reports, theses, dissertations, search engines or organisations websites) and preprints will not be searched for this review. The search will be carried out in the following steps:

1. An initial search was conducted in MEDLINE to identify potentially relevant articles on the topic.
2. Analysis of text words and keywords in the search results from step 1 was used to develop a search strategy for MEDLINE (online supplemental appendix I).
3. The MEDLINE search will be translated for the following databases: Embase, CENTRAL on the Cochrane Library and Global Health.
4. The reference lists of included studies and relevant systematic reviews or scoping reviews will be checked to identify any additional potentially relevant reports of studies.

### Study/source of evidence selection

The search results will be uploaded into Covidence systematic review software for the screening process ([www.covidence.org](http://www.covidence.org)). A pilot test will be done and subsequently titles and abstracts of records identified by the searches will be screened independently by two authors (FG and WN). Disagreements will be resolved by discussion, with the rest of the author team if necessary. Full text of all potentially eligible studies will also be screened independently by two authors working in pairs (FG and FK/FG and WN) against the inclusion criteria above. Studies excluded at this stage will be listed with reasons for exclusion.

### Patient and public involvement

There will be no patient involvement in this review.

### Review end date

All databases will be searched from their inception. This review end date is planned to be April 2024.

### Data extraction

A data extraction tool developed by the reviewers will be used for data charting by two independent reviewers from the selected papers that met the eligibility criteria of the scoping review (online supplemental appendix II). Data to be extracted will comprise the following.

- Author(s).

- Year of publication.
- Source origin/country of origin/subcontinent/continent.
- Aims/purpose.
- Study population.
- Sample size.
- Methodology.
- Portable device used (and comparator if applicable).
- Reliability and sensitivity of portable devices in the diagnosis and monitoring of glaucoma.
- Duration of the intervention.
- How outcomes are measured.

We will pilot the draft extraction tool on five publications and will document any modifications during the pilot stage and during the course of the data extraction. Any disagreements that arise between the reviewers will be resolved through discussion, or with an additional reviewer/s. If appropriate, authors of papers will be contacted to request missing or additional data, where required.

### Data analysis and presentation

Results will be presented in a tabular form showing the following characteristics.

- Study population: setting used (community, primary or secondary health centre).
- Intervention type: type of portable device used.
- Duration of intervention.
- Aims.
- Methodology adopted.
- Key findings.
- Gaps in the research.

A narrative component will be included explaining how the results are related to the review questions.

### Ethics and dissemination

Ethical approval is not required for this study. Published articles and publicly accessible data will be used. This will form part of the literature search of a PhD project. We will publish our findings in a peer-reviewed journal and develop an accessible summary of results and make recommendations on the use of portable devices in the screening and diagnosis of glaucoma in communities.

**Twitter** Farouk Garba @fgali2002

**Contributors** FG contributed to develop the research topic, questions and contributed substantially to the drafting and editing. MJB, FK, WN and VHH conceived of the idea the scoping review, contributed developed the research questions and contributed and supervised extensively to the drafting and editing of the manuscript. JRE and IG contributed to the development of the methods, preparation of the protocol and they critically reviewed the manuscript. All authors have approved the final manuscript. FG is the guarantor of the review.

**Funding** This work is supported by Velux Stiftung, Switzerland. MJB is supported by the Wellcome Trust (grant number: 207472/Z/17/Z).

**Disclaimer** The funders were not involved in developing the protocol.

**Competing interests** None declared.

**Patient and public involvement** Patients and/or the public were not involved in the design, or conduct, or reporting, or dissemination plans of this research.

**Patient consent for publication** Not applicable.



**Provenance and peer review** Not commissioned; peer reviewed for ethical and funding approval prior to submission.

**Supplemental material** This content has been supplied by the author(s). It has not been vetted by BMJ Publishing Group Limited (BMJ) and may not have been peer-reviewed. Any opinions or recommendations discussed are solely those of the author(s) and are not endorsed by BMJ. BMJ disclaims all liability and responsibility arising from any reliance placed on the content. Where the content includes any translated material, BMJ does not warrant the accuracy and reliability of the translations (including but not limited to local regulations, clinical guidelines, terminology, drug names and drug dosages), and is not responsible for any error and/or omissions arising from translation and adaptation or otherwise.

**Open access** This is an open access article distributed in accordance with the Creative Commons Attribution Non Commercial (CC BY-NC 4.0) license, which permits others to distribute, remix, adapt, build upon this work non-commercially, and license their derivative works on different terms, provided the original work is properly cited, appropriate credit is given, any changes made indicated, and the use is non-commercial. See: <http://creativecommons.org/licenses/by-nc/4.0/>.

#### ORCID iD

Farouk Garba <http://orcid.org/0000-0001-5341-0853>

## REFERENCES

- 1 Kyari F, Gilbert C, Blanchet K, *et al.* Improving services for glaucoma care in Nigeria: implications for policy and programmes to achieve universal health coverage. *Br J Ophthalmol* 2017;101:543–7.
- 2 Tham Y-C, Li X, Wong TY, *et al.* Global prevalence of glaucoma and projections of glaucoma burden through 2040: a systematic review and meta-analysis. *Ophthalmology* 2014;121:2081–90.
- 3 Smith AF, Negretti G, Mascaro A, *et al.* Glaucoma control strategies in sub-Saharan Africa: a review of the clinical and health economic evidence. *Ophthalmic Epidemiol* 2018;25:419–35.
- 4 Burton MJ, Ramke J, Marques AP, *et al.* The lancet global health commission on global eye health: vision beyond 2020. *Lancet Glob Health* 2021;9:e489–551.
- 5 DeBuc DC. The role of retinal imaging and portable screening devices in tele-ophthalmology applications for diabetic retinopathy management. *Curr Diab Rep* 2016;16:132.
- 6 Jones PR. An open-source static threshold perimetry test using remote eye-tracking (Eyecatcher): description, validation, and preliminary normative data. *Trans Vis Sci Tech* 2020;9:18.
- 7 Jones L, Callaghan T, Campbell P, *et al.* Acceptability of a home-based visual field test (Eyecatcher) for glaucoma home monitoring: a qualitative study of patients' views and experiences. *BMJ Open* 2021;11:e043130.
- 8 Jones PR, Campbell P, Callaghan T, *et al.* Glaucoma home monitoring using a tablet-based visual field test (Eyecatcher): an assessment of accuracy and adherence over 6 months. *Am J Ophthalmol* 2021;223:42–52.
- 9 Upadhyaya S, Agarwal A, Rengaraj V, *et al.* Validation of a portable, non-mydiatic fundus camera compared to gold standard dilated fundus examination using slit lamp biomicroscopy for assessing the optic disc for glaucoma. *Eye (Lond)* 2022;36:441–7.
- 10 Li Y, Carpenter CR, Nicholson K, *et al.* Diagnostic accuracy of the iCare rebound Tonometer compared to the Perkins Applanation Tonometer in assessing intraocular pressure in rural patients. *Diagnosis (Berl)* 2015;2:227–34.
- 11 McGarva E, Farr J, Dabasia P, *et al.* Initial experience in self-monitoring of intraocular pressure. *Eur J Ophthalmol* 2021;31:1326–32.
- 12 AigbiremolenAlphonsus O. Primary health care in Nigeria: from conceptualization to implementation. *J of Medical and Applied Bioscience* 2014;6:35–43.
- 13 Gofin J, Gofin R. Community-oriented primary care and primary health care. *Am J Public Health* 2005;95:757; author reply 757.
- 14 Aghaji AE, Gilbert C, Ihebuzor N, *et al.* Strengths, challenges and opportunities of implementing primary eye care in Nigeria. *BMJ Glob Health* 2018;3:e000846.
- 15 Das T, Keeffe J, Sivaprasad S, *et al.* Capacity building for universal eye health coverage in South East Asia beyond 2020. *Eye (Lond)* 2020;34:1262–70.
- 16 Gessesse GW, Damji KF. Advanced glaucoma: management pearls. *Middle East Afr J Ophthalmol* 2013;20:131–41.
- 17 The advanced glaucoma intervention study (AGIS): 3. baseline characteristics of black and white patients. *Ophthalmology* 1998;105:1137–45.
- 18 Adekoya BJ, Adepoju FG, Moshood KF, *et al.* Challenges in the management of glaucoma in a developing country: a qualitative study of providers' perspectives. *Niger J Med* 2015;24:315–22.
- 19 King AJ, Hudson J, Fernie G, *et al.* Primary trabeculectomy for advanced glaucoma: pragmatic multicentre randomised controlled trial (TAGS). *BMJ* 2021;373:n1014.
- 20 Peters MDJ, Marnie C, Tricco AC, *et al.* Updated methodological guidance for the conduct of scoping reviews. *JBI Evid Synth* 2020;18:2119–26.
- 21 Tricco AC, Lillie E, Zarin W, *et al.* PRISMA extension for scoping reviews (PRISMA-SCR): checklist and explanation. *Ann Intern Med* 2018;169:467–73.