BMJ Open

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Journal:	*BMJ Open*
Manuscript ID	bmjopen-2023-082375
Article Type:	Protocol
Date Submitted by the Author:	21-Nov-2023
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Keywords:	Glaucoma < OPHTHALMOLOGY, Public health < INFECTIOUS DISEASES, Protocols & guidelines < HEALTH SERVICES ADMINISTRATION & MANAGEMENT

Portable Devices for Diagnosis of Glaucoma: A Scoping Review Protocol

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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 health care 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 utilised. We will publish our findings in an open-access, peer-reviewed journal and develop an accessible summary of results and recommendations.

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

Introduction

Glaucoma is a disease of public health importance, ultimately resulting in irreversible blindness.[1] It is characterized 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.[1] 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.[2, 3] In the recent *Lancet Global Health* Commission on global eye health, glaucoma was reported to have caused blindness in 3.61 million people (uncertainty interval [UI] 2.81-4.42 million) and moderate or severe vision impairment in a further 4.13 million (UI 3.24-5.18 million).[4]

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 health care 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.[5] 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.[5,6,7,8,9,10]

In high-income countries, portable devices are now being used to monitor glaucoma by assessing IOP at home using devices like the icare® HOME.[11] The possibility of remote visual field assessment by patients using portable, easy to operate devices has also been demonstrated in some studies.[7,8] However, the situation is different in low- and middle-income countries (LMICs), where the initial diagnosis of glaucoma is challenging due to lack of specialised diagnostic equipment and personnel.

The Primary Health Care (PHC) system has been adopted universally in LMICs, with the aim of addressing basic health needs in the community.[12] 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.[13] 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.[14] 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 primary eye care 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.[4,14,15] Equipping PHCs with portable devices which reliable and easy to operate in the

detection of glaucoma could make a great impact the 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.[16] Primary Open Angle Glaucoma (POAG) tends to present with more severe visual field defects in African origin populations, and particularly in West African populations, compared to Caucasian populations.[17,18] Hence, vigorous treatment needs to be instituted. Treatment options include long-term daily eye drops, surgery, laser, or combined therapy to lower the IOP.[18,19,] 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.[3]

The task of preventing vision loss from progressing to end stage glaucoma is difficult for the health system, the patient and care givers. 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. 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 taken at more than one sitting.

Considering the challenges highlighted above in making 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. Diagnosed or established cases could also periodically check their IOP (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 and management 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 detection and diagnosis of glaucoma?
2. What is the range of reported specificity and sensitivity of these portable devices in detecting and diagnosing 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 (JBI) methodology for scoping reviews and reported according to the relevant PRISMA guideline. (22,23)

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. Example, icare tonometer, tonopen, Perkins applanation tonometer, handheld fundus camera, portable visual field analysers.

- Studies conducted in all parts of the world including all races 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 randomized controlled trials, non-randomized 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 (e.g. 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 were used to develop a search strategy for MEDLINE.

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). 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, 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& JE/ FG&FK / FG&WN) against the inclusion criteria above. Studies excluded at this stage will be listed with reasons for exclusion.

Patient and Public involvement

No patient involvement

Review end date

All databases will be searched from their inception. This review end date is planned to be December 2023.

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 (appendix I). Data to be extracted will comprise of the following.

- Author(s)
- Year of publication
- Source origin/country of origin/Sub-Continent/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 5 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 utilised. 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.

Authors Contribution FG contributed to develop the research topic, questions and contributed substantially to the drafting and editing. MB, FK, WN and VH 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.

JE & 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.

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

Competing of interests: None declared.

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Appendix I: Data Extraction Tool

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Data Collection Tool		
Reviewers Details and Date:		
Article No.		
Parameters	Extraction	Comment (if any)
Author(s)		
Year of publication		
Aim/purpose		
Continent & Country		
Study population		
Sample size		
Methodology		
Type of Glaucoma		
Portable devices used and comparator		
Reliability and sensitivity of portable devices in diagnosis of glaucoma		
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Introduction:

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The task of preventing vision loss from progressing to end stage glaucoma is difficult for the health system, the patient and care givers. 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. 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 taken at more than one sitting.

Considering the challenges highlighted above in making 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. Diagnosed or established cases could also periodically check their IOP (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.

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1. What is the extent of published literature on the use of portable devices in detection and diagnosis of glaucoma?
2. What is the range of reported specificity and sensitivity of these portable devices in detecting and diagnosing glaucoma?
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In this review, we will include studies:

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Patient and Public involvement

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- Year of publication
- Source origin/country of origin/Sub-Continent/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 5 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 utilised. 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.

Authors Contribution FG contributed to develop the research topic, questions and contributed substantially to the drafting and editing. MB, FK, WN and VH 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.

JE & 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) . The funders were not involved in developing the protocol.

Competing of interests: None declared.

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Appendix I – MEDLINE search strategy.

MEDLINE Ovid

1. exp Glaucoma/
2. Intraocular Pressure/
3. Ocular Hypertension/
4. Visual Field Tests/
5. (glaucoma$ or ocular hypertensi$).tw.
6. intraocular pressure$.tw.
7. intra-ocular pressure$.tw.
8. (visual adj2 field$ adj2 test$).tw.
9. (retina$ adj2 imaging).tw.
10. (OAG or POAG or ACG or PACG or IOP or OHT).tw.
11. or/1-10
12. EyeSnellen.tw.
13. ((EyeChart or EyeXam) adj1 app).tw.
14. (Peek adj1 acuity).tw.
15. iSight Pro.tw.
16. SmartOptometry.tw.
17. ((handheld or hand-held or portable or smartphone or app) adj2 (Snellen or LogMAR)).tw.
18. ((handheld or hand-held or portable or smartphone or app) adj2 visual acuit$).tw.
19. (Peek adj1 contrast adj1 sensitivity).tw.
20. PeekCS.tw.
21. VCS Test online.tw.
22. (Icare adj4 tonometer$).tw.
23. (Perkin$ adj4 tonometer$).tw.
24. Tonopen.tw.
25. ((handheld or hand-held or portable) adj4 tonometer$).tw.
26. (Topcon adj3 NW8).tw.
27. (Remidio adj2 NMFOP).tw.

28. (Volk adj3 (Pictor or iNview)).tw.
29. (oDocs adj2 visoScope).tw.
30. (MiiS adj2 Horus adj2 Scope).tw.
31. (Horus adj3 (DEC200 or DEC300)).tw.
32. Smartscope.tw.
33. ((handheld or hand-held or portable) adj4 (fundus adj2 camera)).tw.
34. (Portable adj2 slit adj2 lamp).tw.
35. Eyecatcher.tw.
36. ((tablet or ipad) adj1 perimeter$).tw.
37. (Melbourne adj1 Rapid adj1 Fields).tw.
38. (VF2000 adj1 Focus).tw.
39. ((handheld or hand-held or portable) adj4 visual adj1 field$).tw.
40. (portable adj2 perimetry).tw.
41. nGoggle.tw.
42. (C3 adj2 field adj2 analyzer$).tw.
43. C3FA.tw.
44. (VisualFields adj1 Easy).tw.
45. (Visual adj1 Fields adj1 Easy).tw.
46. (virtual adj1 reality adj1 glasses).tw.
47. or/12-46
48. 11 and 47
49. Animals/
50. (animal or animals or mouse or mice or rat or rats or rabbit$ or dog or dogs or canine or cat or cats or pig or pigs or veterinary).tw.
51. or/49-50
52. 48 not 51
53. exp case reports/
54. (case adj2 report$).tw.
55. or/53-54
56. 52 not 55

Appendix II: Data Extraction Tool

Portable Devices for Diagnosis of Glaucoma: A Scoping Review		
Data Collection Tool		
Reviewers Details and Date:		
Article No.		
Parameters	Extraction	Comment (if any)
Author(s)		
Year of publication		
Aim/purpose		
Continent & Country		
Study population		
Sample size		
Methodology		
Type of Glaucoma		
Portable devices used and comparator		
Reliability and sensitivity of portable devices in diagnosis of glaucoma		
Reliability and sensitivity of portable devices in diagnosis of glaucoma		
Duration of the intervention		
How outcomes are measured		

PRISMA-P 2015 Checklist

This checklist has been adapted for use with systematic review protocol submissions to BioMed Central journals from Table 3 in Moher D et al: Preferred reporting items for systematic review and meta-analysis protocols (PRISMA-P) 2015 statement. *Systematic Reviews* 2015 **4**:1

An Editorial from the Editors-in-Chief of *Systematic Reviews* details why this checklist was adapted - Moher D, Stewart L & Shekelle P: Implementing PRISMA-P: recommendations for prospective authors. *Systematic Reviews* 2016 **5**:15

Section/topic	#	Checklist item	Information reported		Line number(s)
			Yes	No	
ADMINISTRATIVE INFORMATION					
Title					
Identification	1a	Identify the report as a protocol of a systematic review	☒	☐	Protocol of a scoping review
Update	1b	If the protocol is for an update of a previous systematic review, identify as such	☐	☒	
Registration	2	If registered, provide the name of the registry (e.g., PROSPERO) and registration number in the Abstract	☐	☒	
Authors					
Contact	3a	Provide name, institutional affiliation, and e-mail address of all protocol authors; provide physical mailing address of corresponding author	☒	☐	Page 1, line 12 - 41
Contributions	3b	Describe contributions of protocol authors and identify the guarantor of the review	☒	☐	Page 7, line 19
Amendments	4	If the protocol represents an amendment of a previously completed or published protocol, identify as such and list changes; otherwise, state plan for documenting important protocol amendments	☐	☒	
Support					
Sources	5a	Indicate sources of financial or other support for the review	☒	☐	Page 7 line 37
Sponsor	5b	Provide name for the review funder and/or sponsor	☒	☐	Page 7, line 37
Role of sponsor/funder	5c	Describe roles of funder(s), sponsor(s), and/or institution(s), if any, in developing the protocol	☒	☐	

Section/topic	#	Checklist item	Information reported		Line number(s)
			Yes	No	
INTRODUCTION					
Rationale	6	Describe the rationale for the review in the context of what is already known	☒	☐	Page 3,line 4 to Page 4 line 38
Objectives	7	Provide an explicit statement of the question(s) the review will address with reference to participants, interventions, comparators, and outcomes (PICO)	☒	☐	Page 4, line 41 to line 54
METHODS					
Eligibility criteria	8	Specify the study characteristics (e.g., PICO, study design, setting, time frame) and report characteristics (e.g., years considered, language, publication status) to be used as criteria for eligibility for the review	☒	☐	Page 5, line 11
Information sources	9	Describe all intended information sources (e.g., electronic databases, contact with study authors, trial registers, or other grey literature sources) with planned dates of coverage	☒	☐	Page 5 line 45 to Page 6 line
Search strategy	10	Present draft of search strategy to be used for at least one electronic database, including planned limits, such that it could be repeated	☒	☐	Page 11, line 1
STUDY RECORDS					
Data management	11a	Describe the mechanism(s) that will be used to manage records and data throughout the review	☒	☐	Page 6,line 5
Selection process	11b	State the process that will be used for selecting studies (e.g., two independent reviewers) through each phase of the review (i.e., screening, eligibility, and inclusion in meta-analysis)	☒	☐	Page 6, line 7
Data collection process	11c	Describe planned method of extracting data from reports (e.g., piloting forms, done independently, in duplicate), any processes for obtaining and confirming data from investigators	☒	☐	Page 6, line 18
Data items	12	List and define all variables for which data will be sought (e.g., PICO items, funding sources), any pre-planned data assumptions and simplifications	☒	☐	Appendix
Outcomes and prioritization	13	List and define all outcomes for which data will be sought, including prioritization of main and additional outcomes, with rationale	☒	☐	Page 7, line 1
Risk of bias in individual studies	14	Describe anticipated methods for assessing risk of bias of individual studies, including whether this will be done at the outcome or study level, or both; state how this information will be used in data synthesis	☐	☒	~~Page 7, line 1~~Not applicable, scoping review
DATA					

Section/topic	#	Checklist item	Information reported		Line number(s)
			Yes	No	
Synthesis	15a	Describe criteria under which study data will be quantitatively synthesized	☐	☒	
	15b	If data are appropriate for quantitative synthesis, describe planned summary measures, methods of handling data, and methods of combining data from studies, including any planned exploration of consistency (e.g., I^2, Kendall's tau)	☐	☒	
	15c	Describe any proposed additional analyses (e.g., sensitivity or subgroup analyses, meta-regression)	☐	☒	
	15d	If quantitative synthesis is not appropriate, describe the type of summary planned	☒	☐	Page 7, line 1
Meta-bias(es)	16	Specify any planned assessment of meta-bias(es) (e.g., publication bias across studies, selective reporting within studies)	☐	☒	
Confidence in cumulative evidence	17	Describe how the strength of the body of evidence will be assessed (e.g., GRADE)	☐	☒	