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# BMJ Open

## A systematic review of remote rehabilitation (telerehabilitation) services to support people with vision impairment.

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3 1 **Title:** A systematic review of remote rehabilitation (telerehabilitation) services to  
4 support people with vision impairment.  
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## 22 ABSTRACT

23 **Objective:** To describe the nature of telerehabilitation services available to people  
24 with vision impairment and summarise available evidence relating to effectiveness.

25 **Design:** Systematic review.

26 **Data sources:** CINAHL Plus, MEDLINE, PsycARTICLES, PsychINFO, Embase,  
27 PubMed, HMIC and Ovid Emcare were searched, without date restrictions up to 24  
28 May 2021. A detailed search of online grey literature was also conducted.

29 **Eligibility criteria:** Eligible studies evaluated effectiveness of telerehabilitation  
30 services for visually impaired people. Studies were excluded if they did not relate to  
31 remote service delivery, were not available in English, or focused on distance learning  
32 of visually impaired students.

33 **Data extraction and synthesis:** Two independent reviewers screened articles and  
34 extracted data. A risk of bias analysis was performed.

35 **Outcome measures:** Measures of effectiveness included performance-based  
36 assessment, patient-reported outcomes, and cost-effectiveness.

37 **Results:** Of 4,472 articles, 10 eligible studies were included. Four studies (33.3%)  
38 addressed patient satisfaction and recommendations, two studies (16.6%) related to  
39 vision training, four studies (33.3%) measured patient-reported outcomes and well-  
40 being, one study (8.3%) addressed managing clinical symptoms and one study (8.3%)  
41 analysed cost-effectiveness. Two studies featured across multiple domains.

42 **Conclusion:** Publication trends suggest telerehabilitation is increasingly featuring in  
43 the low vision rehabilitation care pathway. Patients are generally accepting of this  
44 model and may benefit from improved functional and quality-of-life outcomes. This  
45 systematic review highlights that further trials are needed to evaluate telerehabilitation  
46 using a robust set of outcome measures.

47 **PROSPERO registration number:** CRD42021254825

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3 50 **Strengths and limitations of this study**  
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- This review provides novel findings informing design of future trials and evaluations of telerehabilitation.
  - Inclusion of grey literature reduces publication bias and increases the comprehensiveness of the review.
  - Only articles written in English were included and results were seldom disaggregated by disease type or severity.

For peer review only

## 60 INTRODUCTION

61 Visual impairment is a broad term used to describe a reduction in visual sensitivity that  
62 cannot be corrected by standard eyeglasses or medical treatment. It is estimated that  
63 over 2 million people in the United Kingdom (UK) are living with a form of visual  
64 impairment <sup>(1)</sup>. Visually impaired individuals may be classified as 'sight impaired' (i.e.,  
65 partially sighted) or 'severely sight impaired' (i.e., legally blind) <sup>(2)</sup>. The impact of visual  
66 impairment can be complex and highly heterogenous, affecting aspects of daily  
67 functioning, mobility, and quality of life <sup>(3-8)</sup>. Among the widely prevalent ophthalmic  
68 conditions such as age-related macular degeneration, glaucoma, and diabetic  
69 retinopathy, loss of vision is typically progressive and irreversible; hence, support  
70 heavily relies on rehabilitation to promote adaption, enabling patients to better manage  
71 the challenges associated with vision loss and to live an independent and fulfilling life  
72 <sup>(9, 10)</sup>.

73 The mainstay of rehabilitation is to restore or maintain physical and/or  
74 psychological functioning to the maximum degree possible in individuals living with  
75 disease or injury. In vision rehabilitation, eye care providers are encouraged to provide  
76 rehabilitative support or refer patients to relevant services, even in cases of mild or  
77 moderate sight loss <sup>(11)</sup>. Rehabilitation encompasses many disciplines, and  
78 interventions may include provision of visual aids, devices and software, behavioural  
79 training, home environment assessments and adaptations, social and psychological  
80 support, leisure and vocational activities, or a combination of these strategies <sup>(12, 13)</sup>.  
81 However, rehabilitation is characteristically structured around overcoming the practical  
82 and functional challenges of sight loss, whilst psychological outcomes are seldom  
83 addressed directly <sup>(14)</sup>. The type of services which are offered often depends on the  
84 nature of the visual impairment. For example, the rehabilitative needs of individuals  
85 with central visual field loss may differ from those with impaired peripheral vision <sup>(15)</sup>.  
86 The traditional mode of delivery for vision rehabilitation has been in face-to-face  
87 settings within outpatient clinics or home visits by low vision specialists or allied health  
88 professionals; though digital developments have increased opportunity for remote  
89 service delivery (i.e., telerehabilitation).

90 Telerehabilitation, also known as virtual training or e-learning, refers to  
91 delivering rehabilitative services using a remote or virtual approach, facilitated by  
92 telecommunication technologies. Services may comprise a range of elements

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3 93 designed to assess, prevent, treat, educate, or counsel individuals living with chronic  
4 health conditions <sup>(16)</sup>. Telerehabilitation services may be synchronous, whereby  
5 94 services are delivered in real-time using two-way video or audio communication, or  
6 95 asynchronous, such as remote evaluation of recorded videos or other measurements  
7 96 such as surveys or psychophysical testing <sup>(17)</sup>. Compared to traditional face-to-face  
8 97 rehabilitation, telerehabilitation offers potential benefits, such as reduced costs,  
9 98 increased geographical accessibility, and creating opportunities to extend limited  
10 99 resources <sup>(18)</sup>. Moreover, telerehabilitation has been identified as an effective means  
11 100 of delivering support to individuals with chronic conditions including multiple sclerosis,  
12 101 osteoarthritis, and stroke <sup>(19-21)</sup>.  
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21 103 Whilst there is convincing evidence to suggest telerehabilitation can be effective  
22 104 at improving physical and psychological functioning in people living with chronic health  
23 105 conditions, less is known about the effectiveness of telerehabilitation services for  
24 106 people with a vision impairment. For example, a previous review sought to compare  
25 107 outcomes between face-to-face and virtual vision rehabilitation services, yet no  
26 108 completed studies in this area were found <sup>(22)</sup>. Additionally, new services emerging  
27 109 during the COVID-19 pandemic have yet to be reviewed. This is significant given the  
28 110 rapid and extensive scale-up of telehealth services since the beginning of the  
29 111 pandemic <sup>(23, 24)</sup>. This systematic review, therefore, aims to draw together evidence on  
30 112 telerehabilitation services, and describe their impact on health and well-being  
31 113 outcomes in people with vision impairment.  
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## 44 115 **Objectives**

- 45 116 1. Describe the nature of telerehabilitation services available to people with vision  
46 117 impairment.
- 47 118 2. Collect and summarise evidence on the impact of telerehabilitation in terms of  
48 119 health-related outcomes, well-being and cost-effectiveness.

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3 **123 METHODS**  
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5 124 This review follows best practice for conducting systematic reviews as outlined by the  
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7 125 Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA)  
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9 126 checklist to ensure all aspects of the process are undertaken using rigorous and  
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11 127 transparent methods <sup>(25, 26)</sup>. A search of the electronic databases CINAHL Plus and  
12  
13 128 MEDLINE (via EBSCOhost) and PsycARTICLES, PsychINFO, Embase, PubMed,  
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15 129 HMIC and Ovid Emcare (via Ovid) was undertaken. As recommended by The  
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17 130 Cochrane Handbook for Systematic Reviews of Interventions, medical subject  
18  
19 131 headings (MeSH) were used to identify the most relevant articles <sup>(27)</sup>. MeSH terms are  
20  
21 132 official words or phrases selected to represent medical concepts and are assigned to  
22  
23 133 articles in order to describe what the research item is about <sup>(28)</sup>. This process provided  
24  
25 134 a list of keywords relating to vision impairment and telerehabilitation. For detailed  
26  
27 135 search terms, see Table 1. Reference lists of included studies and any identified  
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29 136 systematic reviews were also reviewed for relevant articles, and citation tracking was  
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31 137 performed using Google Scholar.  
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33 138

Vision impairment term		Telerehabilitation term
vision OR low vision OR vision loss OR reduced vision OR subnormal vision OR diminished vision OR vis* impair* OR sight loss OR blind* OR partially sighted	AND	telerehab* OR tele-rehab* OR remote rehab* OR virtual rehab* OR e-learning OR online learning OR online training OR telephone training OR telephone rehab* OR telephone learning OR virtual learning OR web training OR virtual training

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44 **Table 1.** Search terms  
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48 140 In addition, we reviewed online conference proceedings for relevant abstracts. A  
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50 141 search of grey literature included searching for relevant articles or reports on the  
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52 142 websites of organisations such as the UK National Institute for Health and Clinical  
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54 143 Excellence (NICE; [www.nice.org.uk](http://www.nice.org.uk)) and National Health Service (NHS) Evidence  
55  
56 144 ([www.evidence.nhs.uk](http://www.evidence.nhs.uk)). We also conducted an extensive search of the UK Charity  
57  
58 145 Commission website to identify organisations with links to vision impairment and  
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60 146 rehabilitation. Relevant charity websites were then searched and in cases where  
147 telerehabilitation was documented, any available documentation was downloaded and

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3 148 reviewed, and charities were contacted to enquire about the current status of  
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5 149 telerehabilitation.

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7 150 Articles written in English, with no restrictions on publication period, and only where  
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9 151 the full text was available were included. Studies were further required to address the  
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11 152 exposure of interest (i.e., visual impairment and telerehabilitation). Articles were  
12  
13 153 excluded if they did not relate to remote service delivery (i.e., face-to-face services).  
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15 154 Articles focusing only on an educational context were also excluded. For example,  
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17 155 visually impaired students using home technology for distance learning.

18 156 Two authors (LJ and ML) independently screened studies using Covidence systematic  
19  
20 157 review software (Veritas Health Innovation Ltd, Melbourne, Australia; available  
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22 158 at [www.covidence.org](http://www.covidence.org)) to assess eligibility. Any disagreement in coding decisions  
23  
24 159 were resolved through discussion. Relevant information (e.g., publication details,  
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26 160 characteristics of participants, study design, outcomes measured, study results, and  
27  
28 161 conclusions) from eligible articles was entered into a data extraction table.

29 162 Studies were assessed for quality using Kmet *et al.* 'Standard Quality Assessment  
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31 163 Criteria for Evaluating Primary Research Papers from a Variety of Fields' <sup>(29)</sup>. This  
32  
33 164 quality appraisal tool was chosen because of both quantitative and qualitative studies  
34  
35 165 emerging from the literature search. This review is registered online with the  
36  
37 166 International prospective register of systematic reviews (PROSPERO;  
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39 167 [www.crd.york.ac.uk/prospero/](http://www.crd.york.ac.uk/prospero/); Reference CRD42021254825).

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### 41 169 **Patient and public involvement**

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44 170 No patients were involved in the design of the review. We will disseminate plain  
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46 171 language summaries to relevant patient groups including members of Blind Veterans  
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48 172 UK.

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### 50 51 174 **Research ethics approval**

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54 175 Ethical approval for this systematic review was not required.

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## 177 RESULTS

178 Searches were run on 24 May 2021 and yielded 4,472 results. Of these, 658 were  
179 automatically removed as duplicates. This left 3,814 studies to screen using title and  
180 abstract, of which 3,719 were excluded and 95 were assessed for full-text eligibility.  
181 Studies were mostly excluded at the title and abstract screening stage because they  
182 did not relate to telerehabilitation or did not involve visually impaired individuals. These  
183 two reasons were also the primary cause for exclusion at the full-text review  
184 accounting for 17 and 38 exclusions, respectively. A further two studies were added  
185 through reference list searching. Ultimately, 10 full-text studies were selected for  
186 inclusion. The study selection process is shown in the PRISMA diagram in Figure 1.

187  
188 <Insert Figure 1 here>

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190 **Figure 1.** PRISMA diagram showing study selection process. Key: VI = vision impairment

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192 Quality appraisal was conducted on all 10 studies. The lowest score was 0.64, the  
193 highest was 1.00 (i.e., all responses to relevant questions in the Kmet *et al.* appraisal  
194 criteria were 'Yes'), and the median score was 0.93. The most frequent issues with the  
195 studies were the presence of only a partial description of subject characteristics (2 of  
196 10) and study conclusions not being fully supported by the data (3 of 10); however,  
197 this was the case for just a small proportion of the studies.

198 The following overview of study findings is organised according to the main  
199 outcome domains for each of the 10 articles identified in the systematic literature  
200 search. Two articles feature in more than one section as the outcomes were  
201 translatable across multiple domains. Four studies (33.3%) addressed patient  
202 satisfaction and recommendations, two studies (16.6%) related to vision training, four  
203 studies (33.3%) measured patient-reported outcomes and well-being, one study  
204 (8.3%) addressed managing clinical symptoms and a further one study (8.3%) was an  
205 analysis of cost-effectiveness. For full details of the included studies, refer to the data  
206 extraction table (Supplementary material).

### ***Patient satisfaction and recommendations***

Four articles explored patients' satisfaction with telerehabilitation and recommendations for key features to improve uptake of services. Three of these articles reported the findings of feasibility studies and one was a qualitative analysis of patient experiences. All of these studies included participants with a visual impairment caused by a range of pathologies including age-related macular degeneration, optic nerve disease, retinitis pigmentosa, and stroke-related visual field deficit.

Dunne *et al.*'s <sup>(30)</sup> study of stroke survivors reports the outcomes of qualitative interviews and focus groups with patients and carers. The study was informed by the findings of a survey of Stroke Association group members in the UK and the aims were to understand experiences of a compensatory eye-movement tool and training packages. The Durham Reading and Exploration Training (DREX) is a computer-based telerehabilitation training system teaching adaptive eye movement strategies to enable stroke survivors to cope more effectively with visual field deficits. DREX is a mobile application which incorporates tasks that combine both reading and exploration (e.g., scanning an array to locate a target). The wider study required patients with stroke-related visual field defects to complete the DREX trials on a tablet in their own homes and outcomes were compared to a control intervention, which consisted of attention-based tasks with no eye movement or exploration exercises. Significantly greater gains were observed in performance, visual functioning and everyday behaviours following DREX than the control intervention <sup>(31)</sup>. Qualitative responses highlighted a range of issues in the application of telerehabilitation for visually impaired stroke survivors. For example, a lack of confidence with technology, perceived fear of making mistakes while online, distrust of the quality of the intervention, and concerns with reduced face-to-face contact. However, these issues could be addressed in initial in-person visits to alleviate concerns and facilitate engagement and motivation in the rehabilitation process. One challenge is that compensatory training is inherently repetitive in nature; thus, measures should be taken to ensure telerehabilitation tools remain accessible to avoid disengagement. The authors propose one approach which may obviate disengagement is to employ feedback and goal setting to improve motivation and provide tangible progress updates.

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3 Patient satisfaction was assessed by Bittner *et al.* <sup>(32)</sup> in a pilot study to develop,  
4 administer and evaluate a synchronous virtual low vision portal providing  
5 telerehabilitation services. Ten patients diagnosed with either age-related macular  
6 degeneration (n = 9) or diabetic retinopathy (n = 1) were enrolled. Participants were  
7 required to have access to a home telephone to use the Internet-based video  
8 conference portal. Tablet devices were provided as well as MiFi (wireless router which  
9 acts as a mobile Wi-Fi hotspot) to enable connection to the Internet. Each participant  
10 received one telerehabilitation session which lasted approximately one hour. The  
11 session included administration of the MNREAD chart which consists of a series of  
12 60-character sentences displayed over three lines and is used to assess reading  
13 fluency and proficiency using optical magnifiers, using video and audio recordings of  
14 the participant. Assessments of working distance and lighting were made by the  
15 provider viewing the video of the participant reading with their magnifier, whereas  
16 assessments of reading speed and accuracy relied on the audio component as  
17 participants read aloud during the MNREAD and near acuity tests. The outcomes  
18 were participants' and providers' audio and video quality ratings. Video quality was  
19 rated as excellent to good, whereas audio ratings were more variable. All participants  
20 were satisfied and comfortable receiving telerehabilitation and evaluation via  
21 videoconferencing. Eight of 10 reported that their magnifier use improved after  
22 telerehabilitation. All except one reported that they were very interested in receiving  
23 telerehabilitation services again if their visual needs changed.

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40 Lorenzini and Wittich report outcomes related to patient satisfaction in a  
41 feasibility study using a head-mounted video platform to deliver synchronous  
42 telerehabilitation sessions at home <sup>(33)</sup>. Participants received real-time distance  
43 training sessions delivered by a low vision therapist. The intervention focused on the  
44 technical aspects of using eSight eyewear, an assistive technology designed to  
45 maximise visual input and compensate for vision loss. The intervention group  
46 underwent a personalised training programme including eSkills functional learning  
47 activities such as reading, writing, and distance vision training. A control group were  
48 allocated to conventional eSight self-training using the eSkills user guide. Fifty-seven  
49 visually impaired participants were enrolled (experimental group, n = 28), the most  
50 common causes of sight loss were optic nerve disease, age-related macular  
51 degeneration, retinopathy of prematurity, and retinitis pigmentosa. Retention rates  
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3 during the study were 93% (n = 53) at 2 weeks, 68% (n = 39) at 3 months, and 65%  
4 (n = 37) at 6 months. A higher proportion of patients who withdrew from the study were  
5 enrolled into the control group. Participants reported being comfortable with receiving  
6 telerehabilitation training at home, with 16 of 23 (66%) agreeing the programme was  
7 effective and efficient, and the majority (20 of 23) approving that they would be  
8 interested in using telerehabilitation again in the future.  
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14 A parallel investigation by Lorenzini and Wittich used standardised measures  
15 to assess quality of life and patient satisfaction following the eSight telerehabilitation  
16 programme<sup>(34)</sup>. Quality of life outcomes are reported in a later section. Satisfaction  
17 was measured using the 12-item Quebec User Evaluation of Satisfaction with  
18 Assistive Technology (QUEST) tool. Scores on the measure increased for participants  
19 in both the experimental and control group between baseline and 3-months of device  
20 usage, suggesting satisfaction improved independently of the type of training. There  
21 were no differences in assistive technology-related satisfaction based on age or sex.  
22 Improvement in QUEST scores were not maintained at 6-months. The authors suggest  
23 this may be due to the device no longer meeting certain needs after extended usage,  
24 or a lessening impact of social desirability, leading to more realistic and honest  
25 responses from participants over time.  
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### ***Vision training***

40 Two studies focused on training related to optimisation of vision delivered through a  
41 telerehabilitation service. Both studies included patients with measurable visual field  
42 loss including areas of diminished sensitivity in glaucoma and hemianopia in stroke  
43 patients.  
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47 Sabel and Gudlin compared outcomes of behavioural training using a 1-hour  
48 computer-based vision restoration programme for people with glaucoma and a  
49 placebo group<sup>(35)</sup>. Participants were required to have a stable glaucomatous visual  
50 field defect inside 30° eccentricity in at least one eye, with well controlled intraocular  
51 pressure. After baseline assessments, training was performed 6-days per week for 3-  
52 months at home on a commercially available computer with adaptive parameter  
53 adjustments. The experimental group performed vision training similar to perimetry  
54 whereby visual stimuli of varying luminance are presented in areas of residual vision.  
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3 The placebo group performed stimulus discrimination training. Vision restoration  
4 exercises led to improved vision-related performance (detection accuracy and faster  
5 reaction time) without affecting eye movements. The authors conclude that visual  
6 system plasticity can be retained into older age despite widespread visual deterioration  
7 and activation of residual vision may partly reverse vision loss.  
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12 A study on patients with hemianopia used a bespoke asynchronous audio-  
13 visual telerehabilitation system <sup>(36)</sup>. The system featured a semi-circular apparatus in  
14 which visual and acoustic stimuli are presented and a central camera to control head  
15 and eye movements. Patients used the system at home on a customised tablet which  
16 was controlled by a hospital-based therapist. Following an initial assessment in the  
17 clinic, participants underwent training at home at least 5 days a week for up to 12  
18 months. The aim of the training was to stimulate multisensory integration mechanisms  
19 to reinforce visual and spatial compensatory functions, for example, adoption of  
20 oculomotor strategies. Among the sample of three adults with hemianopia, all were  
21 capable of actively using the device independently whilst under remote supervision  
22 and showed improvements in visual detection abilities over the study period. The  
23 authors conclude that the device may contribute to better visual outcomes and could  
24 be used to reduce the need for one-to-one hospital visits.  
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### 37 **Quality-of-life and well-being**

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39 Four articles assessed outcomes relating to quality-of-life and well-being following  
40 telerehabilitation. The studies use patient-reported outcome measures and  
41 behavioural measurements to examine the effectiveness of remote interventions in  
42 people with a vision impairment. Two articles are case reports, and two articles  
43 describe the quality-of-life outcomes from the eSight eyewear and vision restoration  
44 training programmes described in an earlier section.  
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51 Lorenzini and Wittich <sup>(34)</sup> measure changes in quality-of-life following  
52 telerehabilitation with the eSight eyewear programme using the Psychosocial Impact  
53 of Assistive Devices Scale (PIADS), a 26-item questionnaire composed of three  
54 subscales (competence, adaptability, and self-esteem), and the Veterans Affairs Low  
55 Vision Visual Functioning Questionnaire (VA LV VFQ-48), a 48-item instrument used  
56 to measure outcomes of patients receiving low vision rehabilitation. Visually impaired  
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3 participants completed the measures at baseline, 2-weeks, 3-months, and 6-months.  
4 Results patterns were similar across the three subscales of the PIADS showing  
5 statistically significantly improved scores after 3 months in both the intervention and  
6 control groups, indicating that assistive technology-related quality-of-life (i.e.,  
7 perceived impact of assistive devices on quality-of-life) improved independently of the  
8 type of training received. Self-reported functional vision outcomes, as determined by  
9 the VA LV VFQ-48, yielded statistically significant improvements in overall scores, as  
10 well as in all subscales (reading, visual information, mobility, visual motor) after 2  
11 weeks of using the device; improvements also continued after 3 months.  
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19 Sabel and Gudlin's <sup>(35)</sup> vision restoration programme used the National Eye  
20 Institute Visual Function Questionnaire (NEI-VFQ-25) and the Short-Form-36 (SF-36)  
21 to measure changes in quality of life between baseline and post-intervention follow-  
22 up. Vision training was not associated with robust changes on these measures. Only  
23 the mental health subscale of the SF-36 was found to have improved, which may be  
24 caused by non-specific training effects such as attention, alertness, or expectation.  
25 However, participants had generally scored highly on both measures at baseline,  
26 indicating few everyday vision deficits.  
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34 A case report by Dogru-Huzmeli *et al.* <sup>(37)</sup> explored whether diplopia complaints  
35 could be ameliorated using the Cawthorne-Cooksey exercises applied via  
36 telerehabilitation in a multiple sclerosis patient with a visual field scotoma. Cawthorne-  
37 Cooksey exercises use a set of eye and head movements which are based on the  
38 concept of habituation and designed to build up a tolerance mechanism to support  
39 equilibrium and balance. Exercises were delivered through WhatsApp video calls over  
40 30 sessions. Comparison of pre- and post- eye examinations suggested gaze  
41 restriction had improved and that the patient had fewer double vision complaints. Pre-  
42 and post-intervention quality-of-life was assessed using the SF-36 measure of general  
43 health. The authors report improvement in all domains of the SF-36, except for  
44 physical functioning, where there was no change.  
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53 A study from Lancioni and colleagues assessed whether two congenitally blind  
54 women could be supported to make independent phone calls using a computer-aided  
55 system <sup>(38)</sup>. Both women attended a rehabilitation centre where the study took place.  
56 The system comprised of a netbook computer which was enabled with a global system  
57 for mobile communication with a headset and microphone apparatus. The study  
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3 adopted an ABAB design in which A represented baseline phases and B represented  
4 intervention phases with the telephone system. Communication-related outcomes  
5 included the total number of calls made, number of calls met with a response, and  
6 length of calls. Both participants learnt to use the system and made phone calls  
7 independently to a variety of contacts such as family members, friends, and care staff  
8 personnel, indicating that the intervention may be useful for enabling people with a  
9 vision impairment to manage phone calls on their own.  
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### 18 ***Managing symptoms***

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20 One study used a telerehabilitation approach to support patients attending a  
21 residential school for visually impaired people during the COVID-19 pandemic. Senjam  
22 and colleagues<sup>(39)</sup> used voice-over internet protocols (e.g., WhatsApp calling, Zoom)  
23 to enable a rehabilitation team to deliver education and counselling interventions and  
24 monitor ocular complaints among visually impaired adults and children. Over a 2-  
25 month study period, 492 patients contacted the team. Health-related complaints were  
26 made by 335 patients, the most common ocular complaints being itching (36.1%),  
27 watering (16.1%), and painful eyes (3.6%). Counselling sessions addressed  
28 uncertainty surrounding clinical monitoring of eye health. The study suggests that  
29 preventative strategies to help manage ocular symptoms could be delivered through  
30 telerehabilitation, although the outcome of interventions was not known.  
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### 42 ***Cost-effectiveness***

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44 A retrospective cost analysis from Ihrig<sup>(40)</sup> examined the economic practicality of a  
45 clinical model of telerehabilitation for visually impaired military veterans.  
46 Telerehabilitation was delivered by an optometrist and rehabilitation therapist to  
47 veterans with conditions including age-related macular degeneration, glaucoma,  
48 diabetic retinopathy, cataracts, and retinitis pigmentosa. Sessions took place remotely  
49 at either the participants' home or local community outpatient centre. Total and median  
50 travel cost and time savings were estimated per veteran per fiscal year. Introduction  
51 of the telerehabilitation service in 2012 increased access to rural veterans in Western  
52 New York. Over a 5-year period, 419 veterans who were unable to access traditional  
53 low vision rehabilitation due to travel issues accessed the remote service. The  
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3 proportion of patients accessing the telerehabilitation service represented 24% of the  
4 overall rehabilitation caseload. Median saving of travel miles was 122 miles per  
5 veteran (51,136 miles/419 veterans). Median saving of travel time was 2.09 hours per  
6 veteran (878 hours/419 veterans). Overall, median travel cost saving per rural  
7 individual was \$65.29 per veteran (\$27,357.76/419 veterans). The authors conclude  
8 that telerehabilitation can be a practical, time-saving, and cost-saving alternative to  
9 traditional face-to-face consultations.  
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### 18 ***Grey literature***

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20 Searches of charity websites led to the identification of 11 organisations in the UK  
21 where vision rehabilitation services had been shifted to remote delivery. The charities  
22 were contacted about the nature of services and whether any evaluations had been  
23 undertaken. This process resulted in the review of seven documents, predominantly  
24 internal reports about the restructure of rehabilitation services during the COVID-19  
25 pandemic. While these documents were mostly descriptive, there was useful  
26 information demonstrating telerehabilitation practice patterns in the third sector. For  
27 example, Blind Veterans UK, a charity providing support and services to visually  
28 impaired UK veterans, reported information about the needs of their beneficiaries,  
29 experimental methods in delivering remote rehabilitation, and working with allied  
30 agencies throughout the COVID-19 pandemic to signpost members to support.  
31 Similarly, charities such as Royal National Institute of Blind People and National  
32 Federation of the Blind describe telerehabilitation frameworks which have been  
33 implemented during the pandemic.  
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### 48 ***Trends in publishing***

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50 There has been an increase over time in published studies evaluating the impact of  
51 telerehabilitation on people with a vision impairment. Yet, these studies represent only  
52 a small proportion of the total research on people with vision impairment. For example,  
53 a PubMed search for articles with 'vision impairment' or 'blindness' in the title or  
54 abstract yields 17,783 results since 2010 alone; while in that same period just 10  
55 articles (0.06%) were published that were relevant to telerehabilitation and were  
56 included in this review.  
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## Discussion

Vision rehabilitation is a key stage in the eye care journey. Rehabilitative services can help to mitigate the impact of vision loss by equipping patients with new skills and training while providing social connectedness and psychological support<sup>(41-45)</sup>. This review shows that the landscape of rehabilitation is evolving to include synchronous and asynchronous approaches to remote rehabilitation for people with sight loss conditions. Studies using patient-reported outcome measures suggest telerehabilitation can lead to improved outcomes relating to daily functioning and quality-of-life. In addition, there is generally a high level of acceptability from patients for this shift in service delivery. However, there remain certain distinct challenges associated with telerehabilitation which may curtail the extent to which this approach is adopted and retained more widely.

Several of the studies in this review included recommendations for telerehabilitation which provide helpful insights. For example, a period of direct training with home-based technology was regarded positively, suggesting such training can provide patients with a helpful rehabilitation framework. Despite an increasing number of visually impaired adults engaging with technology<sup>(46)</sup>, it is inevitable that some individuals will have underlying concerns about their technical readiness to operate devices at home. An assessment of individual self-efficacy regarding health management and aptitude for telerehabilitation may, therefore, help to prioritise individuals for whom this approach is most likely to be tolerated and successful.

A key challenge associated with telerehabilitation is maintaining patient motivation and engagement. Rehabilitation is, by nature, highly repetitive and often requires continuous engagement over long periods of time before measurable effects can be observed. Although studies in this review yielded good patient satisfaction ratings<sup>(34)</sup> and high retention rates<sup>(33)</sup>, it is difficult to predict the sustainability of telerehabilitation outside the context of a research study. For example, devices risk becoming a nuisance if required long term, and whilst acceptable within research, patients may resist such commitments becoming the standard of care<sup>(47)</sup>. Studies in this review described intensive programmes of telerehabilitation, in some instances requiring several hours of engagement per week. Further research using real-world data on patterns of engagement with telerehabilitation will be a valuable addition to

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3 the literature and could help to identify factors associated with adherence and  
4 withdrawal, and behavioural strategies to encourage adoption.  
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7 One aspect of telerehabilitation which increases its appeal is the potential for  
8 substantial direct and indirect cost savings. The 2019 study by Ihrig<sup>(40)</sup> highlighted that  
9 telerehabilitation was associated with considerable time and cost savings for patients  
10 by reducing travel requirements and fuel consumption. However, in cases where  
11 individual specialist equipment was required, such as the adapted telephone system  
12 in the study from Lancioni and colleagues<sup>(38)</sup>, costs per unit were expected to be in  
13 the region of \$2,000 USD. The economic value of telerehabilitation from a provider  
14 perspective requires more research. For example, additional costs may be incurred  
15 for services such as training, measurement readings, data management, and ongoing  
16 maintenance of many devices. Indeed, remote service delivery has been associated  
17 with slightly higher costs to service providers, such as speech therapy in people with  
18 Parkinson's disease<sup>(48)</sup>. Nevertheless, it could be expected that remote rehabilitation  
19 costs would be largely absorbed by the reduced need for time and resources required  
20 for non-remote services. It is noteworthy that telerehabilitation may have a wider reach  
21 than standard rehabilitation services, and the increased availability and convenience  
22 of a remote service may be more appealing to a broader profile of patients (e.g.,  
23 working age individuals with minimal time for in-person sessions). As shown by Ihrig  
24<sup>(40)</sup>, remote service delivery led to an average workload increase of 24% due to a  
25 higher number of patents accessing the service. If this finding applied to a broader  
26 audience, there will likely be a larger rehabilitation patient caseload, with possible  
27 capacity implications for clinical practice.  
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44 One difficulty associated with comparing results across studies is the lack of  
45 consensus when measuring outcomes. Across all ten studies identified in this review,  
46 27 different outcome measures were used to assess the effectiveness of  
47 telerehabilitation. These included both performance-based assessments, such as  
48 psychometric testing, and subjective or patient-reported measures of health status,  
49 visual functioning and quality of life. In the four studies which used patient-reported  
50 outcomes, just one measure (SF-36) was used in more than one study. An important  
51 consideration for clinicians, researchers and trialists could be to aim for a more unified  
52 approach when deciding on a core set of outcome measures in future trials and  
53 evaluations of telerehabilitation. Secondly, whilst it is encouraging that patients' views  
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3 and experiences are being considered when measuring the effectiveness of  
4 telerehabilitation, it is important to consider the sensitivity of outcome measures to  
5 meaningful changes in areas such as functionality, symptomatology, and quality-of-  
6 life etc. For example, the non-significant changes in quality-of-life observed in the  
7 study by Sabel and Gudlin <sup>(35)</sup> could be explained by the use of non-disease-specific  
8 measures, which may not be sufficiently sensitive to detect small or subtle changes in  
9 visual function <sup>(49)</sup>. Finally, the evidence synthesised in this review suggests that  
10 telerehabilitation is generally regarded as acceptable by those who are willing to  
11 engage with it. Yet, acceptability is a multifaceted concept which may not be fully  
12 explained by behaviour such as the degree of adherence or engagement with an  
13 intervention; thus, future studies investigating acceptability may benefit from a  
14 theoretical framework to guide the assessment of acceptability <sup>(50)</sup>.

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16 Although no studies were formally excluded on the basis of insufficient quality,  
17 some common study limitations were identified. The majority of the studies introduce  
18 a self-selection bias when participants elect to take part in research and are  
19 willing/show willingness to engage with telerehabilitation programmes. Although  
20 common in cross-sectional research, self-selection bias can complicate the  
21 interpretation of study data as participants' propensity for participating in research may  
22 correlate with the topic under investigation. For example, Lorenzini and Wittich <sup>(33)</sup>  
23 report that 79% of eligible participants declined to take part in the study. As such, the  
24 conclusions are based on a relatively small proportion of the target population.  
25 Reasons for non-participation were seldom discussed in the published reports;  
26 therefore, it is unclear whether factors such as level of familiarity with devices, visual  
27 functioning, extent of sight loss, or having assistance from a normally sighted friend or  
28 family member impact on engagement with telerehabilitation. In addition, study  
29 findings to date have evaluated telerehabilitation over a relatively short period of time.  
30 As observed by Lorenzini and Wittich <sup>(33)</sup>, engagement is more likely to decrease after  
31 6 months, highlighting the need for more longitudinal studies. A further common  
32 limitation was the relatively small sample sizes observed in the studies. For example,  
33 four of the 10 studies included in this review had a sample size of 10 or fewer. There  
34 are currently very few randomised controlled clinical trials evaluating patient outcomes  
35 in telerehabilitation, and we propose this would be an important avenue for further  
36 research.

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This review's methodology has a number of limitations. Only articles written in English were screened and ultimately included, thus excluding potentially relevant studies in languages other than English. However, only three studies were excluded for this reason. Moreover, included studies were required to relate to some form of vision impairment, and several studies included heterogenous samples of varying or unknown degrees of sight loss from numerous conditions. A range of vision impairment terms were used across the studies including 'sight loss', 'blindness' and "low vision". Results were rarely disaggregated by disease severity or type, thereby making it difficult to account for potential nuances between different patient groups under the broad overarching term of 'vision impairment'. A key strength of this review was the inclusion of grey literature. Grey literature includes a range of documents not controlled by commercial publishing organisations and can be a rich source of information which cannot be obtained from other sources <sup>(51)</sup>. Our analysis of grey literature showed that after an initial switch to remote service delivery during the COVID-19 pandemic, many charities were reviewing their long-term rehabilitation frameworks with an indication that pathways will include a blended approach, offering both remote and face-to-face services on a personalised basis, but require further auditing and evaluation. It is notable that besides a few national sight loss charities (Blind Veterans UK, RNIB), the availability of telerehabilitation appeared to vary greatly, with availability appearing highest within local charities in areas including Cambridgeshire, Leicestershire, and Nottinghamshire. While a paucity of online documentation in other regions does not necessarily equate to an absence of such services, it does suggest a possible unevenness in their availability across local authorities. This may reflect broader issues pertaining to unequal access to sight loss support nationwide. As telerehabilitation continues to emerge as an effective and potentially permanent fixture in the care pathways of visually impaired people, there is a need to bridge the gaps in service delivery to ensure there is equitable provision across all areas of the UK, particularly given the potential for a wider geographical reach with remote services thereby increasing access to support.

In summary, the COVID-19 pandemic necessitated a redesign of traditional face-to-face rehabilitation pathways to remote service delivery. A previous systematic review assessing the effectiveness of low vision telerehabilitation found no studies had been completed in this area <sup>(22)</sup>. We identified a range of remote-based rehabilitation



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3 services aimed at optimising vision and encouraging adjustment to sight loss, with  
4 evidence to suggest some patients are generally accepting of this model and may  
5 benefit from improved functional and quality-of-life outcomes, whilst potentially offering  
6 a more cost-effective approach to continuing care. The weight of the evidence  
7 suggests telerehabilitation has a promising role in patient care pathways for people  
8 with a vision impairment; however, issues around long-term desirability and  
9 compliance remain unclear. Given the variability in patients' aptitude and motivation  
10 to sustainably engage with telerehabilitation, a self-select approach may be the most  
11 practical means of ensuring effective implementation of remote services. This review  
12 has addressed increasingly relevant questions about the role of telerehabilitation when  
13 applied among visually impaired people. The findings to date begin to illustrate the  
14 effectiveness of remote rehabilitation services, but more research is needed to better  
15 understand its scalability and longevity. Ultimately, we hope this review can inform key  
16 stakeholders, including hospital eye services, community groups, and charities about  
17 priority areas for future research and development.

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32 **Author contributions:** All authors made substantial contributions to the design and  
33 analysis of the work. LJ and ML performed the literature search, article screening, data  
34 extraction, quality appraisal and manuscript preparation. CLC, NH, and RSMG  
35 conceptualised the review and edited the manuscript. All authors approved the final  
36 manuscript.

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41 **Competing interests:** None

42  
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44 TP-211.

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47 **Data availability statement:** No data are available.

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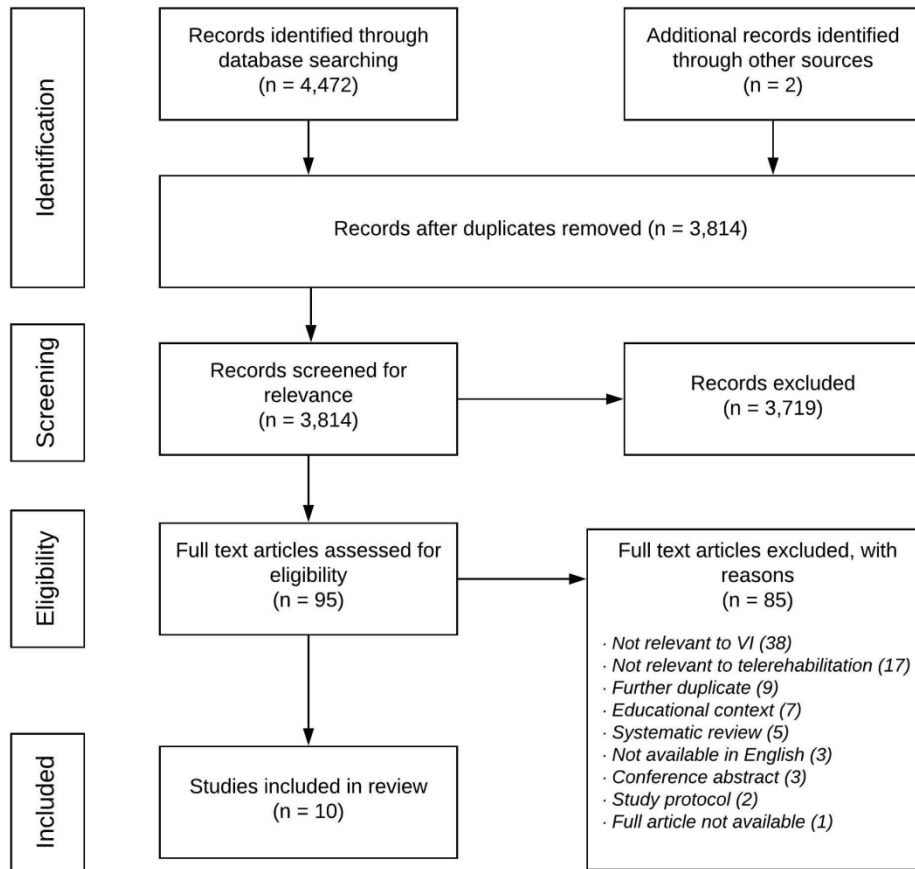


Figure 1. PRISMA diagram showing study selection process. Key: VI = vision impairment

170x159mm (300 x 300 DPI)

## Supplementary material – Data extraction table

Authors	Study title	Design	Domain(s) of outcomes	Location	Study objectives	Study populations	Main results/conclusions
Bittner <i>et al.</i> , 2018	Feasibility of telerehabilitation for low vision: satisfaction ratings by providers and patients	Experimental	Patient satisfaction and recommendations	USA	To develop, administer, refine and evaluate components required to deliver follow-up low vision telerehabilitation services.	10 participants with self-rated vision ranging from good to poor. 9 with AMD; 1 with DR. Average age 80 (range = 63-91) years.	Providers and participants rated video quality as excellent to good. Audio quality ratings were variable, generally related to signal strength or technical issues during some sessions. All participants agreed that they were satisfied and comfortable receiving telerehabilitation. Eight of 10 reported that their magnifier use improved. All except one reported that they were very interested in receiving telerehabilitation again. Positive feedback from both participants and providers in this pilot study supports the feasibility, acceptability, and potential value of low vision telerehabilitation.
Dogru-Huzmeli <i>et al.</i> , 2021	Can diplopia complaint be reduced by telerehabilitation in multiple sclerosis patient during the pandemic? A case report	Case report	QoL and well-being	Turkey	To determine the effect of Cawthorne-Cooksey exercises applied via telerehabilitation on eye movements, vision, and quality of life in a multiple sclerosis patient with diplopia.	1 male participant with multiple sclerosis aged 39 years.	Following 4 months of telerehabilitation, the participant stated that his double vision complaints decreased, and his eyes could move more easily. When eye movements were evaluated, outward gaze restriction had improved. There was no change in visual acuity, anterior and posterior segment examinations, and OCT examination. It can be feasible to administer Cawthorne-Cooksey exercises using telerehabilitation to reduce diplopia.
Dunne <i>et al.</i> , 2020	Maximizing telerehabilitation for patients with visual loss after stroke: interview and focus group study with stroke survivors, carers, and	Qualitative	Patient satisfaction and recommendations	UK	To identify barriers and facilitators using rehabilitation tools and elements of good practice in telerehabilitation among stroke survivors.	66 focus group participants. 32 stroke survivors with partial vision loss (18 men; aged 43-83 years, mean age 62.28 years), 10 carers (7 women; 41-75 years, mean age 54.70 years), and 24	Themes identified problems associated with poststroke health care from both patients' and occupational therapists' perspectives that need to be addressed to improve uptake of telerehabilitation. Themes included identifying additional materials or assistance to boost the impact of training packages. Perceptions of technology were considered a barrier

Authors	Study title	Design	Domain(s) of outcomes	Location	Study objectives	Study populations	Main results/conclusions
	occupational therapists					occupational therapists (19 women; 22-31 years, mean age 31.13 years)	by some but a facilitator by others. In addition, 4 key features of telerehabilitation were identified: additional materials, the importance of goal setting, repetition, and feedback.
Ihrig, 2019	Travel cost savings and practicality for low vision telerehabilitation	Cost analysis	Cost-effectiveness	USA	To evaluate patient acceptance and practicality of low vision telerehabilitation.	419 veterans, average age 83 (range = 60-101) years. 406 were male. 208 had diagnosis that resulted in non-correctable or best corrected visual acuity in both eyes up to 20/150 (defined as not legally blind); 149 had non-correctable or best corrected visual acuity in both eyes of 20/200 or worse (defined as legal blindness); 22 had non-correctable peripheral visual field loss in one or both eyes >20 degrees (defined as not legally blind); and 40 had non-correctable peripheral visual field loss in both eyes <20 degrees (defined as legal blindness).	Of the 419 veterans seen since November 2012 (FY 13), the median saving of travel miles for rural patients was 122 miles per veteran (51,136 miles/419 veterans) and the median saving of travel time was 2.09 h per veteran (878 h/419 veterans). Overall, the median saving of the travel cost per rural individual (utilizing \$0.535 per mile) was \$65.29 per veteran (\$27,357.76/419). Travel mileage and time saving resulted in an increase in access to low-vision rehabilitation (24% increase in partially sighted veterans evaluated in 5 years) by reducing the veteran's travel distance, time, and cost. Utilising low vision telerehabilitation increases early access and enables veterans who cannot travel to a specialty clinic the opportunity to prevent potential decline in functional ability over time.
Lancioni <i>et al.</i> , 2011	Enabling two women with blindness and additional disabilities to make phone calls independently via a	Case report	QoL and well-being	Italy	To assess whether two women with blindness and additional disabilities could make independent phone calls through a	Two female participants aged 30 and 41 years. One participant with retinopathy and congenital cataract leading to total blindness by age 28.	Both participants learnt to use the system and made phone calls independently to family members, friends and staff personnel. Neither participant made calls independently at baseline. During the first intervention phase, one participant had a mean cumulative conversation time per



Authors	Study title	Design	Domain(s) of outcomes	Location	Study objectives	Study populations	Main results/conclusions
	computer-aided telephone system				computer-aided telephone system.	One congenitally blind participant due to gestational complications.	session of ~11 minutes. The mean length of the sessions was ~21 minutes. For the second participant, mean (cumulative) conversation time per session was ~10 minutes. The mean length of the sessions was ~17 minutes.
Lorenzini & Wittich, 2021	Personalised telerehabilitation for a head-mounted low vision aid: A randomized feasibility study	Observational case-control	Patient satisfaction and recommendations	Canada	To determine the feasibility of telerehabilitation using eSight eyewear with low vision participants. Feasibility defined as achieving recruitment target, proportion of participants lost to follow up, and whether the intervention was accessible and acceptable.	57 participants; 88% male, average age 54.5 (range = 21-82) years. All were categorized as having an ocular disease, most common were optic nerve disease, AMD, RP, and retinopathy of prematurity.	Withdrawal rate was higher in the control group but did not differ significantly from the experimental group. High accessibility (93% of participants accessed the platform) and global acceptability (100% overall satisfaction) were reported among those who completed the telerehabilitation protocol. The therapist had no difficulty judging the participants' reading performances qualitatively while participants used their device to read their eSkills and VisExc guides. Most participants improved their daily activities, based on qualitative reports of the attained goals. Seventy-nine percent of individuals declined to participate, whereas 16% of participants decided not to use eSight Eyewear anymore. Positive feedback from the participants and the low vision therapist suggests the potential value of this modality for low vision services.
Lorenzini & Wittich, 2021	Head-mounted visual assistive technology-related quality of life changes after telerehabilitation	Observational case-control	Patient satisfaction and recommendations / QoL and well-being	Canada	To explore the effect of telerehabilitation (eSight eyewear) on quality-of-life and functional vision in individuals with low vision using a head-mounted display.	57 participants; 88% male, average age 54.5 (range = 21-82) years. All were categorized as having an ocular disease, most common were optic nerve disease, AMD, RP, and retinopathy of prematurity.	Assistive technology-related quality of life was improved when measured by the satisfaction scale but not the psychosocial scale within the first 3 months, independently of training type. Overall, functional vision improvement was observed within the first 2 weeks of device use and maintained during the 6-month study, independently of group type. eSight Eyewear, either with telerehabilitation or with the manufacturer

Authors	Study title	Design	Domain(s) of outcomes	Location	Study objectives	Study populations	Main results/conclusions
							self-training comparison, improved functional vision and increased users' quality of life within the initial 3 months of device training and practice.
Sabel & Gudlin, 2014	Vision restoration training for glaucoma: A randomized clinical trial	Randomised clinical trial	Vision training / QoL and well-being	Germany	To determine if behavioural activation of areas of residual vision using daily 1-hour vision restoration training for glaucoma for 3-months improves detection accuracy compared with placebo.	30 participants; 4 male; mean [SD] age 61.7 [10.1] years; 20 participants with primary open angle glaucoma; 5 with normal tension glaucoma; 4 with secondary glaucoma; 1 with angle-closure glaucoma. Mean [SD] visual acuity was 0.62 [0.34] (range 0.0-1.3 logMAR) in the right eye and 0.76 [0.40] (range 0.0-1.8 logMAR) in the left eye.	Vision restoration training for glaucoma led to significant detection accuracy gains in high-resolution perimetry (P = .007), which were not found with white-on-white or blue-on-yellow perimetry. Pre-post differences after vision restoration training for glaucoma were greater compared with placebo in all perimetry tests (P = .02 for high-resolution perimetry, P = .04 for white on white, and P = .04 for blue on yellow), and these results were independent of eye movements. Vision restoration training for glaucoma (but not placebo) also led to faster reaction time (P = .009). Vision-related quality of life was unaffected, but the health-related quality-of-life mental health domain increased in both groups.
Senjam <i>et al.</i> , 2021	Tele-rehabilitation for visually challenged students during COVID-19 pandemic: Lesson learned	Case report	Managing symptoms	India	To report experiences of a telerehabilitation service available primarily for students with visual disabilities amidst the COVID-19 pandemic.	492 participants (male = 388). The majority of beneficiaries were between 11 and 30 years (82.3%). Around 96% of beneficiaries were visually disabled, and 16.5% had unknown visual status (waiting or applied for certificates).	The most common ocular complaints for which beneficiaries required advice were itching (N= 121; 36.1%); watering eyes (N = 54; 16.1%); painful eyes (N = 12; 3.6%), redness (N = 5; 1.5%). Telerehabilitation can offer a safe and efficient means of providing reliable information to visually impaired individuals.



Authors	Study title	Design	Domain(s) of outcomes	Location	Study objectives	Study populations	Main results/conclusions
Tinelli <i>et al.</i> , 2017	Development and implementation of a new telerehabilitation system for audio-visual stimulation training in hemianopia	Experimental	Vision training	Italy	To test the feasibility and efficacy of audio-visual telerehabilitation in three adult patients with chronic visual field defects.	Three participants with hemianopia. One male had cerebral stroke; one adult had drug-resistant epilepsy caused by a focal cortical dysplasia type 2a; one male had partial left homonymous hemianopia following surgery for a meningioma in the right hemisphere.	Results suggest audio-visual telerehabilitation is an effective treatment based on the stimulation of ocular movements and visual exploration functions through compensative strategies. Patients were instructed to use saccadic eye movements for the detection of visual targets and thus they showed, at the end of the treatment, an activation of the oculomotor system and a change in responsiveness toward visual stimuli, confirmed by behavioural data, mostly using the Unimodal Visual Test. The test allows patients to exercise independently in a familiar context, while under remote supervision. It may give the patient a sense of control and autonomy, which can contribute to a better therapy outcome, also reducing the need for one-to-one treatment time and home visits.

**Supplementary material – Data extraction table.** Data extraction table. **Key** - QoL: quality-of-life. AMD: age-related macular degeneration. DR: diabetic retinopathy. RP: retinitis pigmentosa. SD: standard deviation. logMAR: logarithm of the minimum angle of resolution. OCT: optical coherence tomography. FY: fiscal year.

# Reporting checklist for systematic review (with or without a meta-analysis).

Based on the PRISMA guidelines.

## Instructions to authors

Complete this checklist by entering the page numbers from your manuscript where readers will find each of the items listed below.

Your article may not currently address all the items on the checklist. Please modify your text to include the missing information. If you are certain that an item does not apply, please write "n/a" and provide a short explanation.

Upload your completed checklist as an extra file when you submit to a journal.

In your methods section, say that you used the PRISMA reporting guidelines, and cite them as:

Page MJ, McKenzie JE, Bossuyt PM, Boutron I, Hoffmann TC, Mulrow CD, Shamseer L, Tetzlaff JM, Akl EA, Brennan SE, Chou R, Glanville J, Grimshaw JM, Hróbjartsson A, Lalu MM, Li T, Loder EW, Mayo-Wilson E, McDonald S, McGuinness LA, Stewart LA, Thomas J, Tricco AC, Welch VA, Whiting P, Moher D. The PRISMA 2020 statement: An updated guideline for reporting systematic reviews

	Reporting Item	Page Number
<b>Title</b>		
Title	<a href="#">#1</a> Identify the report as a systematic review	1
<b>Abstract</b>		

1	Abstract	<a href="#">#2</a>	Report an abstract addressing each item in the	2
2			PRISMA 2020 for Abstracts checklist	
3				
4				
5				
6	<b>Introduction</b>			
7				
8				
9	Background/rationale	<a href="#">#3</a>	Describe the rationale for the review in the context	4
10			of existing knowledge	
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14	Objectives	<a href="#">#4</a>	Provide an explicit statement of the objective(s) or	5
15			question(s) the review addresses	
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19				
20	<b>Methods</b>			
21				
22				
23	Eligibility criteria	<a href="#">#5</a>	Specify the inclusion and exclusion criteria for the	7
24			review and how studies were grouped for the	
25			syntheses	
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30	Information sources	<a href="#">#6</a>	Specify all databases, registers, websites,	6
31			organisations, reference lists, and other sources	
32			searched or consulted to identify studies. Specify	
33			the date when each source was last searched or	
34			consulted	
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43	Search strategy	<a href="#">#7</a>	Present the full search strategies for all databases,	6
44			registers, and websites, including any filters and	
45			limits used	
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51	Selection process	<a href="#">#8</a>	Specify the methods used to decide whether a	7
52			study met the inclusion criteria of the review,	
53			including how many reviewers screened each	
54			record and each report retrieved, whether they	
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1			worked independently, and, if applicable, details of	
2			automation tools used in the process	
3				
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5				
6	Data collection	<a href="#">#9</a>	Specify the methods used to collect data from	7
7				
8	process		reports, including how many reviewers collected	
9			data from each report, whether they worked	
10			independently, any processes for obtaining or	
11			confirming data from study investigators, and, if	
12			applicable, details of automation tools used in the	
13			process	
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22	Data items	<a href="#">#10a</a>	List and define all outcomes for which data were	Supplementary
23			sought. Specify whether all results that were	material
24			compatible with each outcome domain in each	
25			study were sought (for example, for all measures,	
26			time points, analyses), and, if not, the methods	
27			used to decide which results to collect	
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37	Study risk of bias	<a href="#">#11</a>	Specify the methods used to assess risk of bias in	8
38			the included studies, including details of the tool(s)	
39	assessment		used, how many reviewers assessed each study	
40			and whether they worked independently, and, if	
41			applicable, details of automation tools used in the	
42			process	
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51	Effect measures	<a href="#">#12</a>	Specify for each outcome the effect measure(s)	N/A
52			(such as risk ratio, mean difference) used in the	
53			synthesis or presentation of results	
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1	Synthesis methods	<a href="#">#13a</a>	Describe the processes used to decide which	8
2			studies were eligible for each synthesis (such as	
3			tabulating the study intervention characteristics and	
4			comparing against the planned groups for each	
5			synthesis (item #5))	
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13	Synthesis methods	<a href="#">#13b</a>	Describe any methods required to prepare the data	N/A
14			for presentation or synthesis, such as handling of	
15			missing summary statistics or data conversions	
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21	Synthesis methods	<a href="#">#13c</a>	Describe any methods used to tabulate or visually	Supplementary
22			display results of individual studies and syntheses	material
23				
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26	Synthesis methods	<a href="#">#13d</a>	Describe any methods used to synthesise results	N/A
27			and provide a rationale for the choice(s). If meta-	
28			analysis was performed, describe the model(s),	
29			method(s) to identify the presence and extent of	
30			statistical heterogeneity, and software package(s)	
31			used	
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41	Synthesis methods	<a href="#">#13e</a>	Describe any methods used to explore possible	N/A
42			causes of heterogeneity among study results (such	
43			as subgroup analysis, meta-regression)	
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48	Synthesis methods	<a href="#">#13f</a>	Describe any sensitivity analyses conducted to	N/A
49			assess robustness of the synthesised results	
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1	Reporting bias	<a href="#">#14</a>	Describe any methods used to assess risk of bias	6
2				
3	assessment		due to missing results in a synthesis (arising from	
4			reporting biases)	
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9	Certainty	<a href="#">#15</a>	Describe any methods used to assess certainty (or	7
10				
11	assessment		confidence) in the body of evidence for an outcome	
12				
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14	Data items	<a href="#">#10b</a>	List and define all other variables for which data	Supplementary
15			were sought (such as participant and intervention	material
16			characteristics, funding sources). Describe any	
17			assumptions made about any missing or unclear	
18			information	
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26	<b>Results</b>			
27				
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29	Study selection	<a href="#">#16a</a>	Describe the results of the search and selection	8
30			process, from the number of records identified in	
31			the search to the number of studies included in the	
32			review, ideally using a flow diagram	
33			( <a href="http://www.prisma-statement.org/PRISMAStatement/FlowDiagram">http://www.prisma-</a>	
34			<a href="http://www.prisma-statement.org/PRISMAStatement/FlowDiagram">statement.org/PRISMAStatement/FlowDiagram</a> )	
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41	Study selection	<a href="#">#16b</a>	Cite studies that might appear to meet the inclusion	8
42			criteria, but which were excluded, and explain why	
43			they were excluded	
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51	Study characteristics	<a href="#">#17</a>	Cite each included study and present its	9-15 +
52			characteristics	Supplementary
53				material
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1	Risk of bias in	<a href="#">#18</a>	Present assessments of risk of bias for each	8
2				
3	studies		included study	
4				
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6	Results of individual	<a href="#">#19</a>	For all outcomes, present for each study (a)	N/A
7				
8	studies		summary statistics for each group (where	
9			appropriate) and (b) an effect estimate and its	
10			precision (such as confidence/credible interval),	
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16			ideally using structured tables or plots	
17				
18	Results of syntheses	<a href="#">#20a</a>	For each synthesis, briefly summarise the	8
19				
20			characteristics and risk of bias among contributing	
21			studies	
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26	Results of syntheses	<a href="#">#20b</a>	Present results of all statistical syntheses	N/A
27				
28			conducted. If meta-analysis was done, present for	
29			each the summary estimate and its precision (such	
30			as confidence/credible interval) and measures of	
31			statistical heterogeneity. If comparing groups,	
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33			describe the direction of the effect	
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40	Results of syntheses	<a href="#">#20c</a>	Present results of all investigations of possible	N/A
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42			causes of heterogeneity among study results	
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46	Results of syntheses	<a href="#">#20d</a>	Present results of all sensitivity analyses	N/A
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48			conducted to assess the robustness of the	
49			synthesised results	
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1	Risk of reporting	<a href="#">#21</a>	Present assessments of risk of bias due to missing	N/A
2				
3	biases in syntheses		results (arising from reporting biases) for each	
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5			synthesis assessed	
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9	Certainty of evidence	<a href="#">#22</a>	Present assessments of certainty (or confidence) in	16-20
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11			the body of evidence for each outcome assessed	
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14	<b>Discussion</b>			
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17	Results in context	<a href="#">#23a</a>	Provide a general interpretation of the results in the	16-20
18				
19			context of other evidence	
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23	Limitations of	<a href="#">#23b</a>	Discuss any limitations of the evidence included in	18
24				
25	included studies		the review	
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28	Limitations of the	<a href="#">#23c</a>	Discuss any limitations of the review processes	19
29				
30	review methods		used	
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33	Implications	<a href="#">#23d</a>	Discuss implications of the results for practice,	16-20
34				
35			policy, and future research	
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39	<b>Other information</b>			
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42	Registration and	<a href="#">#24a</a>	Provide registration information for the review,	7
43				
44	protocol		including register name and registration number, or	
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46			state that the review was not registered	
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49	Registration and	<a href="#">#24b</a>	Indicate where the review protocol can be	7
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51	protocol		accessed, or state that a protocol was not prepared	
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1	Registration and	<a href="#">#24c</a>	Describe and explain any amendments to	N/A
2				
3	protocol		information provided at registration or in the	
4				
5			protocol	
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8	Support	<a href="#">#25</a>	Describe sources of financial or non-financial	20
9				
10			support for the review, and the role of the funders	
11				
12			or sponsors in the review	
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15	Competing interests	<a href="#">#26</a>	Declare any competing interests of review authors	20
16				
17	Availability of data,	<a href="#">#27</a>	Report which of the following are publicly available	20
18				
19	code, and other		and where they can be found: template data	
20				
21	materials		collection forms; data extracted from included	
22			studies; data used for all analyses; analytic code;	
23			any other materials used in the review	
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 33 CC-BY. This checklist was completed on 07. December 2021 using <https://www.goodreports.org/>, a  
 34 tool made by the [EQUATOR Network](#) in collaboration with [Penelope.ai](#)  
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# BMJ Open

## A scoping review of remote rehabilitation (telerehabilitation) services to support people with vision impairment.

Journal:	<i>BMJ Open</i>
Manuscript ID	bmjopen-2021-059985.R1
Article Type:	Original research
Date Submitted by the Author:	24-May-2022
Complete List of Authors:	Jones, Lee; BRAVO VICTOR; UCL, Institute of Ophthalmology Lee, Matthew; BRAVO VICTOR; Blind Veterans UK Castle, Claire L.; BRAVO VICTOR Heinze, Nikki; BRAVO VICTOR Gomes, Renata S.M.; BRAVO VICTOR; Northumbria University, Department of Nursing, Midwifery and Health
<b>Primary Subject Heading</b>:	Ophthalmology
Secondary Subject Heading:	Rehabilitation medicine
Keywords:	OPHTHALMOLOGY, REHABILITATION MEDICINE, Quality in health care < HEALTH SERVICES ADMINISTRATION & MANAGEMENT

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2  
3 1 **Title:** A scoping review of remote rehabilitation (telerehabilitation) services to support  
4 2 people with vision impairment.  
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## 22 ABSTRACT

23 **Objective:** Telerehabilitation for individuals with vision impairment aims to maintain  
24 maximum physical and/or psychological functioning through remote service delivery.  
25 This review aims to describe the type of telerehabilitation services available to people  
26 with vision impairment and summarise evidence on health-related outcomes, well-  
27 being and cost-effectiveness.

28 **Design:** Scoping review.

29 **Data sources:** CINAHL Plus, MEDLINE, PsycARTICLES, PsychINFO, Embase,  
30 PubMed, HMIC and Ovid Emcare were searched, without date restrictions up to 24  
31 May 2021. Charity and government websites, conference proceedings, and clinical  
32 trial databases were also examined.

33 **Eligibility criteria:** Eligible studies evaluated benefits of telerehabilitation services for  
34 adults with vision impairment. Studies were excluded if they were not available in  
35 English, or focused on distance learning of visually impaired students.

36 **Data extraction and synthesis:** Two independent reviewers screened articles and  
37 extracted data. A risk of bias analysis was performed.

38 **Outcome measures:** Measures of benefit included performance-based assessment,  
39 patient-reported outcomes, and cost-effectiveness.

40 **Results:** Of 4,472 articles, 10 eligible studies were included. Outcomes addressed  
41 patient satisfaction (n=4;33.3%), quality-of-life, activities of daily living, and well-being  
42 (n=4;33.3%), objective visual function (n=2;16.6%), and knowledge relating to ocular  
43 symptoms (n=1;8.3%). Two studies addressed multiple outcomes. Cost-effectiveness  
44 was addressed in one article (8.3%). Patients were generally satisfied with their  
45 experiences, which had a range of positive benefits on functional and quality-of-life  
46 outcomes in areas relating to daily activities (e.g., reading, making phone calls).  
47 Telerehabilitation allowed patients to undertake vision optimisation training to prevent  
48 vision deterioration. Grey literature indicated there are no completed clinical trials  
49 relating to low vision telerehabilitation. Charity services had implemented digital skills  
50 training to help beneficiaries communicate remotely.

51 **Conclusion:** While acceptability of telerehabilitation was mostly high, limited real-  
52 world data are available which raises questions around the long-term desirability of

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2  
3 53 this Further trials are needed to evaluate telerehabilitation using a robust set of  
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5 54 outcome measures.

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7 55 **PROSPERO registration number:** CRD42021254825  
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For peer review only



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**Strengths and limitations of this study**

- This review provides novel findings informing design of future trials and evaluations of telerehabilitation.
- Inclusion of grey literature reduces publication bias and increases the comprehensiveness of the review.
- Only articles written in English were included and results were seldom disaggregated by disease type or severity.

For peer review only

## 64 INTRODUCTION

65 Visual impairment is a broad term used to describe a reduction in visual sensitivity that  
66 cannot be corrected by standard eyeglasses or medical treatment. It is estimated that  
67 over 2 million people in the United Kingdom (UK) are living with a form of visual  
68 impairment <sup>(1)</sup>. People with vision impairment may be classified as 'sight impaired' (i.e.,  
69 partially sighted) or 'severely sight impaired' (i.e., legally blind) <sup>(2)</sup>. The impact of visual  
70 impairment can be complex and highly heterogenous, affecting aspects of daily  
71 functioning, mobility, and quality of life <sup>(3-8)</sup>. Among the widely prevalent ophthalmic  
72 conditions such as age-related macular degeneration, glaucoma, and diabetic  
73 retinopathy, loss of vision is typically progressive and irreversible; hence, support  
74 relies heavily on rehabilitation to promote adaption, enabling patients to better manage  
75 the challenges associated with vision loss and to live an independent and fulfilling life  
76 <sup>(9, 10)</sup>.

77 The mainstay of rehabilitation is to restore or maintain physical and/or  
78 psychological functioning to the maximum degree possible in individuals living with  
79 disease or injury <sup>(11)</sup>. In vision rehabilitation, eye care providers are encouraged to  
80 provide rehabilitative support or refer patients to relevant services, even in cases of  
81 mild or moderate sight loss <sup>(12)</sup>. Rehabilitation encompasses many disciplines, and  
82 interventions may include provision of visual aids, devices and software, behavioural  
83 training, home environment assessments and adaptations, social and psychological  
84 support, leisure and vocational activities, or a combination of these strategies <sup>(13, 14)</sup>.  
85 However, rehabilitation is characteristically structured around overcoming the practical  
86 and functional challenges of sight loss, whilst psychological outcomes are seldom  
87 addressed directly <sup>(15)</sup>. The type of services which are offered often depends on the  
88 nature of the visual impairment. For example, the rehabilitative needs of individuals  
89 with central visual field loss may differ from those with impaired peripheral vision <sup>(16)</sup>.  
90 The traditional mode of delivery for vision rehabilitation has been in face-to-face  
91 settings within outpatient clinics or home visits by low vision specialists or allied health  
92 professionals; though digital developments have increased opportunity for remote  
93 service delivery (i.e., telerehabilitation).

94 Telerehabilitation, also known as virtual training, refers to delivering  
95 rehabilitative services using a remote or virtual approach, facilitated by  
96 telecommunication technologies. Services may comprise a range of elements

1  
2  
3 97 designed to assess, prevent, treat, educate, or counsel individuals living with chronic  
4  
5 98 health conditions <sup>(17)</sup>. Telerehabilitation services may be synchronous, whereby  
6  
7 99 services are delivered in real-time using two-way video or audio communication, or  
8  
9 100 asynchronous, such as remote evaluation of recorded videos or other measurements  
10  
11 101 such as surveys or psychophysical testing <sup>(18)</sup>. Compared to traditional face-to-face  
12  
13 102 rehabilitation, telerehabilitation offers potential benefits, such as reduced costs,  
14  
15 103 increased geographical accessibility, and creating opportunities to extend limited  
16  
17 104 resources <sup>(19)</sup>. Moreover, telerehabilitation has been identified as an effective means  
18  
19 105 of delivering support to individuals with chronic conditions including multiple sclerosis,  
20  
21 106 osteoarthritis, and stroke <sup>(20-22)</sup>.

22  
23 107 Whilst there is convincing evidence to suggest telerehabilitation can be effective  
24  
25 108 at improving physical and psychological functioning in people living with chronic health  
26  
27 109 conditions <sup>(20-22)</sup>, less is known about the benefits of telerehabilitation services for  
28  
29 110 people with a vision impairment. For example, a previous systematic review sought to  
30  
31 111 compare outcomes between face-to-face and virtual vision rehabilitation services, yet  
32  
33 112 no completed studies were found <sup>(23)</sup>. Additionally, new services such as remote  
34  
35 113 delivery of clinical care (telehealth) are likely to have emerged during the COVID-19  
36  
37 114 pandemic which have yet to be reviewed. This is significant given the rapid and  
38  
39 115 extensive scale-up of telehealth services since the beginning of the pandemic <sup>(24, 25)</sup>.  
40  
41 116 This scoping review, therefore, aims to draw together evidence on telerehabilitation  
42  
43 117 services, and describe their impact on health and well-being outcomes in people with  
44  
45 118 vision impairment.

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## 48 120 **Objectives**

- 49 121 1. Describe the type of telerehabilitation services available to people with vision  
50 122 impairment.
- 51 123 2. Provide insight on the impact of telerehabilitation in terms of health-related  
52 124 outcomes, well-being and cost-effectiveness.

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3 **128 METHODS**  
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5 129 This review follows best practice for conducting scoping reviews as outlined by the  
6  
7 130 Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA)  
8  
9 131 extension for Scoping Reviews checklist to ensure all aspects of the process are  
10  
11 132 undertaken using rigorous and transparent methods <sup>(26)</sup>. A search of the electronic  
12  
13 133 databases CINAHL Plus and MEDLINE (via EBSCOhost) and PsycARTICLES,  
14  
15 134 PsychINFO, Embase, PubMed, HMIC and Ovid Emcare (via Ovid) was undertaken  
16  
17 135 without date restrictions or topic filters. As recommended by The Cochrane Handbook  
18  
19 136 for Systematic Reviews of Interventions, medical subject headings (MeSH) were used  
20  
21 137 to identify the most relevant articles <sup>(27)</sup>. MeSH terms are official words or phrases  
22  
23 138 selected to represent medical concepts and are assigned to articles in order to  
24  
25 139 describe what the research item is about <sup>(28)</sup>. This process provided a list of keywords  
26  
27 140 relating to vision impairment and telerehabilitation. For detailed search terms, see  
28  
29 141 Table 1. Reference lists of included studies and any identified systematic reviews were  
30  
31 142 also reviewed for relevant articles, and citation tracking was performed using Google  
32  
33 143 Scholar.  
34  
35 144

Vision impairment term		Telerehabilitation term
vision OR low vision OR vision loss OR reduced vision OR subnormal vision OR diminished vision OR vis* impair* OR sight loss OR blind* OR partially sighted	AND	telerehab* OR tele-rehab* OR remote rehab* OR virtual rehab* OR e-learning OR online learning OR online training OR telephone training OR telephone rehab* OR telephone learning OR virtual learning OR web training OR virtual training

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45 **Table 1.** Search terms  
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47 145  
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49 146 In addition, we reviewed online conference proceedings for relevant abstracts by  
50  
51 147 searching the websites of the International Society of Physical and Rehabilitation  
52  
53 148 Medicine; American Congress of Rehabilitation Medicine; Association for Research in  
54  
55 149 Vision and Ophthalmology; American Academy of Ophthalmology; European  
56  
57 150 Association for Vision and Eye Research. A search of grey literature included  
58  
59 151 searching for relevant articles or reports on the websites of organisations such as the  
60  
152 UK National Institute for Health and Clinical Excellence (NICE; [www.nice.org.uk](http://www.nice.org.uk)) and

1  
2  
3 153 National Health Service (NHS) Evidence ([www.evidence.nhs.uk](http://www.evidence.nhs.uk)). World Health  
4  
5 154 Organisation International Clinical Trials Registry Platform (ICTRP) and the US  
6  
7 155 National Institute of Health trial register (ClinicalTrials.gov) were searched for ongoing  
8  
9 156 and completed trials relating to vision impairment and telerehabilitation. We also  
10  
11 157 conducted an extensive search of the UK Charity Commission website to identify  
12  
13 158 organisations with links to vision impairment and rehabilitation. Relevant charity  
14  
15 159 websites were then searched and in cases where telerehabilitation was documented,  
16  
17 160 any available documentation was downloaded and reviewed, and charities were  
18  
19 161 contacted to enquire about the current status of telerehabilitation.

## 19 162 **Population**

20  
21 163 Adult patients (aged 18 years or older) with visual impairment caused by any  
22  
23 164 underlying condition, medical or non-medical trauma.

## 25 165 **Intervention**

26  
27 166 The scoping review considered how telerehabilitation services have impacted people  
28  
29 167 with vision impairment. Where available, evidence on cost-effectiveness will be  
30  
31 168 included. The review included studies where a telerehabilitation service is delivered  
32  
33 169 and evaluated, which could relate to improving well-being; increased social  
34  
35 170 participation/connectivity; maintaining activities of daily living (e.g., mobility);  
36  
37 171 optimisation of vision.

38  
39 172 Articles written in English, with no restrictions on publication period, and only where  
40  
41 173 the full text was available were included. Studies were required to address the  
42  
43 174 intervention (telerehabilitation) and population of interest (adults with visual  
44  
45 175 impairment). Articles were excluded if they did not relate to remote service delivery  
46  
47 176 (i.e., face-to-face services). Articles focusing only on an educational context (e.g., e-  
48  
49 177 learning) were also excluded. For example, visually impaired students using home  
50  
51 178 technology for distance learning.

52  
53 179 Two authors (LJ and ML) independently screened studies using Covidence systematic  
54  
55 180 review software (Veritas Health Innovation Ltd, Melbourne, Australia; available  
56  
57 181 at [www.covidence.org](http://www.covidence.org)) to assess eligibility. Any disagreement in coding decisions  
58  
59 182 were resolved through discussion. Relevant information (e.g., publication details,  
60  
183 characteristics of participants, study design, outcomes measured, study results, and  
184 conclusions) from eligible articles was entered into a data extraction table.

1  
2  
3 185 Studies were assessed for quality using Kmet *et al.* 'Standard Quality Assessment  
4 186 *Criteria for Evaluating Primary Research Papers from a Variety of Fields*' (29). This  
5 187 quality appraisal tool was chosen because of both quantitative and qualitative studies  
6 188 emerging from the literature search. The tool uses a checklist to provide guidance on  
7 189 study aspects which should be considered when making a decision regarding quality  
8 190 of reporting. For example, in response to the item regarding subject characteristics,  
9 191 the study in question must provide at least the age and sex of participants. This review  
10 192 is registered online with the International prospective register of systematic reviews  
11 193 (PROSPERO; [www.crd.york.ac.uk/prospero/](http://www.crd.york.ac.uk/prospero/); Reference CRD42021254825).

12  
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14 194

### 15 195 **Patient and public involvement**

16 196 No patients were involved in the design of the review. We will disseminate plain  
17 197 language summaries to relevant patient groups including beneficiaries of Blind  
18 198 Veterans UK.

19 199

### 20 200 **Research ethics approval**

21 201 Ethical approval for this scoping review was not required.

## 202 RESULTS

203 Searches were run on 24 May 2021 and yielded 4,472 results. Of these, 658 were  
204 automatically removed as duplicates. This left 3,814 studies to screen using title and  
205 abstract, of which 3,719 were excluded and 95 were assessed for full-text eligibility.  
206 Studies were mostly excluded at the title and abstract screening stage because they  
207 did not relate to telerehabilitation or did not involve people with a vision impairment.  
208 These two reasons were also the primary cause for exclusion in the full-text review  
209 accounting for 17 and 38 exclusions, respectively. A further two studies were added  
210 through reference list searching. Ultimately, 10 full-text studies were selected for  
211 inclusion. The study selection process is shown in the PRISMA diagram in Figure 1.

<Insert Figure 1 here>

**Figure 1.** PRISMA diagram showing study selection process. Key: VI = vision impairment

217 Two authors (LJ and ML) independently assessed the quality of all 10 studies. The  
218 lowest score was 0.64, the highest was 1.00 (i.e., all responses to relevant questions  
219 in the Kmet *et al.* appraisal criteria were 'Yes'), and the median score was 0.93. Full  
220 details of quality appraisal are provided in Supplementary Material 1.

221 The following overview of study findings is organised according to the main  
222 outcome domains for each of the 10 articles identified in the literature search. Two  
223 articles feature in more than one section as the outcomes were translatable across  
224 multiple domains. Four studies (33.3%) addressed patient satisfaction<sup>(30, 31, 32, 33)</sup>, two  
225 studies (16.6%) related to objective visual function <sup>(34, 35)</sup>, four studies (33.3%)  
226 measured patient-reported outcomes, activities of daily living, and well-being <sup>(33, 34, 36,</sup>  
227 <sup>37)</sup>, one study (8.3%) addressed knowledge relating to ocular symptoms <sup>(38)</sup>, and a  
228 further one study (8.3%) was an analysis of cost-effectiveness <sup>(39)</sup>. Six studies used a  
229 synchronous modality whereas four studies were asynchronous in nature. For full  
230 details of the included studies, refer to the data extraction table (Supplementary  
231 Material 2).



## 232 **Patient satisfaction**

233 Four articles explored patients' satisfaction with telerehabilitation which led to  
234 recommendations for key features to improve uptake of services. Three of these  
235 articles reported the findings of feasibility studies<sup>(31, 32, 33)</sup>, and one was a qualitative  
236 analysis of patient experiences<sup>(30)</sup>. All of these studies included participants with a  
237 visual impairment caused by a range of pathologies including age-related macular  
238 degeneration, optic nerve disease, retinitis pigmentosa, and stroke-related visual field  
239 deficit.

240 Dunne *et al.*'s<sup>(30)</sup> study of stroke survivors reports the outcomes of qualitative  
241 interviews and focus groups with patients and carers. The study was informed by the  
242 findings of a survey of Stroke Association group members in the UK and the aims were  
243 to understand experiences of a compensatory eye-movement tool and training  
244 packages. The Durham Reading and Exploration Training (DREX) is a computer-  
245 based telerehabilitation training system teaching adaptive eye movement strategies to  
246 enable stroke survivors to cope more effectively with visual field deficits<sup>(40)</sup>. DREX is  
247 a mobile application which incorporates tasks that combine both reading and  
248 exploration (e.g., scanning an array to locate a target). In the context of rehabilitation,  
249 the application is asynchronous in nature whereby healthcare professionals can  
250 access and review patients' results at a later time through a clinical portal. The wider  
251 study required patients with stroke-related visual field defects to complete the DREX  
252 trials on a tablet in their own homes and outcomes were compared to a control  
253 intervention, which consisted of attention-based tasks with no eye movement or  
254 exploration exercises. Significantly greater gains were observed in visual exploration  
255 (12.9%, 95% confidence interval [CI] = 8.4 to 17.3%) and reading (18.5%, 95% CI =  
256 9.9 to 27.0%) following DREX than in the control intervention for both tasks,  
257 respectively (exploration = 4.8%, 95% CI = 0.1 to 9.5%; reading = 1.6%, 95% CI =  
258 -4.8 to 8.7%)<sup>(40)</sup>. Qualitative responses highlighted a range of issues in the application  
259 of telerehabilitation for visually impaired stroke survivors. For example, a lack of  
260 confidence with technology, perceived fear of making mistakes while online, distrust  
261 of the quality of the intervention, and concerns with reduced face-to-face contact.  
262 However, these issues could be addressed in initial in-person visits to alleviate  
263 concerns and facilitate engagement and motivation in the rehabilitation process. One  
264 challenge is that compensatory training is inherently repetitive in nature; thus,

1  
2  
3 265 measures should be taken to ensure telerehabilitation tools remain accessible and  
4  
5 266 stimulating to avoid disengagement. The authors propose that one approach which  
6  
7 267 may obviate disengagement is to employ feedback and goal setting to improve  
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9 268 motivation and provide tangible progress updates.

10  
11 269 Patient satisfaction was assessed by Bittner *et al.* <sup>(31)</sup> in a pilot study to develop,  
12  
13 270 administer and evaluate a synchronous virtual low vision portal providing  
14  
15 271 telerehabilitation services. Ten patients diagnosed with either age-related macular  
16  
17 272 degeneration (n = 9) or diabetic retinopathy (n = 1) were enrolled. Participants were  
18  
19 273 required to have access to a home telephone to use the Internet-based video  
20  
21 274 conference portal. Tablet devices were provided as well as MiFi (wireless router which  
22  
23 275 acts as a mobile Wi-Fi hotspot) to enable connection to the Internet. Each participant  
24  
25 276 received one telerehabilitation session which lasted approximately one hour. The  
26  
27 277 session included administration of the MNREAD chart which consists of a series of  
28  
29 278 60-character sentences displayed over three lines and is used to assess reading  
30  
31 279 fluency and proficiency using optical magnifiers, using video and audio recordings of  
32  
33 280 the participant. Assessments of working distance and lighting were made by the  
34  
35 281 provider viewing the video of the participant reading with their magnifier, whereas  
36  
37 282 assessments of reading speed and accuracy relied on the audio component as  
38  
39 283 participants read aloud during the MNREAD and near acuity tests. The outcomes  
40  
41 284 were participants' and providers' audio and video quality ratings. Video quality was  
42  
43 285 rated as excellent to good, whereas audio ratings were more variable. All participants  
44  
45 286 were satisfied and comfortable receiving telerehabilitation and evaluation via  
46  
47 287 videoconferencing. Eight of 10 reported that their magnifier use improved after  
48  
49 288 telerehabilitation. All except one reported that they were very interested in receiving  
50  
51 289 telerehabilitation services again if their visual needs changed.

52  
53 290 Lorenzini and Wittich <sup>(32)</sup> reported outcomes related to patient satisfaction in a  
54  
55 291 randomised feasibility study using a head-mounted display and a telehealth platform  
56  
57 292 to deliver synchronous telerehabilitation sessions at home. Participants received real-  
58  
59 293 time distance training sessions delivered by a low vision therapist. The intervention  
60  
294 focused on the functional aspects of using eSight eyewear, an assistive technology  
295 designed to maximise visual input and compensate for vision loss. The intervention  
296 group underwent a personalised training programme including eSkills functional  
297 learning activities such as reading, writing, and distance vision training. A control group

1  
2  
3 298 were randomly allocated to conventional eSight self-training using the eSkills user  
4  
5 299 guide. Fifty-seven visually impaired participants were enrolled (experimental group, n  
6  
7 300 = 28), the most common causes of sight loss were optic nerve disease, age-related  
8  
9 301 macular degeneration, retinopathy of prematurity, and retinitis pigmentosa. Retention  
10  
11 302 rates during the study were 93% (n = 53) at 2 weeks, 68% (n = 39) at 3 months, and  
12  
13 303 65% (n = 37) at 6 months. A higher proportion of patients who withdrew from the study  
14  
15 304 were enrolled into the control group. Participants reported being comfortable with  
16  
17 305 receiving telerehabilitation training at home, with 16 of 23 (66%) agreeing the  
18  
19 306 programme was effective and efficient, and the majority (20 of 23) approving that they  
20  
21 307 would be interested in using telerehabilitation again in the future.

22  
23 308 A parallel investigation by Lorenzini and Wittich<sup>(33)</sup> used standardised  
24  
25 309 measures to assess quality of life and patient satisfaction following the eSight  
26  
27 310 telerehabilitation programme. Quality of life outcomes are reported in a later section.  
28  
29 311 Satisfaction was measured using the 12-item Quebec User Evaluation of Satisfaction  
30  
31 312 with Assistive Technology (QUEST) tool<sup>(41)</sup>. Scores on the measure increased for  
32  
33 313 participants in both the experimental and control group between baseline and 3-  
34  
35 314 months of device usage, suggesting satisfaction improved independently of the type  
36  
37 315 of training. There were no differences in assistive technology-related satisfaction  
38  
39 316 based on age or sex. Improvement in QUEST scores were not maintained at 6-  
40  
41 317 months. The authors suggest this may be due to the device no longer meeting certain  
42  
43 318 needs after extended usage, or a lessening impact of social desirability, leading to  
44  
45 319 more realistic and honest responses from participants over time.

### 42 320 **Objective visual function**

44 321 Two studies focused on training related to optimisation of vision delivered through a  
45  
46 322 telerehabilitation service. The studies used visual exploration and ocular movement  
47  
48 323 tasks to activate neuroplasticity to compensate for visual loss. Both studies included  
49  
50 324 patients with measurable visual field loss including areas of diminished sensitivity in  
51  
52 325 glaucoma and hemianopia in stroke patients.

53 326 Sabel and Gudlin<sup>(34)</sup> compared outcomes of asynchronous behavioural training  
54  
55 327 using a 1-hour computer-based vision restoration programme for people with  
56  
57 328 glaucoma and a placebo group. Participants were required to have a stable  
58  
59 329 glaucomatous visual field defect inside 30° eccentricity in at least one eye, with well  
60

1  
2  
3 330 controlled intraocular pressure. After baseline assessments, training was performed  
4  
5 331 6-days per week for 3-months at home on a commercially available computer with  
6  
7 332 adaptive parameter adjustments. The experimental group performed vision training  
8  
9 333 similar to perimetry whereby visual stimuli of varying luminance are presented in areas  
10  
11 334 of residual vision. The placebo group performed stimulus discrimination training.  
12  
13 335 Vision restoration exercises led to improved vision-related performance in detection  
14  
15 336 accuracy as determined by high-resolution perimetry ( $p=0.007$ ). Pre versus post  
16  
17 337 differences after vision training for glaucoma were greater compared with placebo in  
18  
19 338 all perimetry tests ( $p=0.02$  for high-resolution perimetry;  $p=0.04$  for white-on-white  
20  
21 339 perimetry;  $p=0.04$  for blue on yellow perimetry), without affecting eye movements.  
22  
23 340 Moreover, the vision restoration training led to faster reaction time for the glaucoma  
24  
25 341 group ( $p=0.009$ ). The authors conclude that a telerehabilitation system designed to  
26  
27 342 promote visual system plasticity can be used among older age adults despite  
28  
29 343 widespread visual deterioration, and activation of residual vision may partly reverse  
30  
31 344 vision loss.

32  
33 345 A study on patients with hemianopia used a bespoke asynchronous audio-  
34  
35 346 visual telerehabilitation system <sup>(35)</sup>. The system featured a semi-circular apparatus in  
36  
37 347 which visual and acoustic stimuli are presented and a central camera to control head  
38  
39 348 and eye movements. Patients used the system at home on a customised tablet which  
40  
41 349 was controlled by a hospital-based therapist. Following an initial assessment in the  
42  
43 350 clinic, participants underwent training at home at least 5 days a week for up to 12  
44  
45 351 months. The aim of the training was to stimulate multisensory integration mechanisms  
46  
47 352 to reinforce visual and spatial compensatory functions, for example, adoption of  
48  
49 353 oculomotor strategies. Among the sample of three adults with hemianopia, all were  
50  
51 354 capable of actively using the device independently whilst under remote supervision.  
52  
53 355 Participants showed some improvements in visual detection abilities, which was  
54  
55 356 assessed using two procedures (a unimodal test using only visual stimuli presented at  
56  
57 357 one of 12 spatial locations lasting 100 milliseconds, and a bimodal audio-visual test  
58  
59 358 whereby visual stimuli was paired with sound), with the strongest effect on both testing  
60  
359 procedures observed when participants were free to use eye movements to detect  
360 targets, rather than the fixed eye condition.

### 361 ***Quality-of-life, activities of daily living, and well-being***

1  
2  
3 362 Four articles assessed outcomes relating to quality-of-life, activities of daily living, and  
4 well-being following telerehabilitation (33, 34, 36, 37). The studies use patient-reported  
5 363 outcome measures and behavioural measurements to examine the benefits of remote  
6 364 interventions in people with a vision impairment. Two articles are case reports (36, 37),  
7 365 and two articles describe the quality-of-life outcomes from the eSight eyewear (33), and  
8 366 vision restoration training programmes (34), described in an earlier section.  
9 367

10 368 Lorenzini and Wittich (33) measure changes in quality-of-life following  
11 369 telerehabilitation with the eSight eyewear programme using the Psychosocial Impact  
12 370 of Assistive Devices Scale (PIADS) (42), a 26-item questionnaire composed of three  
13 371 subscales (competence, adaptability, and self-esteem), and the Veterans Affairs Low  
14 372 Vision Visual Functioning Questionnaire (VA LV VFQ-48) (43), a 48-item instrument  
15 373 used to measure subjective visual outcomes. Visually impaired participants completed  
16 374 the measures at baseline, 2-weeks, 3-months, and 6-months. Results patterns were  
17 375 similar across the three subscales of the PIADS showing statistically significantly  
18 376 improved scores after 3 months in both the intervention and control groups ( $p=0.05$ ),  
19 377 indicating that assistive technology-related quality-of-life (i.e., perceived impact of  
20 378 assistive devices on quality-of-life) improved independently of the type of training  
21 379 received. Self-reported functional vision outcomes, as determined by the VA LV VFQ-  
22 380 48, yielded statistically significant improvements in overall scores, as well as in  
23 381 subscales (reading ( $p=0.03$ ), visual information ( $p<0.001$ ), mobility ( $<0.001$ )) after 2  
24 382 weeks of using the device; improvements also continued after 3 months (all  $p \leq$   
25 383  $0.05$ ).

26 384 Sabel and Gudlin's (34) vision restoration programme used the National Eye  
27 385 Institute Visual Function Questionnaire (NEI-VFQ-25) (44) and the Short-Form-36 (SF-  
28 386 36) (45) to measure changes in quality of life between baseline and post-intervention  
29 387 follow-up. Vision training was not associated with robust changes on these measures.  
30 388 Only the mental health subscale of the SF-36 was found to have improved, which may  
31 389 be caused by non-specific training effects such as attention, alertness, or expectation.  
32 390 However, participants had generally scored highly on both measures at baseline,  
33 391 indicating few everyday vision deficits.

34 392 A case report by Dogru-Huzmeli *et al.* (36) explored whether diplopia complaints  
35 393 could be ameliorated using the Cawthorne-Cooksey exercises applied via  
36 394 telerehabilitation in a multiple sclerosis patient with a visual field scotoma. Cawthorne-



1  
2  
3 395 Cooksey exercises use a set of eye and head movements which are based on the  
4  
5 396 concept of habituation and designed to build up a tolerance mechanism to support  
6  
7 397 equilibrium and balance <sup>(46, 47)</sup>. Exercises were delivered synchronously through  
8  
9 398 WhatsApp video calls over 30 sessions. Comparison of pre- and post- eye  
10  
11 399 examinations suggested gaze restriction, as determined through ophthalmic  
12  
13 400 examination, had improved and that the patient had fewer self-reported double vision  
14  
15 401 complaints. Pre- and post-intervention quality-of-life was assessed using the SF-36  
16  
17 402 measure of general health. Analysis was based on descriptive reporting of changes in  
18  
19 403 scores, with no statistical analysis reported. The authors report improvement in all  
20  
21 404 domains of the SF-36, except for physical functioning, where there was no change.

22  
23 405 A study from Lancioni and colleagues <sup>(37)</sup> assessed whether two congenitally  
24  
25 406 blind women could be supported to make independent phone calls using a computer-  
26  
27 407 aided system. Both women attended a rehabilitation centre where the study took  
28  
29 408 place. The system comprised of a netbook computer which was enabled with a global  
30  
31 409 system for mobile communication with a headset and microphone apparatus. The  
32  
33 410 study adopted an ABAB design in which A represented baseline phases and B  
34  
35 411 represented intervention phases with the telephone system. Communication-related  
36  
37 412 outcomes included the total number of calls made, number of calls met with a  
38  
39 413 response, and length of calls. Both participants learnt to use the system and made  
40  
41 414 phone calls independently to a variety of contacts such as family members, friends,  
42  
43 415 and care staff personnel, indicating that the intervention may be useful for enabling  
44  
45 416 people with a vision impairment to manage phone calls on their own.

#### 42 417 ***Knowledge relating to ocular symptoms***

44 418 One study used a telerehabilitation approach to increase knowledge of ocular  
45  
46 419 symptoms to support patients attending a residential school for visually impaired  
47  
48 420 people during the COVID-19 pandemic <sup>(38)</sup>. Senjam and colleagues <sup>(38)</sup> used voice-  
49  
50 421 over internet protocols (e.g., WhatsApp calling, Zoom) to enable rehabilitation  
51  
52 422 practitioners at a tertiary eye centre in India to deliver therapeutic education and  
53  
54 423 counselling interventions and monitor ocular complaints among visually impaired  
55  
56 424 adults and children who were unable to attend face-to-face appointments. Over a 2-  
57  
58 425 month study period, 492 patients contacted the team. Health-related complaints were  
59  
60 426 made by 335 patients, the most common ocular complaints being itching (36.1%),  
427 watering (16.1%), and painful eyes (3.6%). Counselling sessions addressed

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3 428 uncertainty surrounding clinical monitoring of eye health, however specific outcomes  
4  
5 429 of counselling were not reported.

### 6 7 430 **Cost-effectiveness**

8  
9 431 A retrospective cost analysis from Ihrig<sup>(39)</sup> examined the economic practicality of a  
10  
11 432 clinical model of telerehabilitation for visually impaired military veterans.  
12  
13 433 Telerehabilitation was delivered by an optometrist and rehabilitation therapist to  
14  
15 434 veterans with conditions including age-related macular degeneration, glaucoma,  
16  
17 435 diabetic retinopathy, cataracts, and retinitis pigmentosa. Sessions took place remotely  
18  
19 436 at either the participants' home or local community outpatient centre. The rehabilitation  
20  
21 437 intervention included home adaptive skills training, which includes a home safety  
22  
23 438 checklist, orientation and mobility training and computer training, as well as training  
24  
25 439 with vision-related activities such as meal management, financial planning, personal  
26  
27 440 care, and leisure time activities (Ihrig, 2014)<sup>(48)</sup>. Total and median travel cost and time  
28  
29 441 savings were estimated per veteran per fiscal year. Introduction of the  
30  
31 442 telerehabilitation service in 2012 increased access to rural veterans in Western New  
32  
33 443 York. Over a 5-year period, 419 veterans who were unable to access traditional low  
34  
35 444 vision rehabilitation due to travel issues accessed the remote service. The proportion  
36  
37 445 of patients accessing the telerehabilitation service represented 24% of the overall  
38  
39 446 rehabilitation caseload. Median saving of travel miles was 122 miles per veteran  
40  
41 447 (51,136 miles/419 veterans). Median saving of travel time was 2.09 hours per veteran  
42  
43 448 (878 hours/419 veterans). Overall, median travel cost saving per rural individual was  
44  
45 449 \$65.29 per veteran (\$27,357.76/419 veterans). The authors conclude that  
46  
47 450 telerehabilitation can be a practical, time-saving, and cost-saving alternative to  
48  
49 451 traditional face-to-face consultations.

### 46 452 **Grey literature**

48 453 Searches of charity websites led to the identification of 11 organisations in the UK  
49  
50 454 where vision rehabilitation services had been shifted to remote delivery during the  
51  
52 455 pandemic. The full list of organisations and the type of service delivery are described  
53  
54 456 in Supplementary Material 3. The charities were contacted about telerehabilitation  
55  
56 457 services and whether any evaluations had been undertaken. This process resulted in  
57  
58 458 the review of seven documents, predominantly internal reports about the restructure  
59  
60 459 of rehabilitation services during the COVID-19 pandemic. While these documents



1  
2  
3 460 were mostly descriptive, there was useful information demonstrating telerehabilitation  
4  
5 461 practice patterns in the third sector. Analysis of grey literature showed that many  
6  
7 462 charities were reviewing their long-term rehabilitation frameworks with an indication  
8  
9 463 that pathways will include a blended approach, offering both remote and face-to-face  
10  
11 464 services on a personalised basis, but require further auditing and evaluation. Most of  
12  
13 465 the organisations described implementing digital skills training to enable beneficiaries  
14  
15 466 to become more proficient with computers and technology, such as making video calls  
16  
17 467 and downloading smartphone applications. There were also examples of internal  
18  
19 468 service evaluations to identify preferences in rehabilitation delivery. For example, Blind  
20  
21 469 Veterans UK, a charity providing support and services to visually impaired UK  
22  
23 470 veterans, reported information about the needs of their beneficiaries (including  
24  
25 471 emotional support, befriending, assistance with shopping and using technology),  
26  
27 472 methods in delivering remote rehabilitation (including 1:1 interventions such as  
28  
29 473 mindfulness phone sessions and video-based group exercises), and working with  
30  
31 474 allied agencies throughout the COVID-19 pandemic to signpost beneficiaries to  
32  
33 475 support. It was notable that besides a few national sight loss charities (Blind Veterans  
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35 476 UK, RNIB), the availability of telerehabilitation appeared to vary greatly, appearing  
36  
37 477 highest within local charities in areas including Cambridgeshire, Leicestershire, and  
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39 478 Nottinghamshire.

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479 The search of clinical trial databases returned two ongoing trials relevant to  
480 telerehabilitation for visually impaired people, which are briefly described here. Van  
481 der Aa and colleagues (Trial ID: NTR6337) will examine the feasibility of an e-mental  
482 health treatment for patients with retinal exudative diseases receiving anti-VEGF  
483 treatment. The cognitive behavioural therapy-based intervention is offered via the  
484 Internet through the guidance of a social worker. The trial will deliver training and  
485 information which aim to help patients in dealing with their eye condition and managing  
486 uncertainties around treatment. The primary outcomes relate to measurements of  
487 depression, anxiety, and quality of life. Another trial (NCT04926974) will evaluate the  
488 efficacy of a mobile phone application to improve quality of life in older adults with low  
489 vision. The application features include real-time remote personal assistance with  
490 visual tasks, optical character recognition which allows text to be converted to audio  
491 and read aloud, and magnifiers to aid vision. The study seeks to understand the  
492 potential of these technologies to improve daily activities, community participation,

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3 493 independence, and self-sufficiency in people with low vision. Notably, there are a  
4 494 range of ongoing or completed trials relating to telemonitoring of visually impaired  
5 495 people, such as validation of home-based measurement tools (e.g., remote visual field  
6 496 testing). Given such studies are intended to address the broader concept of home  
7 497 monitoring and are not specifically within the context of rehabilitation, these trials were  
8 498 not included.

### 14 499 ***Trends in publishing***

16 500 As shown by the results of this review, studies evaluating the impact of  
17 501 telerehabilitation on people with vision impairment are beginning to emerge among the  
18 502 published literature. Yet, these studies represent only a small proportion of the total  
19 503 research on people with vision impairment. For example, a PubMed search for articles  
20 504 with 'vision impairment' or 'blindness' in the title or abstract yielded 17,783 results  
21 505 since 2010 alone; while in that same period just 10 articles (0.06%) were published  
22 506 that were relevant to telerehabilitation.

## 29 507 **DISCUSSION**

31 508 Vision rehabilitation is a key stage in the eye care journey. Rehabilitative services can  
32 509 help to mitigate the impact of vision loss by equipping patients with new skills and  
33 510 training while providing social connectedness and psychological support<sup>(49-53)</sup>. This  
34 511 review shows that the landscape of rehabilitation is evolving to include synchronous  
35 512 and asynchronous approaches to remote rehabilitation for people with eye conditions.  
36 513 Studies using patient-reported outcome measures suggest telerehabilitation can lead  
37 514 to improved outcomes relating to self-reported daily functioning and quality-of-life<sup>(33,</sup>  
38 515 <sup>34, 36, 37)</sup>. In addition, there is generally a high level of acceptability from patients for this  
39 516 shift in service delivery<sup>(31, 32, 33)</sup>. However, there remain certain distinct challenges  
40 517 associated with telerehabilitation which may curtail the extent to which this approach  
41 518 is adopted and retained more widely.

### 51 519 ***Measuring benefits and acceptability of interventions***

52 520 One difficulty associated with comparing results across studies is the lack of  
53 521 consensus when measuring outcomes. Across all ten studies identified in this review,  
54 522 27 different outcome measures were used to assess the benefits of telerehabilitation.  
55 523 These included both performance-based assessments, such as psychometric testing,  
56 524 and subjective or patient-reported measures of health status, visual functioning and

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3 525 quality of life. In the four studies which used patient-reported outcomes, just one  
4 526 measure (SF-36) was used in more than one study. An important consideration for  
5 527 clinicians, researchers and trialists could be to aim for a more unified approach when  
6 528 deciding on a core set of outcome measures in future trials and evaluations of  
7 529 telerehabilitation. Secondly, whilst it is encouraging that patients' views and  
8 530 experiences are being considered when measuring the benefits of telerehabilitation, it  
9 531 is important to consider the sensitivity of outcome measures to meaningful changes in  
10 532 areas such as functionality, symptomatology, and quality-of-life etc. For example, the  
11 533 non-significant changes in quality-of-life observed in the study by Sabel and Gudlin <sup>(34)</sup>  
12 534 could be explained by the use of non-disease-specific measures, which may not be  
13 535 sufficiently sensitive to detect small or subtle changes in visual function <sup>(54)</sup>. Finally,  
14 536 the evidence synthesised in this review suggests that telerehabilitation is generally  
15 537 regarded as acceptable by those who are willing to engage with it. Yet, acceptability  
16 538 is a multifaceted concept which may not be fully explained by quantitative behaviour  
17 539 metrics such as the degree of adherence or engagement with an intervention. No  
18 540 studies included in this review describe a framework for acceptability, indicating further  
19 541 research is needed to understand acceptability of telerehabilitation using a robust  
20 542 assessment of relevant factors such as affective attitudes, opportunity costs, ethicality,  
21 543 and self-efficacy; thus, future studies investigating acceptability may benefit from a  
22 544 theoretical framework to guide the assessment of acceptability <sup>(55)</sup>.

### 37 38 545 ***Recommendations and challenges in practise***

39  
40 546 Several of the studies in this review included recommendations for  
41 547 telerehabilitation which provide helpful insights. For example, a period of direct training  
42 548 with home-based technology was regarded positively, suggesting such training can  
43 549 provide patients with a helpful rehabilitation framework. Despite an increasing number  
44 550 of visually impaired adults engaging with technology <sup>(56)</sup>, it is inevitable that some  
45 551 individuals will have underlying concerns about their technical readiness to operate  
46 552 devices at home. An assessment of individual self-efficacy regarding health  
47 553 management and aptitude for telerehabilitation may, therefore, help to prioritise  
48 554 individuals for whom this approach is most likely to be acceptable and successful.

49  
50  
51 555 A key challenge associated with telerehabilitation is maintaining patient  
52 556 motivation and engagement. Rehabilitation is, by nature, highly repetitive and often  
53 557 requires engagement over long periods of time before measurable improvements in

1  
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3 558 areas such as functional vision can be observed. Although studies in this review  
4  
5 559 yielded good patient satisfaction ratings <sup>(33)</sup> and high retention rates <sup>(32)</sup>, it is difficult to  
6  
7 560 predict the sustainability of telerehabilitation outside the context of a research study.  
8  
9 561 For example, devices risk becoming a nuisance if required long term, and whilst  
10 562 acceptable within research, patients may resist such commitments becoming the  
11  
12 563 standard of care. Similar findings regarding the acceptability of telerehabilitation have  
13  
14 564 been described in a recent systematic review of telerehabilitation for improving  
15 565 adaptive skills in people with multiple disabilities <sup>(57)</sup>, which found that patients are  
16  
17 566 particularly satisfied with the convenience of undergoing rehabilitation from home.  
18  
19 567 However, studies in this review described potentially intensive programmes of  
20  
21 568 telerehabilitation, in some instances requiring several hours of engagement on  
22  
23 569 consecutive days per week. For example, Tinelli and colleagues' <sup>(35)</sup> participants were  
24  
25 570 asked to use the telerehabilitation tools for 5-days per week for up to 12-months.  
26  
27 571 Further research using real-world data on patterns of engagement with  
28  
29 572 telerehabilitation will be a valuable addition to the literature and could help to identify  
30  
31 573 factors associated with adherence and withdrawal, and behavioural strategies to  
32  
33 574 encourage adoption.

### 33 575 ***Cost and capacity considerations***

35 576 One aspect of telerehabilitation which increases its appeal is the potential for  
36  
37 577 substantial direct and indirect cost savings. The 2019 study by Ihrig <sup>(39)</sup> highlighted that  
38  
39 578 telerehabilitation was associated with considerable time and cost savings for patients  
40  
41 579 by reducing travel requirements and fuel consumption. However, in cases where  
42  
43 580 individual specialist equipment was required, such as the adapted telephone system  
44  
45 581 in the study from Lancioni and colleagues <sup>(37)</sup>, costs per unit were expected to be in  
46  
47 582 the region of \$2,000 USD. The economic value of telerehabilitation from a provider  
48  
49 583 perspective requires more research. For example, additional costs may be incurred  
50  
51 584 for services such as training, measurement readings, data management, and ongoing  
52  
53 585 maintenance of many devices. Indeed, remote service delivery has been associated  
54  
55 586 with slightly higher costs to service providers, such as speech therapy in people with  
56  
57 587 Parkinson's disease <sup>(58)</sup>. Nevertheless, it could be expected that remote rehabilitation  
58  
59 588 costs would be largely absorbed by the reduced need for time and resources required  
60  
61 589 for non-remote services. It is noteworthy that telerehabilitation may have a wider reach  
62  
63 590 than standard rehabilitation services, and the increased availability and convenience

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3 591 of a remote service may be more appealing to a broader profile of patients (e.g.,  
4 592 working age individuals with minimal time for in-person sessions). As shown by Ihrig  
5 593 (39), remote service delivery led to an average workload increase of 24% due to a  
6 594 higher number of patients accessing the service. If this finding applied to a broader  
7 595 audience, there will likely be a larger rehabilitation patient caseload, with possible  
8 596 capacity implications for clinical practice.

### 14 597 **Limitations of identified studies**

16 598 Although no studies were formally excluded on the basis of insufficient quality  
17 599 (inclusion threshold set at 55% [0.55]), some common study limitations were identified.  
18 600 The most frequent issues with the studies according to the Kmet et al checklist was  
19 601 the presence of only a partial description of subject characteristics (2 of 10) and study  
20 602 conclusions not being fully supported by the data (3 of 10). Additionally, the majority  
21 603 of the studies introduce a self-selection bias when participants elect to take part in  
22 604 research and are willing to engage with telerehabilitation programmes. Although  
23 605 common in cross-sectional research, self-selection bias can complicate the  
24 606 interpretation of study data as participants' propensity for participating in research may  
25 607 correlate with the topic under investigation. For example, Lorenzini and Wittich (32)  
26 608 report that 79% of eligible participants declined to take part in the study. As such, the  
27 609 conclusions are based on a relatively small proportion of the target population.  
28 610 Reasons for non-participation were seldom discussed in the published reports;  
29 611 therefore, it is unclear whether factors such as level of familiarity with devices, visual  
30 612 functioning, extent of sight impairment, or having assistance from a sighted friend or  
31 613 family member impact on engagement with telerehabilitation. In addition, the studies  
32 614 in this review report the outcomes of telerehabilitation after a relatively short period of  
33 615 time (i.e., less than 1-year). As observed by Lorenzini and Wittich (32), engagement is  
34 616 more likely to decrease after 6 months, highlighting the need for more longitudinal  
35 617 studies. A further common limitation was the relatively small sample sizes observed in  
36 618 the studies. For example, four of the ten studies included in this review had a sample  
37 619 size of 10 or fewer. Although this review set out to describe the type of telerehabilitation  
38 620 for people with vision impairment, participants across the identified studies were  
39 621 mostly low vision patients with mild or moderate visual loss; therefore, the findings  
40 622 may not extend to other subgroups within the vision impairment population, such as  
41 623 those with severe sight impairment or no perception of light. There are currently very



1  
2  
3 624 few randomised controlled clinical trials evaluating patient outcomes in  
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5 625 telerehabilitation, for example, three of the ten studies identified in this review used  
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7 626 random allocation to an intervention and control group <sup>(32, 33, 34)</sup>, and we propose this  
8  
9 627 would be an important avenue for further research, as well as comparisons between  
10  
11 628 traditional face-to-face and telerehabilitation services to understand the challenges  
12  
13 629 associated with telerehabilitation in the specific context of vision impairment.

### 14 630 **Limitations**

15  
16 631 This review's methodology has a number of limitations. Only articles written in  
17  
18 632 English were screened and ultimately included, thus excluding potentially relevant  
19  
20 633 studies in languages other than English. However, only three studies were excluded  
21  
22 634 for this reason. Moreover, included studies were required to relate to some form of  
23  
24 635 vision impairment, and several studies included heterogenous samples of varying or  
25  
26 636 unknown degrees of sight loss from numerous conditions. A range of vision  
27  
28 637 impairment terms were used across the studies including 'sight loss', 'blindness' and  
29  
30 638 'low vision'. Results were rarely disaggregated by disease severity or type, thereby  
31  
32 639 making it difficult to account for potential nuances between different patient groups  
33  
34 640 under the broad overarching term of 'vision impairment'. A key strength of this review  
35  
36 641 was the inclusion of grey literature. Grey literature includes a range of documents not  
37  
38 642 controlled by commercial publishing organisations and can be a rich source of  
39  
40 643 information which cannot be obtained from other sources <sup>(59)</sup>. This review highlights  
41  
42 644 that the availability of telerehabilitation through local charity networks appeared to vary  
43  
44 645 depending on location. While a paucity of online documentation regarding charity  
45  
46 646 telerehabilitation services in some regions does not necessarily equate to an absence  
47  
48 647 of such services, it does suggest a possible unevenness in their availability across  
49  
50 648 local authorities. This may reflect broader issues pertaining to unequal access to sight  
51  
52 649 loss support nationwide. As telerehabilitation continues to emerge as an effective and  
53  
54 650 potentially permanent fixture in the care pathways of visually impaired people, there is  
55  
56 651 a need to bridge the gaps in service delivery to ensure there is equitable provision  
57  
58 652 across all areas of the UK, particularly given the potential for a wider geographical  
59  
60 653 reach with remote services thereby increasing access to support.

## 656 **Conclusions**

657 In summary, the COVID-19 pandemic necessitated a redesign of traditional  
658 face-to-face rehabilitation pathways to remote service delivery. A previous systematic  
659 review assessing the effectiveness of low vision telerehabilitation found no studies had  
660 been completed in this area <sup>(23)</sup>. We identified a range of remote-based rehabilitation  
661 services aimed at optimising vision and encouraging adjustment to sight loss, with  
662 evidence to suggest some patients are generally accepting of this model and may  
663 benefit from improved functional and quality-of-life outcomes, whilst potentially offering  
664 a more cost-effective approach to continuing care. The weight of the evidence  
665 suggests telerehabilitation has a promising role in patient care pathways for people  
666 with a vision impairment; however, issues around long-term desirability and  
667 compliance remain unclear. Given the variability in patients' aptitude and motivation  
668 to sustainably engage with telerehabilitation, a self-select approach which allows  
669 patients to choose their preferred mode of rehabilitation delivery or individualised  
670 interventions may be the most practical means of ensuring effective implementation  
671 of remote services. This review has addressed increasingly relevant questions about  
672 the role of telerehabilitation when applied among visually impaired people. The  
673 findings to date illustrate the benefits of remote rehabilitation services, but more  
674 research is needed to better understand its overall effectiveness, scalability and  
675 longevity. Ultimately, we hope this review can inform key stakeholders, including  
676 hospital eye services, community groups, and charities about priority areas for future  
677 research and development.

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679 analysis of the work. LJ and ML performed the literature search, article screening, data  
680 extraction, quality appraisal and manuscript preparation. CLC, NH, and RSMG  
681 conceptualised the review and edited the manuscript. All authors approved the final  
682 manuscript.

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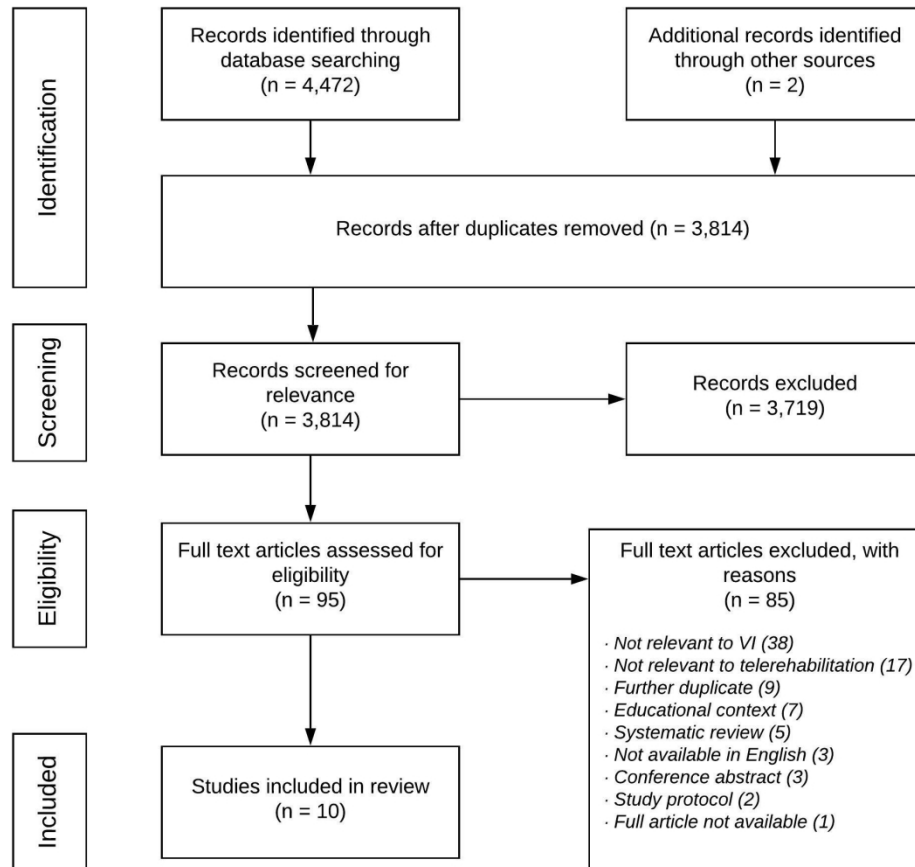


Figure 1. PRISMA diagram showing study selection process. Key: VI = vision impairment

170x159mm (300 x 300 DPI)

## Supplementary material 1 – Quality appraisal

Quantitative studies (N=9)

Authors	Is the question / objective sufficiently described?	Is the study design evident and appropriate?	Is the method of subject/comparison group selection or source of information/input variables described and appropriate?	Are the Subject (and comparison group, if applicable) characteristics sufficiently described?	If interventional and random allocation was possible, was it described?	If interventional and blinding of investigators was possible, was it reported?	If interventional and blinding of subjects was possible, was it reported?	Are outcome and (if applicable) exposure measure(s) well defined and robust to measurement / misclassification bias? Are means of assessment reported?	Is the sample size appropriate?	Are the analytic methods described/justified and appropriate?	Is some estimate of variance is reported for the main results?	Controlled for confounding?	Are results reported in sufficient detail?	Are conclusions supported by the results?	Overall score
Bittner <i>et al.</i> , 2018	Yes (2)	Yes (2)	Yes (2)	Yes (2)	N/A	N/A	N/A	Yes (2)	N/A	Yes (2)	Yes (2)	N/A	Yes (2)	Yes (2)	1.00
Dogru-Huzmeli <i>et al.</i> , 2021	Yes (2)	Yes (2)	N/A	Partial (1)	N/A	N/A	N/A	Partial (1)	N/A	N/A	N/A	N/A	Partial (1)	Partial (1)	0.67
Ihrig, 2019	Yes (2)	Yes (2)	N/A	Partial (1)	N/A	N/A	N/A	Yes (2)	N/A	Yes (2)	Yes (2)	N/A	Yes (2)	Yes (2)	0.94
Lancioni <i>et al.</i> , 2011	Yes (2)	Yes (2)	N/A	Yes (2)	N/A	N/A	N/A	Partial (1)	N/A	N/A	No (0)	N/A	Yes (2)	Yes (2)	0.64
Lorenzini & Wittich, 2021	Yes (2)	Yes (2)	Yes (2)	Yes (2)	Yes (2)	Yes (2)	N/A	Yes (2)	Yes (2)	Yes (2)	Yes (2)	Yes (2)	Yes (2)	Yes (2)	1.00



1	Lorenzini & Wittich, 2021	Yes (2)	Yes (2)	Yes (2)	Yes (2)	Yes (2)	Yes (2)	N/A	Yes (2)	Yes (2)	Yes (2)	N/A	Yes (2)	Yes (2)	Yes (2)	1.00
4	Sabel & Gudlin, 2014	Yes (2)	Yes (2)	Yes (2)	Yes (2)	Yes (2)	Yes (2)	Yes (2)	Yes (2)	Partial (1)	Yes (2)	Yes (2)	Yes (2)	Yes (2)	Partial (1)	0.93
9	Senjam <i>et al.</i> , 2021	Yes (2)	Yes (2)	Yes (2)	Yes (2)	N/A	N/A	N/A	Yes (2)	N/A	N/A	N/A	N/A	Yes (2)	Partial (1)	0.93
11	Tinelli <i>et al.</i> , 2017	Yes (2)	Yes (2)	Partial (1)	Yes (2)	N/A	N/A	N/A	Yes (2)	N/A	Yes (2)	Yes (2)	N/A	Yes (2)	Yes (2)	0.94

### Qualitative study (N=1)

21	Authors	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37
		Question / objective sufficiently described?	Study design evident and appropriate?	Context for the study clear?	Connection to a theoretical framework / wider body of knowledge?	Sampling strategy described, relevant and justified?	Data collection methods clearly described and systematic?	Data analysis clearly described and systematic?	Use of verification procedure(s) to establish credibility?	Conclusions supported by the results?	Reflexivity of the account?	Overall score					
35	Dunne <i>et al.</i> , 2020	Yes (2)	Yes (2)	Yes (2)	Yes (2)	Partial (1)	Yes (2)	Partial (1)	Yes (2)	Yes (2)	Partial (1)	0.85					

## Supplementary material 2 – Data extraction table

Authors	Study title	Design	Domain(s) of outcomes	Location	Study objectives	Study populations	Main results/conclusions
Bittner <i>et al.</i> , 2018	Feasibility of telerehabilitation for low vision: satisfaction ratings by providers and patients	Experimental	Patient satisfaction and recommendations	USA	To develop, administer, refine and evaluate components required to deliver follow-up low vision telerehabilitation services.	10 participants with self-rated vision ranging from good to poor. 9 with AMD; 1 with DR. Average age 80 (range = 63-90) years.	Providers and participants rated video quality as excellent to good. Audio quality ratings were variable, generally related to signal strength or technical issues during some sessions. All participants agreed that they were satisfied and comfortable receiving telerehabilitation. Eight of 10 reported that their magnifier use improved. All except one reported that they were very interested in receiving telerehabilitation again. Positive feedback from both participants and providers in this pilot study supports the feasibility, acceptability, and potential value of low vision telerehabilitation.
Dogru-Huzmeli <i>et al.</i> , 2021	Can diplopia complaint be reduced by telerehabilitation in multiple sclerosis patient during the pandemic? A case report	Case report	QoL and well-being	Turkey	To determine the effect of Cawthorne-Cooksey exercises applied via telerehabilitation on eye movements, vision, and quality of life in a multiple sclerosis patient with diplopia.	1 male participant with multiple sclerosis aged 39 years.	Following 4 months of telerehabilitation, the participant stated that his double vision complaints decreased, and his eyes could move more easily. When eye movements were evaluated, outward gaze restriction had improved. There was no change in visual acuity, anterior and posterior segment examinations, and OCT examination. It can be feasible to administer Cawthorne-Cooksey exercises using telerehabilitation to reduce diplopia.
Dunne <i>et al.</i> , 2020	Maximizing telerehabilitation for patients with visual loss after stroke: interview and focus group study with stroke survivors, carers, and	Qualitative	Patient satisfaction and recommendations	UK	To identify barriers and facilitators using rehabilitation tools and elements of good practice in telerehabilitation among stroke survivors.	66 focus group participants. 32 stroke survivors with partial vision loss (18 men; aged 43-83 years, mean age 62.28 years), 10 carers (7 women; 41-75 years, mean age 54.70 years), and 24	Themes identified problems associated with poststroke health care from both patients' and occupational therapists' perspectives that need to be addressed to improve uptake of telerehabilitation. Themes included identifying additional materials or assistance to boost the impact of training packages. Perceptions of technology were considered a barrier

Authors	Study title	Design	Domain(s) of outcomes	Location	Study objectives	Study populations	Main results/conclusions
	occupational therapists					occupational therapists (19 women; 22 years, mean age 31.13 years)	by some but a facilitator by others. In addition, 4 key features of telerehabilitation were identified: additional materials, the importance of goal setting, repetition, and feedback.
Ihrig, 2019	Travel cost savings and practicality for low vision telerehabilitation	Cost analysis	Cost-effectiveness	USA	To evaluate patient acceptance and practicality of low vision telerehabilitation.	419 veterans, average age 83 (range = 60-101) years. 406 were male. 208 had diagnosis that resulted in non-correctable or best corrected visual acuity in both eyes up to 20/150 (defined as not legally blind); 149 had non-correctable or best corrected visual acuity in both eyes of 20/200 or worse (defined as legal blindness); 22 had non-correctable peripheral visual field loss in one or both eyes >20 degrees (defined as not legally blind); and 40 had non-correctable peripheral visual field loss in both eyes <20 degrees (defined as legal blindness).	Of the 419 veterans seen since November 2012 (FY 13), the median saving of travel miles for rural patients was 122 miles per veteran (51,136 miles/419 veterans) and the median saving of travel time was 2.09 h per veteran (878 h/419 veterans). Overall, the median saving of the travel cost per rural individual (utilizing \$0.535 per mile) was \$65.29 per veteran (\$27,357.76/419). Travel mileage and time saving resulted in an increase in access to low-vision rehabilitation (24% increase in partially sighted veterans evaluated in 5 years) by reducing the veteran's travel distance, time, and cost. Utilising low vision telerehabilitation increases early access and enables veterans who cannot travel to a specialty clinic the opportunity to prevent potential decline in functional ability over time.
Lancioni <i>et al.</i> , 2011	Enabling two women with blindness and additional disabilities to make phone calls independently via a	Case report	QoL and well-being	Italy	To assess whether two women with blindness and additional disabilities could make independent phone calls through a	Two female participants aged 30 and 41 years. One participant with retinopathy and congenital cataract leading to total blindness by age 28.	Both participants learnt to use the system and made phone calls independently to family members, friends and staff personnel. Neither participant made calls independently at baseline. During the first intervention phase, one participant had a mean cumulative conversation time per

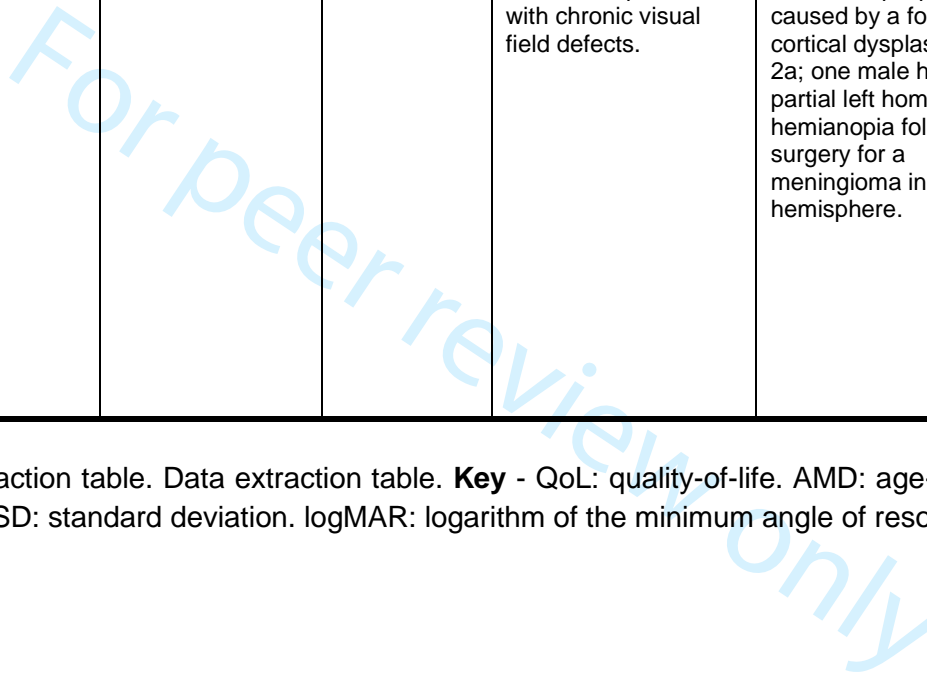
Authors	Study title	Design	Domain(s) of outcomes	Location	Study objectives	Study populations	Main results/conclusions
	computer-aided telephone system				computer-aided telephone system.	One congenitally blind participant due to gestational complications.	session of ~11 minutes. The mean length of the sessions was ~21 minutes. For the second participant, mean (cumulative) conversation time per session was ~10 minutes. The mean length of the sessions was ~17 minutes.
Lorenzini & Wittich, 2021	Personalised telerehabilitation for a head-mounted low vision aid: A randomized feasibility study	Randomised controlled trial	Patient satisfaction and recommendations	Canada	To determine the feasibility of telerehabilitation using eSight eyewear with low vision participants. Feasibility defined as achieving recruitment target, proportion of participants lost to follow up, and whether the intervention was accessible and acceptable.	57 participants; 88% male, average age 54.5 (range = 21-82) years. All were categorized as having an ocular disease, most common were optic nerve disease, AMD, RP, and retinopathy of prematurity.	Withdrawal rate was higher in the control group but did not differ significantly from the experimental group. High accessibility (93% of participants accessed the platform) and global acceptability (100% overall satisfaction) were reported among those who completed the telerehabilitation protocol. The therapist had no difficulty judging the participants' reading performances qualitatively while participants used their device to read their eSkills and VisExc guides. Most participants improved their daily activities, based on qualitative reports of the attained goals. Seventy-nine percent of individuals declined to participate, whereas 16% of participants decided not to use eSight Eyewear anymore. Positive feedback from the participants and the low vision therapist suggests the potential value of this modality for low vision services.
Lorenzini & Wittich, 2021	Head-mounted visual assistive technology-related quality of life changes after telerehabilitation	Randomised controlled trial	Patient satisfaction and recommendations / QoL and well-being	Canada	To explore the effect of telerehabilitation (eSight eyewear) on quality-of-life and functional vision in individuals with low vision using a head-mounted display.	57 participants; 88% male, average age 54.5 (range = 21-82) years. All were categorized as having an ocular disease, most common were optic nerve disease, AMD, RP, and retinopathy of prematurity.	Assistive technology-related quality of life was improved when measured by the satisfaction scale but not the psychosocial scale within the first 3 months, independently of training type. Overall, functional vision improvement was observed within the first 2 weeks of device use and maintained during the 6-month study, independently of group type. eSight Eyewear, either with telerehabilitation or with the manufacturer

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Authors	Study title	Design	Domain(s) of outcomes	Location	Study objectives	Study populations	Main results/conclusions
							self-training comparison, improved functional vision and increased users' quality of life within the initial 3 months of device training and practice.
Sabel & Gudlin, 2014	Vision restoration training for glaucoma: A randomized clinical trial	Randomised controlled trial	Vision training / QoL and well-being	Germany	To determine if behavioural activation of areas of residual vision using daily 1-hour vision restoration training for glaucoma for 3-months improves detection accuracy compared with placebo.	30 participants; 4 male; mean [SD] age 61.7 [10.1] years; 20 participants with primary open angle glaucoma; 5 with normal tension glaucoma; 4 with secondary glaucoma; 1 with angle-closure glaucoma. Mean [SD] visual acuity was 0.62 [0.34] (range 0.0-1.3 logMAR) in the right eye and 0.76 [0.50] (range 0.0-1.8 logMAR) in the left eye.	Vision restoration training for glaucoma led to significant detection accuracy gains in high-resolution perimetry (P = .007), which were not found with white-on-white or blue-on-yellow perimetry. Pre-post differences after vision restoration training for glaucoma were greater compared with placebo in all perimetry tests (P = .02 for high-resolution perimetry, P = .04 for white on white, and P = .04 for blue on yellow), and these results were independent of eye movements. Vision restoration training for glaucoma (but not placebo) also led to faster reaction time (P = .009). Vision-related quality of life was unaffected, but the health-related quality-of-life mental health domain increased in both groups.
Senjam <i>et al.</i> , 2021	Tele-rehabilitation for visually challenged students during COVID-19 pandemic: Lesson learned	Case report	Managing symptoms	India	To report experiences of a telerehabilitation service available primarily for students with visual disabilities amidst the COVID-19 pandemic.	492 participants; male = 388. The majority of beneficiaries were between 11 and 30 years (82.3%). Around 96% of beneficiaries were visually disabled, and 16.5% had unknown visual status (waiting or applied for certificates).	The most common ocular complaints for which beneficiaries required advice were itching (N= 121; 36.1%); watering eyes (N = 54; 16.1%); painful eyes (N = 12; 3.6%), redness (N = 5; 1.5%). Telerehabilitation can offer a safe and efficient means of providing reliable information to visually impaired individuals.

Authors	Study title	Design	Domain(s) of outcomes	Location	Study objectives	Study populations	Main results/conclusions
Tinelli <i>et al.</i> , 2017	Development and implementation of a new telerehabilitation system for audio-visual stimulation training in hemianopia	Experimental	Vision training	Italy	To test the feasibility and efficacy of audio-visual telerehabilitation in three adult patients with chronic visual field defects.	Three participants with hemianopia. One male had cerebral stroke; one adult had drug-resistant epilepsy caused by a focal cortical dysplasia type 2a; one male had partial left homonymous hemianopia following surgery for a meningioma in the right hemisphere.	Results suggest audio-visual telerehabilitation is an effective treatment based on the stimulation of ocular movements and visual exploration functions through compensative strategies. Patients were instructed to use saccadic eye movements for the detection of visual targets and thus they showed, at the end of the treatment, an activation of the oculomotor system and a change in responsiveness toward visual stimuli, confirmed by behavioural data, mostly using the Unimodal Visual Test. The test allows patients to exercise independently in a familiar context, while under remote supervision. It may give the patient a sense of control and autonomy, which can contribute to a better therapy outcome, also reducing the need for one-to-one treatment time and home visits.

**Supplementary material** – Data extraction table. Data extraction table. **Key** - QoL: quality-of-life. AMD: age-related macular degeneration. DR: diabetic retinopathy. RP: retinitis pigmentosa. SD: standard deviation. logMAR: logarithm of the minimum angle of resolution. OCT: optical coherence tomography. FY: fiscal year.



### Supplementary Material 3 – Charities delivering remote rehabilitation

Organisation	Remote services
Beacon Centre for the Blind	Telephone-based welfare calls and befriending service. Life skills sessions to promote independent living.
Blind Veterans UK	Practical skills training including maintaining personal (e.g., managing medications) and domestic (e.g., preparing meals) activities of daily living. Remote befriending service and communication technology skills training.
Essex Sight	Telephone-based welfare calls, demonstration of equipment (e.g., kitchen aids and lighting).
Henshaws	Telephone-based welfare calls, befriending groups, physical exercise training (e.g., improving movement, strength and fitness), digital enablement services.
Galloway's	Digital skills training
My Sight Nottinghamshire	Telephone-based befriending, digital skills training, physical exercise training (e.g., chair-based and standing exercises).
Peterborough Association for the Blind	N/A
Sight for Surrey	Digital skills training, assistive technology training (e.g., screen magnification software), communication skills training, everyday living skills advice.
The Cambridgeshire Society for the Blind and Partially Sighted	Telephone-based welfare calls, peer support groups, digital skills training.
Vista	Digital skills training, assistive technology training (activating and optimising accessibility features), life skills (e.g., meal preparation), online well-being activities (e.g., singing and gardening)
The Royal National Institute for Blind People	Telephone-based counselling and befriending groups, signposting to online resources, online activities

**Supplementary material** – Charities delivery remote rehabilitation. **Key** - N/A: not available



## Preferred Reporting Items for Systematic reviews and Meta-Analyses extension for Scoping Reviews (PRISMA-ScR) Checklist

SECTION	ITEM	PRISMA-ScR CHECKLIST ITEM	REPORTED ON PAGE #
<b>TITLE</b>			
Title	1	Identify the report as a scoping review.	1
<b>ABSTRACT</b>			
Structured summary	2	Provide a structured summary that includes (as applicable): background, objectives, eligibility criteria, sources of evidence, charting methods, results, and conclusions that relate to the review questions and objectives.	2
<b>INTRODUCTION</b>			
Rationale	3	Describe the rationale for the review in the context of what is already known. Explain why the review questions/objectives lend themselves to a scoping review approach.	5-6
Objectives	4	Provide an explicit statement of the questions and objectives being addressed with reference to their key elements (e.g., population or participants, concepts, and context) or other relevant key elements used to conceptualize the review questions and/or objectives.	6, 8
<b>METHODS</b>			
Protocol and registration	5	Indicate whether a review protocol exists; state if and where it can be accessed (e.g., a Web address); and if available, provide registration information, including the registration number.	9
Eligibility criteria	6	Specify characteristics of the sources of evidence used as eligibility criteria (e.g., years considered, language, and publication status), and provide a rationale.	7-8
Information sources*	7	Describe all information sources in the search (e.g., databases with dates of coverage and contact with authors to identify additional sources), as well as the date the most recent search was executed.	7-8
Search	8	Present the full electronic search strategy for at least 1 database, including any limits used, such that it could be repeated.	7
Selection of sources of evidence†	9	State the process for selecting sources of evidence (i.e., screening and eligibility) included in the scoping review.	8
Data charting process‡	10	Describe the methods of charting data from the included sources of evidence (e.g., calibrated forms or forms that have been tested by the team before their use, and whether data charting was done independently or in duplicate) and any processes for obtaining and confirming data from investigators.	8 + Supplementary material
Data items	11	List and define all variables for which data were sought and any assumptions and simplifications made.	8 + Supplementary material
Critical appraisal of individual	12	If done, provide a rationale for conducting a critical appraisal of included sources of evidence; describe	8-9



SECTION	ITEM	PRISMA-ScR CHECKLIST ITEM	REPORTED ON PAGE #
sources of evidence§		the methods used and how this information was used in any data synthesis (if appropriate).	
Synthesis of results	13	Describe the methods of handling and summarizing the data that were charted.	8-9
<b>RESULTS</b>			
Selection of sources of evidence	14	Give numbers of sources of evidence screened, assessed for eligibility, and included in the review, with reasons for exclusions at each stage, ideally using a flow diagram.	10
Characteristics of sources of evidence	15	For each source of evidence, present characteristics for which data were charted and provide the citations.	10 + Supplementary material
Critical appraisal within sources of evidence	16	If done, present data on critical appraisal of included sources of evidence (see item 12).	10 + Supplementary material
Results of individual sources of evidence	17	For each included source of evidence, present the relevant data that were charted that relate to the review questions and objectives.	Supplementary material
Synthesis of results	18	Summarize and/or present the charting results as they relate to the review questions and objectives.	Supplementary material
<b>DISCUSSION</b>			
Summary of evidence	19	Summarize the main results (including an overview of concepts, themes, and types of evidence available), link to the review questions and objectives, and consider the relevance to key groups.	10-19
Limitations	20	Discuss the limitations of the scoping review process.	23
Conclusions	21	Provide a general interpretation of the results with respect to the review questions and objectives, as well as potential implications and/or next steps.	24
<b>FUNDING</b>			
Funding	22	Describe sources of funding for the included sources of evidence, as well as sources of funding for the scoping review. Describe the role of the funders of the scoping review.	24

JBI = Joanna Briggs Institute; PRISMA-ScR = Preferred Reporting Items for Systematic reviews and Meta-Analyses extension for Scoping Reviews.

\* Where *sources of evidence* (see second footnote) are compiled from, such as bibliographic databases, social media platforms, and Web sites.

† A more inclusive/heterogeneous term used to account for the different types of evidence or data sources (e.g., quantitative and/or qualitative research, expert opinion, and policy documents) that may be eligible in a scoping review as opposed to only studies. This is not to be confused with *information sources* (see first footnote).

‡ The frameworks by Arksey and O'Malley (6) and Levac and colleagues (7) and the JBI guidance (4, 5) refer to the process of data extraction in a scoping review as data charting.

§ The process of systematically examining research evidence to assess its validity, results, and relevance before using it to inform a decision. This term is used for items 12 and 19 instead of "risk of bias" (which is more applicable to systematic reviews of interventions) to include and acknowledge the various sources of evidence that may be used in a scoping review (e.g., quantitative and/or qualitative research, expert opinion, and policy document).

From: Tricco AC, Lillie E, Zarin W, O'Brien KK, Colquhoun H, Levac D, et al. PRISMA Extension for Scoping Reviews (PRISMA-ScR): Checklist and Explanation. *Ann Intern Med.* 2018;169:467–473. doi: 10.7326/M18-0850.



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