Title

Telerehabilitation for people with low vision.

Journal

Cochrane Database of Systematic Reviews, 1(1)

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Publication Date

2023-01-13

DOI

10.1002/14651858.CD011019.pub4

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Bittner AK, Yoshinaga PD, Rittiphairoj T, Li T

Bittner AK, Yoshinaga PD, Rittiphairoj T, Li T.
Telerehabilitation for people with low vision.
Cochrane Database of Systematic Reviews 2023, Issue 1. Art. No.: CD011019.
DOI: 10.1002/14651858.CD011019.pub4.

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[Intervention Review]

Telerehabilitation for people with low vision

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Editorial group: Cochrane Eyes and Vision Group.
Publication status and date: New search for studies and content updated (conclusions changed), published in Issue 1, 2023.

Citation: Bittner AK, Yoshinaga PD, Rittiphairoj T, Li T. Telerehabilitation for people with low vision. *Cochrane Database of Systematic Reviews* 2023, Issue 1. Art. No.: CD011019. DOI: 10.1002/14651858.CD011019.pub4.

ABSTRACT

Background

Low vision affects over 300 million people worldwide and can compromise both activities of daily living and quality of life. Rehabilitative training and vision assistive equipment (VAE) may help, but some visually impaired people have limited resources to attend in-person visits to rehabilitation clinics to be trained to learn to use VAE. These people may be able to overcome barriers to care through access to remote, internet-based consultation (telerehabilitation).

Objectives

To compare the effects of telerehabilitation with face-to-face (e.g. in-office or inpatient) vision rehabilitation services for improving vision-related quality of life and near reading ability in people with visual function loss due to any ocular condition. Secondary objectives were to evaluate compliance with scheduled rehabilitation sessions, abandonment rates for VAE devices, and patient satisfaction ratings.

Search methods

We searched the Cochrane Central Register of Controlled Trials (CENTRAL), which contains the Cochrane Eyes and Vision Trials Register) (2021, Issue 9); Ovid MEDLINE; Embase.com; PubMed; ClinicalTrials.gov; and the World Health Organization (WHO) International Clinical Trials Registry Platform (ICTRP). We did not use any language restriction or study design filter in the electronic searches; however, we restricted the searches from 1980 onwards because the internet was not introduced to the public until 1982. We last searched CENTRAL, MEDLINE Ovid, Embase, and PubMed on 14 September 2021, and the trial registries on 16 March 2022.

Selection criteria

We included randomized controlled trials (RCTs) or controlled clinical trials (CCTs) in which participants diagnosed with low vision had received vision rehabilitation services remotely from a human provider using internet, web-based technology compared with an approach involving in-person consultations.

Data collection and analysis

Two review authors independently screened titles and abstracts retrieved by the searches of the electronic databases and then full-text articles for eligible studies. Two review authors independently abstracted data from the included studies. Any discrepancies were resolved by discussion.

Main results

We identified one RCT/CCT that indirectly met our inclusion criteria, and two ongoing trials that met our inclusion criteria. The included trial had an overall high risk of bias. We did not conduct a quantitative analysis since multiple controlled trials were not identified.

The single included trial of 57 participants utilized a parallel-group design. It compared 30 hours of either personalized low vision training through telerehabilitation with a low vision therapist (the experimental group) with the self-training standard provided by eSight using the eSkills User Guide that was self-administered by the participants at home for one hour per day for 30 days (the comparison group). The trial investigators found a similar direction of effects for both groups for vision-related quality of life and satisfaction at two weeks, three months, and six months. A greater proportion of participants in the comparison group had abandoned or discontinued use of the eSight Eyewear at two weeks than those in the telerehabilitation group, but discontinuance rates were similar between groups at one month and three months. We rated the certainty of the evidence for all outcomes as very low due to high risk of bias in randomization processes and missing outcome data and imprecision.

Authors' conclusions

The included trial found similar efficacy between telerehabilitation with a therapist and an active control intervention of self-guided training in mostly younger to middle-aged adults with low vision who received a new wearable electronic aid. Given the disease burden and the growing interest in telemedicine, the two ongoing studies, when completed, may provide further evidence of the potential for telerehabilitation as a platform for providing services to people with low vision.

PLAIN LANGUAGE SUMMARY

Telerehabilitation for people with low vision

What was the aim of this review?

The goal of this review was to evaluate the benefits of providing vision rehabilitation services remotely (via telerehabilitation) for people with low vision. In telerehabilitation a vision rehabilitation provider uses an internet-based approach rather than usual care in an office to train people with low vision to improve their use of remaining visual function. Our primary interest was changes in vision-related quality of life achieved by each type of training as measured by questionnaires. We were also interested in visual function, such as reading ability, as well as compliance with scheduled training sessions and satisfaction ratings.

Key messages

Given the growing interest in telemedicine as a way to help address some of the many barriers to in-office care for people with low vision, the two ongoing studies, once completed, may help us understand whether telerehabilitation can be used to provide services to people with low vision, and whether the effects of telerehabilitation are similar to in-office care.

What was studied in the review?

Low vision is a reduction in visual functioning that cannot be fixed by eyeglasses, contact lenses, or other medical and surgical treatments. People with low vision typically find it difficult to perform daily activities, such as reading and driving. About 300 million people have low vision worldwide. Vision rehabilitation is one way to help improve quality of life of people with low vision, by evaluating visual functioning, prescribing appropriate visual assistive aids or devices, offering support services, and providing training to use magnification devices and strategies to make the most of their remaining vision. Office-based rehabilitation training for low vision has been shown to be effective; however, there are many challenges that can prevent patients from attending visits at the doctor's office. When additional training is provided, there is an increased effectiveness of magnification devices and skills to use remaining vision. Technology has made it possible to provide some healthcare services through the internet, including telerehabilitation, which also offers the convenience of rehabilitation sessions at home in the individual's usual environment. However, it is currently unknown whether this approach for remote services works for vision rehabilitation.

What are the main results of the review?

We found two ongoing studies of telerehabilitation for low vision, and one completed trial that indirectly addressed the research question. The completed trial showed similar effects for telerehabilitation with a therapist versus an active control intervention involving a self-administered training guide to learn to use a new wearable electronic device for low vision.

How up-to-date is this review?

The evidence is current to 14 September 2021 for completed trials and 16 March 2022 for ongoing trials.

SUMMARY OF FINDINGS

Summary of findings 1. Telerehabilitation versus self-training for people with low vision

Telerehabilitation versus self-training for people with low vision

Patient or population: people with any eye disease including optic nerve disease, age-related macular degeneration, retinopathy of prematurity, retinitis pigmentosa, diabetic retinopathy, Stargardt disease, congenital nystagmus, retinal detachment, keratoconus, central retinal vein occlusion, central serious retinopathy, malign myopia, stroke, optic atrophy with cerebral visual impairment, congenital cataract, peter syndrome, Erdheim-Chester disease

Setting: eye clinics or medical centers

Intervention: telerehabilitation training provided by a low vision therapist

Comparison: self-training without involvement of a low vision therapist

Outcomes	Illustrative comparative risks (95% CI)		Relative effect (95% CI)	No. of participants (studies)	Certainty of the evidence (GRADE)
	Assumed risk Self-training	Corresponding risk**Telerehabilitation**			
Vision-related patient-reported outcome measurement at 6 months (the greater the score, the better)	"The overall model revealed that visual ability improved over time in both the experimental and control groups (F3,124 = 32.54, P < .001, η2 = 0.37)."		-	57 (1)	⊕⊖⊖⊖ **very low**[1,2]
Clinical measures, such as reading speed or reading acuity at 6 months	No studies measured this outcome.		-	-	-
Compliance at 6 months	**Proportion of participants lost to follow-up**				
	448 in 1000	251 in 1000 (116 to 533)	RR 0.56 (0.26 to 1.19)	57 (1)	⊕⊖⊖⊖ **very low**[1,2]
	Proportion of participants with incomplete treatment				
	207 in 1000	108 in 1000 (29 to 387)	RR 0.52 (0.14 to 1.87)	57 (1)	⊕⊖⊖⊖ **very low**[1,2]

Technical difficulties with the intervention at 6 months	10 in 1000	52 in 1000 (3 to 1000)	RR 5.17 (0.26 to 103.18)	57 (1)	⊕⊖⊖⊖ **very low**[1,2]
Device abandonment rate at 6 months	207 in 1000	108 in 1000 (29 to 387)	RR 0.52 (0.14 to 1.87)	57 (1)	⊕⊖⊖⊖ **very low**[1,2]

[1]Downgraded for limitations in the design and implementation of available studies suggesting high likelihood of bias (−2).
[2]Downgraded for imprecision (−1): small sample size.
RR: relative risk (or risk ratio)

BACKGROUND

Description of the condition

Low vision is defined as "a visual impairment, not corrected by standard eyeglasses, contact lenses, medication, or surgery, that interferes with the ability to perform everyday activities" (NEI glossary). Visual impairment can result from a variety of ocular and systemic disorders and may present as reduced central vision, reduced peripheral vision, blind spots, loss of contrast sensitivity, or a combination of these symptoms. It was estimated in 2008 that about 300 million people had low vision worldwide (Foster 2008). It was estimated in 2017 that nearly 4 million older adult Americans had low vision (best-corrected visual acuity worse than 20/40) (Chan 2018). With the increase in both life span and incidence of age-related diseases, such as diabetic retinopathy and age-related macular degeneration, the number of people with low vision is expected to double by 2050 (Chan 2018).

Without effective intervention, reading, mobility, and functional independence decrease with low vision, and the risk of falls and fractures increases (Lamoureux 2008); these changes are associated with withdrawal from society and depression, resulting in a devastating impact on quality of life (Goldstein 2012). The US National Institutes of Health National Eye Institute's strategic plan Vision for the Future (2021-2025) recommends that researchers establish the efficacy, accessibility, acceptability, and cost-effectiveness of telehealth for people across the visual spectrum, with special attention to the needs of those with low vision, including methods to use telehealth as a modality for vision rehabilitation (www.nei.nih.gov/about/strategic-planning).

Description of the intervention

Low vision rehabilitation is the primary intervention for people with chronic, disabling visual impairment (Markowitz 2006). The goal is to improve activities of daily living by helping people with reduced visual function optimize the use of their remaining sight through the provision of appropriate refractive correction as well as training in the use of vision assistive equipment (VAE) and compensatory strategies (Binns 2012). Individuals are taught to cope with their disability by initiating lifestyle and environmental modifications.

Successful use of VAE is highly dependent on skill reinforcement with a rehabilitation specialist. The Low Vision Intervention Trial (LOVIT) demonstrated a positive effect of inpatient low vision rehabilitation on self-reported visual function (Stelmack 2008); however, the current outpatient-based approach for delivering low vision rehabilitation presents significant challenges due to transportation barriers and insufficient compliance in the use of VAE.

Patients may be provided with limited instructions or training in the use of newly prescribed VAE. VAE require specific working distances, which may be unnatural for the patient and require training, education, practice, and skill reinforcement. Patients may become frustrated and not return for follow-up visits when they continue to experience difficulty using VAE at home or when their vision or general health declines.

Furthermore, the majority of the population seeking outpatient low vision rehabilitation services are elderly, with 73% of individuals aged 65 and older (Goldstein 2012). In addition to their vision impairment, many have age-associated physical, psychological, and cognitive issues, including memory deficits.

This group relies heavily on others for support and transportation. One study found that about two-thirds of the low vision population do not drive (Goldstein 2012). Transportation issues and comorbidities limit the ability to return for the necessary follow-up sessions, which commonly focus on training with VAE.

Given all of these challenges, VAE have variable effectiveness and high rates of abandonment (Watson 1997). The potential efficacy of low vision rehabilitation may not be fully achieved without additional training. The strategy of inpatient rehabilitation employed in the LOVIT study incorporated multiple rehabilitation sessions and found effect sizes that far outweighed typical outpatient low vision rehabilitation (Stelmack 2008), which often may involve only one visit to a low vision clinic.

Telerehabilitation refers to the delivery of rehabilitation services via information and communication technologies (Brennan 2011). Clinically, this term encompasses a range of rehabilitation services that include assessment, monitoring, prevention, intervention, supervision, education, consultation, and counseling. Telerehabilitation is commonly used for individuals with stroke, brain injury, joint replacement, or spinal cord injury (Rogante 2010), and usually involves audio and video technology.

How the intervention might work

Telerehabilitation may offer several important advantages over traditional in-office care and has the potential to lead to improvement in vision- and health-related outcomes (Rogante 2010). Firstly, it has the potential to overcome transportation difficulties, as well as potential safety risks related to health or mobility, or both. Furthermore, health professionals can evaluate patients in their home environment rather than in a clinical setting, thereby providing more personalized care. Telerehabilitation has the potential to expand rehabilitation modalities through the use of secure, internet-based communication technology (e.g. computers, tablets, smartphones), and also may increase efficiency by optimizing the use of time and other resources.

Why it is important to do this review

In ophthalmology, most studies of telemedicine have focused on the transfer of patients' ocular images among providers for interpretation, diagnosis, and management of ocular disease, while fewer studies appear to have used telemedicine to communicate directly with patients or to provide low vision rehabilitation (Tang 2005). The goal of low vision rehabilitation services, whether in person or remotely via telemedicine, is to help people with vision loss maintain visual functioning and activities of daily living, as well as social and psychological well-being. While telemedicine may overcome some barriers, it may present other challenges, including technical ones, in interactions with elderly visually impaired patients. We wanted to determine whether studies on telerehabilitation have achieved success with the low vision population.

OBJECTIVES

To compare the effects of telerehabilitation with face-to-face (e.g. in-office or inpatient) vision rehabilitation services for improving vision-related quality of life and/or near reading ability in people

with visual function loss due to any ocular condition. Secondary objectives were to assess compliance with scheduled rehabilitation sessions, abandonment rates for visual assistive equipment devices, and patient satisfaction.

METHODS

Criteria for considering studies for this review

Types of studies

We included randomized controlled trials (RCTs) and controlled clinical trials (CCTs).

Types of participants

We included trials in which participants of any age were diagnosed with low vision, that is visual function loss due to any ocular condition, as defined in the individual studies. According to the World Health Organization (WHO), low vision is diagnosed when the best-corrected visual acuity in the better eye is between 20/400 and 20/60 (WHO low vision definition); however, as this definition is not universally accepted, we accepted the definitions specified in the included studies.

Types of interventions

The main intervention of interest was telerehabilitation, the use of web-based technology to provide real-time, remote rehabilitation services from a human provider to a population with low vision. The comparison intervention was any face-to-face, in-person communication, such as traditional office-based approaches for providing low vision rehabilitation in a clinic or lab setting. However, given the paucity of trials of telerehabilitation for low vision, we also considered indirect evidence from comparators with an active control intervention that did not provide in-person rehabilitation with a therapist (e.g. self-administered training guides). Low vision rehabilitation included assessing visual status, prescribing VAE (e.g. magnifiers, telescopes, optical or electronic devices), training, education, and counseling. We documented whether each telerehabilitation intervention was combined with any initial or subsequent in-office visits, and also noted the frequency of each type of encounter (i.e. number and proportion of in-person visits).

Types of outcome measures

Primary outcomes

Critical outcome

The primary outcome of the review was vision-related quality of life, measured by any validated visual function questionnaire instrument administered in the trial at 1 to 12 months after start of the intervention. We planned to analyze both absolute values at a follow-up time point and change from baseline whenever data were available. We also planned that when data from multiple time points were available (e.g. when a trial reported 3-, 6-, and/or 12-month data), we would use the data from the longest follow-up time point.

Secondary outcomes

Important outcomes

1. Vision-related quality of life measured by other validated instruments not reported as the primary outcome measure to assess patient-reported visual function at any time points of < 1 month or > 12 months, as reported by trialists.
2. Clinical measures, such as reading speed or reading acuity, at all documented postintervention time points.
3. Patient satisfaction with the intervention, as assessed in an included trial, at the end of the intervention phase.
4. Psychosocial-related patient-reported outcomes measured by any validated instrument to assess patient-reported psychosocial factors, at all documented postintervention time points.
5. Increased use of prescribed VAE measured by frequency or duration of device use, or both, following the intervention at the end of the intervention phase.
6. Compliance (i.e. losses to follow-up and incomplete treatment) at the end of the intervention phase, as judged in the included trial.
7. Technical difficulties with the intervention, as assessed in an included trial, at the end of the intervention phase.
8. Visual assistive device abandonment rate, as assessed in an included trial, at the end of the intervention phase or in the long term, as defined by trialists.

We sought data obtained using standardized and validated measurement methods when they were available (e.g. reading speed in words per minute or critical print size in M decimal notation, using validated texts such as the MNREAD acuity charts) or validated questionnaire data (e.g. the Activity Inventory or Veterans Affairs Low-Vision Visual Functioning Questionnaire).

We reported any adverse event related to the interventions.

Search methods for identification of studies

Electronic searches

The Cochrane Eyes and Vision Information Specialist searched the following electronic databases for potentially eligible trials. We did not use any language restriction or study design filter in the electronic searches; however, we restricted the searches to years from 1980 onwards because the internet was not introduced to the public until 1982. We last searched CENTRAL, MEDLINE Ovid, Embase, and PubMed on 14 September 2021, and the trial registries on 16 March 2022.

The search strategy for each database is provided in the associated appendix.

- Cochrane Central Register of Controlled Trials (CENTRAL; 2021, Issue 9) (which contains the Cochrane Eyes and Vision Trials Register) in the Cochrane Library (searched 14 September 2021) (Appendix 1).
- MEDLINE Ovid (1946 to 14 September 2021) (Appendix 2).
- Embase.com (1947 to 14 September 2021) (Appendix 3).
- PubMed (1948 to 14 September 2021) (Appendix 4).
- US National Institutes of Health Ongoing Trials Register ClinicalTrials.gov (www.clinicaltrials.gov; searched 16 March 2022) (Appendix 5).
- World Health Organization (WHO) International Clinical Trials Registry Platform (ICTRP) (www.who.int/ictrp; searched 16 March 2022) (Appendix 6).

Searching other resources

We searched the reference lists of included studies to identify additional eligible studies.

Data collection and analysis

Selection of studies

Two review authors independently screened the titles and abstracts identified by the searches against the eligibility criteria, labeling each record as 'definitely relevant,' 'possibly relevant,' or 'definitely not relevant.' We retrieved the full-text reports for each record labeled as 'definitely relevant' or 'possibly relevant' by either review author. Two review authors independently assessed the full-text reports for eligibility, documenting the reasons for exclusion of any excluded studies. Any discrepancies were resolved through discussion.

Data extraction and management

Two review authors independently extracted data from the included studies onto a web-based, electronic data collection form in Covidence (Covidence). We extracted information on study design (e.g. study setting, countries in which the participants were recruited, sample size, study duration, types of design and analysis, funding source for the study and any potential conflicts of interest); participant characteristics (e.g. inclusion and exclusion criteria of the study, underlying disease, diagnosis, vision, and medical history); interventions and comparators (e.g. treatment modality, duration, timing); and outcomes (e.g. outcome domain, specific measurement tool, metric, method of aggregation, and time frame). Any discrepancies between review authors were resolved through discussion. One review author entered data into Cochrane's statistical software Review Manager 5 (Review Manager 2020), and a second review author verified the data entered. We presented summary data in the 'Characteristics of included studies' table. We contacted study investigators to obtain any missing or unclearly reported information; whenever we received no response within two weeks, we proceeded with the available information.

Assessment of risk of bias in included studies

Two review authors independently assessed risk of bias for each included trial using Cochrane's RoB 2 tool for our critical outcome (Higgins 2021). We resolved any disagreements via discussion.

We specifically considered and reported on the following domains.

- Bias arising from the randomization process
- Bias introduced by deviations from intended interventions
- Bias due to missing outcome data
- Bias in outcome measurement
- Bias in selective reporting of outcome data

We assigned each domain as 'low risk of bias', 'high risk of bias', or 'some concerns' following each domain's signal questions, and documented the reasons and rationales for our assessments.

Measures of treatment effect

We planned to treat ordinal outcomes and measurement scales, such as level of satisfaction and vision-related quality of life, as continuous or dichotomous data as appropriate, depending on the length of the scale used and the manner in which the outcomes had been reported.

Continuous outcomes

For continuous outcomes (e.g. reading speed rates or critical print size), we planned to use difference in means to measure the treatment effect and to calculate 95% confidence intervals on differences.

Dichotomous outcomes

For dichotomous outcomes, such as compliance with follow-up (defined as the attendance rate of scheduled follow-up training sessions within a specified window of time, and based on a predefined threshold for compliance), we used risk ratios to estimate treatment effects.

Unit of analysis issues

Due to the nature of the intervention, we expected that individual participants would have been randomized in the included studies.

Dealing with missing data

We contacted trial authors for missing or unclearly reported information, such as information required to assess risk of bias or underreported outcomes. We allowed two weeks for the authors to respond, otherwise we moved forward with the best available information. We estimated missing outcome data based on multiple imputation or other imputation approaches that account for the uncertainty in imputing the missing outcome data. When no such estimates were possible, we used estimates reported by the authors and discussed the potential bias that could be introduced by missing data.

Assessment of heterogeneity

We planned to assess clinical and methodological heterogeneity by carefully evaluating the design and participant characteristics of the included studies for factors that could affect the reliability of estimates of the magnitude and direction of treatment effects. Clinical and methodological heterogeneity may manifest as statistical heterogeneity. We planned to quantify statistical heterogeneity using the I^2 statistic, the Q statistic, and the Chi^2 test for heterogeneity, and the Tau^2 value in the case of sufficient studies (Turner 2012). We deemed an I^2 value of 75% or greater as indicative of considerable heterogeneity (Deeks 2022).

Assessment of reporting biases

When study protocols were available, we compared the study protocol with study publications to identify discrepancies in the reporting of outcomes. If a sufficient number of studies (10 or more) are included in future updates, we will use a funnel plot to visualize small-study effects and the potential for publication bias.

Data synthesis

We planned to combine results quantitatively using random-effects meta-analysis when three or more studies had reported data for the same outcome and when the studies were clinically, methodologically, and statistically homogeneous. We would not combine studies in a meta-analysis when there was considerable statistical heterogeneity (i.e. I^2 value of 75% or greater).

Subgroup analysis and investigation of heterogeneity

We planned to consider the following subgroups: ophthalmologic diagnosis (e.g. age-related macular degeneration versus glaucoma), severity of visual impairment (e.g. early versus advanced stage of vision loss; legal blindness or not), and type of impairment (e.g. central versus peripheral visual impairment). Based on our clinical knowledge, we expected the estimated treatment effect to vary according to these factors.

Sensitivity analysis

We planned to conduct a sensitivity analysis by excluding studies assessed as at high risk of bias for allocation concealment before randomization in order to assess the robustness of our findings.

Summary of findings and assessment of the certainty of the evidence

We summarized the main findings, including the strengths and limitations of the evidence for each main outcome. We provided a summary of our perception of how the intervention may work, for whom, and under what circumstances. We provided a general interpretation of the evidence we found in the context of other evidence and discussed implications for practice and future research. We constructed a summary of findings table when appropriate; one review author independently assessed the overall certainty of the evidence for each outcome using the GRADE classification (GRADEpro GDT), and another review author verified the assessments and reasons for any downgrading.

RESULTS

Description of studies

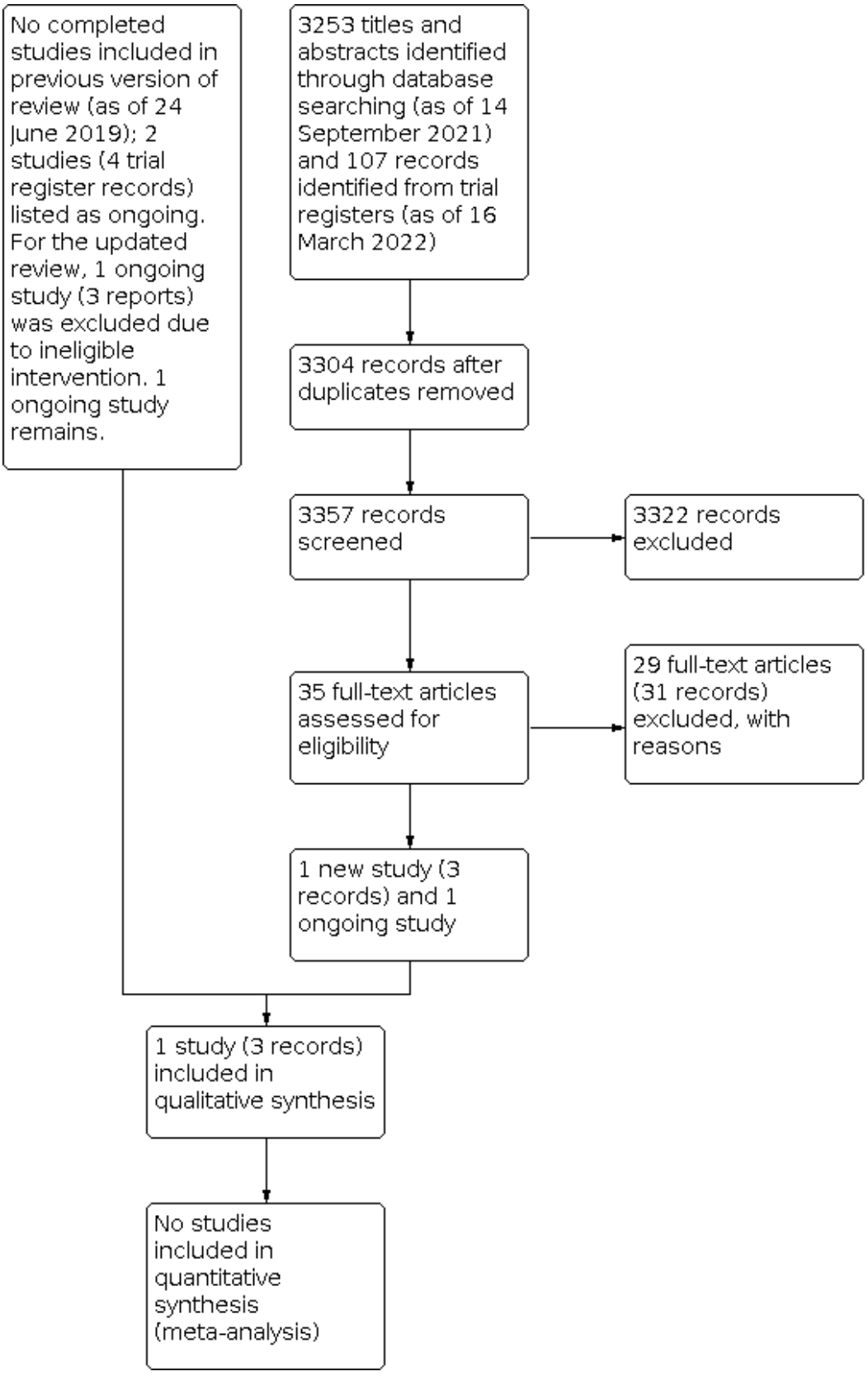
Results of the search

For the 2020 version of this review (Bittner 2020), we screened 3668 records, excluded 11 studies based on full-text review, and identified no eligible studies. We identified two ongoing studies (NCT03957980; van der Aa 2017). We excluded one of these studies from the current review due to no eligible intervention (van der Aa 2017), while the second study is still ongoing (NCT03957980).

Our update of the electronic database searches on 14 September 2021 yielded 3357 unique records. After title and abstract screening, we retrieved 35 full-text reports for further review. We excluded 29 studies (31 records) with reasons provided, and identified three records for one completed study, Lorenzini 2021, and one additional ongoing study (NCT04066075), for a total of one included study and two ongoing studies in this version of the review.

A flow diagram describing the study search, screening, and selection process is shown in Figure 1.

Figure 1. Study flow diagram.



Included studies

Types of studies

Lorenzini 2021 utilized a parallel-group design. The comparator group did not meet our inclusion criteria for in-person services, but we included this trial because the self-guided training as an active control group might provide some evidence of the comparative effects of telerehabilitation. This single-site trial was conducted in Canada with participants from Canada and the USA, and was funded by nonprofit national research institutions that were not involved in the study design, analyses, or interpretation of the findings. Outcomes from Lorenzini 2021 were published in 2021, and the protocol was publicly available. The unit of randomization and analysis was at the individual participant level. The duration of the intervention was one month, and the outcome data were reported at two weeks and three and six months.

Other characteristics of Lorenzini 2021 are summarized in the Characteristics of included studies table.

Types of participants

Lorenzini 2021 enrolled 57 participants who had an internet-enabled device and had purchased or rented eSight Eyewear less than a month before enrollment. Most participants were men (33/57, 58%) and had postsecondary level of education (35/57, 61%), and all were adults (mean age 55 years; range 21 to 82 years). The ocular diagnoses of participants varied, but most had optic nerve disease or age-related macular degeneration. The trial investigators excluded participants who self-reported other severe sensory impairments that might have interfered with communication; who had issues with comprehension or communication, or both, during a 20-minute phone call with a low vision therapist; or who were unable to communicate in French or English.

Types of interventions

Lorenzini 2021 compared 30 hours of personalized low vision training through telerehabilitation with a low vision therapist (experimental group) versus standard self-training provided by eSight using the eSkills User Guide. The self-training was completely self-administered by the participants at home for one hour per day for 30 days (comparison group). The telerehabilitation experimental group also completed exercises from the eSkills User Guide, but they had additional digitized exercises extracted from the VisExc eccentric fixation program that were not completed by the comparison group. Both groups had access to standard support for technical issues available through eSight Corporation staff.

Types of outcomes

We were interested in the effects of the interventions on one critical outcome and eight important outcomes. Lorenzini 2021 reported vision-related quality of life at two weeks, three months, and six months, which was measured by the standardized Veterans Affairs Low-Vision Visual Functioning Questionnaire-48. The trial investigators also reported:

1. patient satisfaction measured by the Quebec User Evaluation of Satisfaction with Assistive Technology;
2. psychosocial-related quality of life, measured by the Psychosocial Impact of Assistive Devices Scale;
3. compliance, measured by the retention rate of participants through six months after randomization;
4. technical difficulties with the intervention, evaluated by accessibility and acceptability of telerehabilitation training; and
5. early and late discontinuance (abandonment) rates for the eSight Eyewear.

The trial investigators did not report clinical measures (e.g. reading speed or reading acuity) or frequency and/or duration of device use following the intervention. All outcomes were measured and reported at two weeks and three and six months.

Excluded studies

We excluded 29 studies reported in 31 records after full-text assessment. Reasons for exclusion are provided in the Characteristics of excluded studies table.

Ongoing studies

We identified two ongoing RCTs, both of which involve participants from the USA (NCT03957980; NCT04066075). Both trials are evaluating a telehealth-based intervention administered at home over a 12-week period as the active intervention. The comparator group is a usual care waitlist control in NCT03957980 and usual care services provided in-office in NCT04066075. One trial involves children with cortical visual impairment and their caregivers (NCT03957980), which is funded by a children's hospital medical center, while the other trial includes adults with low vision due to any ocular disease who have received a new magnification device (NCT04066075), and is funded by the US National Institutes of Health's National Eye Institute and a philanthropic foundation for optometric research.

Risk of bias in included studies

We applied the RoB 2 tool to assess risk of bias for our critical outcome, vision-related quality of life (Risk of bias table for Analysis 1.1). Lorenzini 2021 reported this outcome, but was judged to be at high overall risk of bias due to an inadequate randomization process and missing outcome data.

Domain 1 - Bias arising from the randomization process

We judged Lorenzini 2021 to have high risk of bias because participants were randomized in 1:1 ratio to two groups using coin toss first then alternating. The latter method is subject to manipulations to the allocation process. Of the 57 participants, 28 were allocated to the experimental intervention and 29 to the control group. In terms of allocation concealment, the authors did not specify whether or how allocation concealment was maintained prior to assignment to trial arm. Furthermore, there was an imbalance in participants' baseline characteristics (e.g. "retired participants' preponderance in the comparison-renter subgroup and a male majority in the comparison group"), suggesting a flaw in the allocation process.

Domain 2 - Bias arising from deviations from intended interventions

We rated Lorenzini 2021 as having a low risk of bias for this domain. Although participants and personnel could not be masked to their treatment due to the nature of the intervention, there was no evidence of deviations from the intended intervention. Also,

the authors analyzed outcomes based on the intention-to-treat concept to estimate the effect of assignment to intervention.

Domain 3 - Bias due to missing outcome data

We judged Lorenzini 2021 to have a high risk of bias for this domain as there was significant missing outcome data, with 25% withdrawal for the experimental intervention (7/28) and 45% withdrawal for the comparison intervention (13/29). Withdrawal for both groups was based on lack of completion of the follow-up evaluations and questionnaires. The authors did not present any evidence showing that the result was not biased by missing outcome data. It would have been valuable to know all of the reasons for withdrawal as many participants did not provide a reason, and to indicate whether there were between-group differences in the characteristics of participants who withdrew.

Domain 4 - Bias in outcome measurement

We judged Lorenzini 2021 to have a low risk of bias for this domain as the authors used the Veterans Affairs Low-Vision Visual Functioning Questionnaire-48, which uses closed-ended questions and has been previously validated for use in low vision research. The same questionnaire was used to evaluate vision-related quality of life across groups. For the acceptability of the intervention, interview data for open-ended (interview with low vision therapist) and close-ended questions (satisfaction survey) developed specifically for this study were audio recorded and transcribed verbatim into a Microsoft Word document. The authors stated that the investigator who completed the data analysis had been masked to each participant's treatment allocation until data collection was completed.

Domain 5 - Bias in selective reporting of outcome data

We judged Lorenzini 2021 to have a low risk of bias for this domain as the outcomes reported were prespecified according to the protocol in terms of scales, definition, and time points.

Overall assessment of bias

We assessed Lorenzini 2021 as at overall high risk of bias due to incomplete follow-up of participants and concerns about the process of allocation to the experimental or comparison group.

Effects of interventions

See: **Summary of findings 1** Telerehabilitation versus self-training for people with low vision

Critical outcomes

Vision-related quality of life

Using the Veterans Affairs Low-Vision Visual Functioning Questionnaire-48, Lorenzini 2021 reported that vision-related quality of life increased within the first two weeks of device use and was maintained during the six-month follow-up period for both the telerehabilitation training and self-training groups. Pairwise comparisons between the different time points found that the mean score at baseline was statistically significantly lower than that from two weeks, three months, and six months after intervention for all the subscales, including reading, visual mobility, visual motor, and visual information (all, $P < 0.05$). The magnitudes of effect size when comparing the follow-ups to baseline were large, that is 1.20 logits or greater, which would be considered to be clinically meaningful. The authors did not report the between-group estimates of effect or provide data for us to derive between-group estimates of effect.

We rated the certainty of evidence for this outcome as very low, downgrading for risk of bias (−2), imprecision (−1), and indirectness (−1) (Summary of findings 1).

Important outcomes

Clinical measures (e.g. reading speed or reading acuity)

No study measured and reported this outcome.

Patient satisfaction with the intervention

In support of the acceptability of telerehabilitation in the Lorenzini 2021 trial, most of the participants strongly agreed that they were comfortable receiving telerehabilitation; were overall satisfied with the training via telerehabilitation; and were interested in using telerehabilitation again should their visual needs change in the future. The authors did not report the between-group estimates of effect or provide data for us to derive between-group estimates of effect.

Psychosocial-related patient-reported outcomes

In the Lorenzini 2021 trial, the Psychosocial Impact of Assistive Devices Scale (PIADS) score for both the experimental and control groups did not reveal any statistically significant subsequent pairwise comparisons between the experimental and comparison arms at different time points (baseline, two weeks, three and six months). Mean PIADS scores were not statistically significantly different for participants in the telerehabilitation experimental group versus the control group ($P = 0.56$), but it was not stated whether this comparison was at baseline or overall across time. The authors did not report the between-group estimates of effect or provide data for us to derive between-group estimates of effect.

Increased use of the device measured by frequency or duration of device use, or both, following the intervention

No study measured this outcome.

Compliance (loss to follow-up and incomplete treatment)

In Lorenzini 2021, compliance with the training at six months was not significantly different between the telerehabilitation experimental group and the active control group. We estimated the risk ratio (RR) for both loss to follow-up (RR 0.56, 95% confidence interval (CI) 0.26 to 1.19; N = 57; Analysis 1.2; Figure 2) and incomplete treatment (RR 0.52, 95% CI 0.14 to 1.87; N = 57; Analysis 1.3; Figure 3) at six months.

Figure 2. Forest plot of comparison: 1 Telerehabilitation versus self-training, outcome: 1.2 Proportion of participants lost to follow-up.

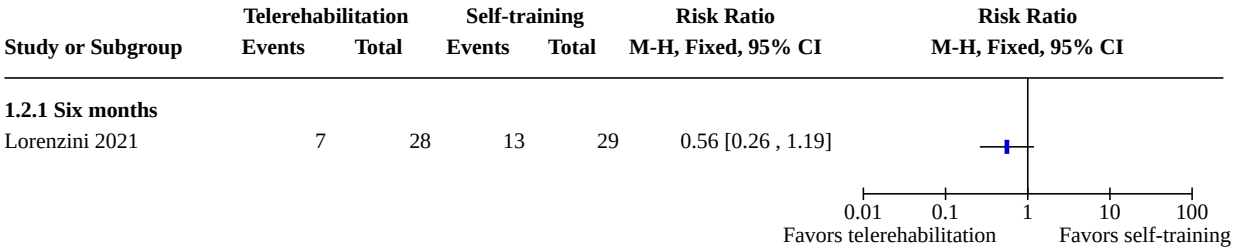
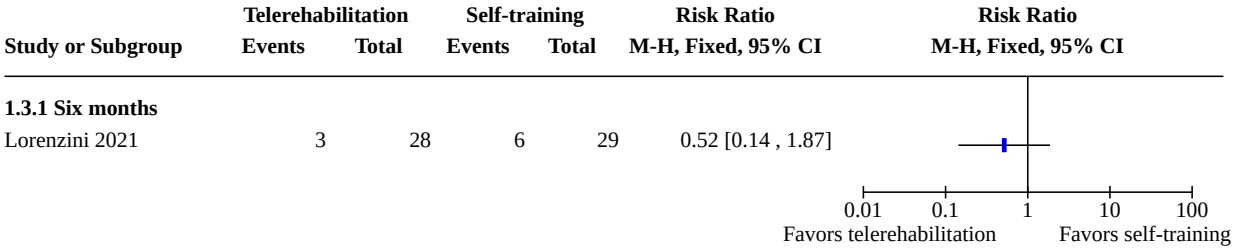


Figure 3. Forest plot of comparison: 1 Telerehabilitation versus self-training, outcome: 1.3 Proportion of participants with incomplete treatment.

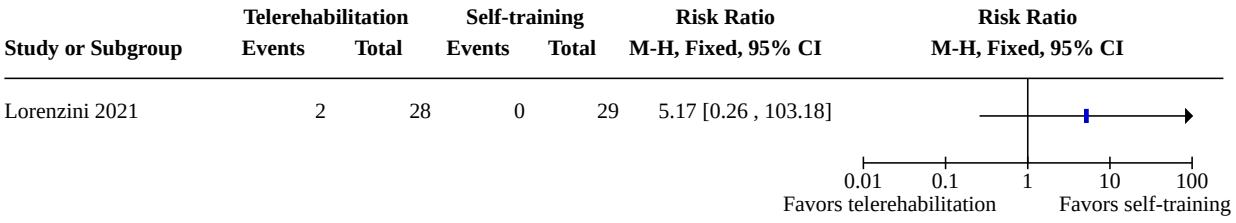


We rated the certainty of evidence for these estimates as very low, downgrading due to high risk of bias (−2) and imprecision (−1) (Summary of findings 1).

Technical difficulties with the intervention

In Lorenzini 2021, two participants in the telerehabilitation experimental group (2/28, 7%) had difficulty accessing the telehealth portal and lacked support from their family or friends for usage of the platform (one of the two had a technical device failure). We estimated the risk ratio for this outcome at the end of the study (six months) (RR 5.17, 95% CI 0.26 to 103.18; N = 57; Analysis 1.4; Figure 4).

Figure 4. Forest plot of comparison: 1 Telerehabilitation versus self-training, outcome: 1.4 Proportion of participants reporting technical difficulties with the intervention.

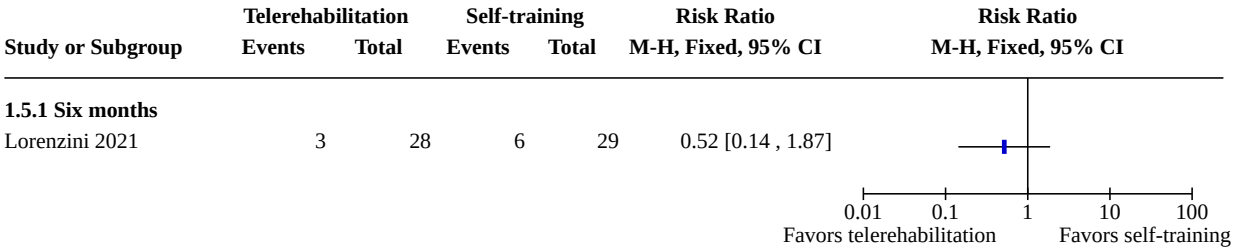


We rated the certainty of evidence for this estimate as very low, downgrading due to high risk of bias (−2) and imprecision (−1) (Summary of findings 1).

Visual assistive device abandonment rate

Lorenzini 2021 found that a greater proportion of participants in the active control group (self-guided training) had abandoned or discontinued use of the eSight Eyewear at two weeks than participants in the telerehabilitation group, but discontinuance rates were not significantly different between groups at one and three months. We estimated the risk ratio for this outcome at six months (RR 0.52, 95% CI 0.14 to 1.87; N = 57; Analysis 1.5; Figure 5).

Figure 5. Forest plot of comparison: 1 Telerehabilitation versus self-training, outcome: 1.5 Proportion of participants abandoning devices.



We rated the certainty of evidence for this estimate as very low, downgrading due to high risk of bias (−2) and imprecision (−1) (Summary of findings 1).

DISCUSSION

Summary of main results

We included only one trial in the review, which partly met our inclusion criteria. The trial investigators found no statistically significant or clinically meaningful differences in vision-related quality of life or satisfaction when comparing telerehabilitation training versus a self-guided, active control intervention for a wearable electronic device for people with low vision. However, there were limitations in the trial design and included population that limit the study's generalizability and conclusions; these are summarized in Overall completeness and applicability of evidence. We found a few review articles that cited studies that are relevant to our topic; these are summarized in Agreements and disagreements with other studies or reviews.

Overall completeness and applicability of evidence

Delivering low vision rehabilitation services remotely via telemedicine has the potential to help people with vision loss maintain function and activities of daily living as well as social and psychological well-being. Although we identified only one completed RCT that specifically addressed telerehabilitation for people with low vision, we found case series, cohort studies, and review articles that cited projects that had assessed the needs and feasibility of telemedicine for ophthalmologic or other medical conditions. These findings are supportive and highlight the need for more specific research on telerehabilitation for people with low vision.

Regarding the included trial, Lorenzini 2021, an acknowledged limitation was the possible lack of generalizability to the low vision population due to the exclusion of individuals who had no internet access and no computer or tablet for videoconferencing. Since a sizable proportion of people with low vision, especially the elderly, may not have access to or familiarity with the devices and technology for videoconferencing in their homes, this restriction should be a consideration in the design of future studies of telerehabilitation that may need to provide accommodations or loaner computer equipment and support for its use. Furthermore, most participants in the trial of eSight Eyewear were younger to middle-aged adults, while a typical low vision population tends to be skewed toward older adults. Another limitation of the trial design was that it was not possible to dissociate the effects of training versus practice or use of the device, which should be considered in the planning stages when designing future controlled trials of telerehabilitation training. Lastly, telerehabilitation was not compared with face-to-face services with a provider, the desired control intervention.

Quality of the evidence

We found no direct evidence for benefit or harm of telerehabilitation compared with in-person training for people with low vision. We found indirect evidence from a small trial of telerehabilitation compared with self-guided training using a vision assistive device that had a high risk of bias with incomplete reporting of primary outcome data. The evidence is thus of very low quality.

Potential biases in the review process

We followed the *Cochrane Handbook for Systematic Reviews of Interventions,* Higgins 2020, and Methodological Expectations of Cochrane Intervention Reviews (MECIR) standards for the reporting of new Cochrane Intervention Reviews (editorial-unit.cochrane.org/mecir) in conducting this review. A trained Information Specialist designed and conducted the electronic search. Two review authors independently screened the search results. None of the review authors has any financial conflicts of interest.

Agreements and disagreements with other studies or reviews

Need for telemedicine: A literature review of eye health in rural Australia highlighted the need for services capable of reaching individuals living in rural areas who had poor access to eye care providers, reduced utilization of services, and increased prevalence of blinding eye diseases (e.g. glaucoma) (Madden 2002). However, Madden 2002 was conducted two decades ago and did not address the use of telehealth for low vision rehabilitation.

Feasibility of telerehabilitation: An overview of telemedicine for eye care suggested that low vision consultation through tele-ophthalmology could improve access to specialized care that was otherwise unavailable in underserved areas. The authors of this report described a low vision population who received consultation using a tele-ophthalmology approach without traveling to the low vision center at the University of Texas at Houston. The tele-ophthalmology services were discontinued after funding for the project ended, and no further details were available (Tang 2005). In a more recently published case series (Bittner 2018), 10 elderly low vision patients with macular pathology received

VAE (i.e. a handheld magnification device) for reading and one-hour telerehabilitation sessions in their homes with their remotely located low vision providers. Both participants and providers gave positive evaluations with respect to feasibility and acceptability of the telerehabilitation sessions. One retrospective cohort study investigated the travel cost and time saved by telerehabilitation in veterans with low vision (Ihrig 2019), reporting that the median saving of travel cost and time between fiscal year 2013 and 2017 was approximately USD 65 and two hours per veteran, respectively.

Two review articles of tele-ophthalmology in India described real-time interactions using a videoconferencing system between the remotely located ophthalmologists and patients undergoing screening for ocular diseases (Murthy 2012; Prathiba 2011). Also in India, the Aravind Tele-ophthalmology Network and Madras Diabetes Research Foundation have provided a videoconferencing system for the retinal specialist at a base hospital to communicate directly with patients in a mobile screening van (Murthy 2012). However, there was no indication that low vision rehabilitation services were delivered to these patients via tele-ophthalmology in these projects. One review specifically stated that low vision consultation could be one potential tele-ophthalmology service (Prathiba 2011).

A systematic review of telemedicine for elderly patients with any health condition found that some telemedicine studies had excluded people with visual impairment. These studies thus did not provide data with regard to the impact of vision loss on patients' ability to participate in the videoconferencing sessions (Van den Berg 2012). Most studies of telemedicine in elderly patients found benefits for behavioral outcomes, such as adherence, self-efficacy, quality of life, and economic outcomes. These findings are encouraging, since most low vision populations are elderly; however, the potential for vision loss to limit access to or use of a videoconferencing portal for telemedicine has not been formally evaluated in an older population.

We identified a somewhat outdated, internet-based survey study on usage of relevant technologies by individuals with low vision, which potentially could be used to deliver telerehabilitation services. In 2014, use of a tablet device was reported by nearly half (48%) of 132 people with low vision or no vision (Crossland 2014). Most respondents (81%) indicated that they used a smartphone, and about half (51%) used their camera and screen as a magnifier. While this study did not specify the proportion of individuals who used video chat on their device, it did suggest that devices with video functionality were being used by the survey respondents. More recent studies on the use of smartphones, internet, and videoconferencing by people with low vision are needed.

AUTHORS' CONCLUSIONS

Implications for practice

There is currently only limited evidence available from one trial to provide a basis for the use of telerehabilitation for people with low vision. Several observational studies and projects have indicated the potential benefit and feasibility of delivering ophthalmologic care via the internet. However, these previous studies and projects have not demonstrated the efficacy of telerehabilitation for low vision and utility in clinical practice.

Implications for research

Given the disease burden and the growing interest in telemedicine, there is a need for future studies to explore the potential for telerehabilitation as a platform for providing remote services to people with low vision. As a logical first step, it would be helpful for research to explore patients' preferences for receiving telerehabilitation versus in-office rehabilitation, considering both ex ante and post hoc elicitation of preferences, as well as individuals' ability to access the internet and videoconference platforms for telerehabilitation services. Next, evidence from trials is needed to compare the outcomes following low vision rehabilitation delivered in office versus remotely via the internet by a therapist for the following types of vision assistive equipment.

1. Wearable electronic devices (e.g. augmented reality glasses)
2. Optical magnifiers, either hand-held or stand, with or without illumination
3. Portable electronic video magnifiers
4. Desktop closed circuit televisions (i.e. large screen-based video magnifiers)
5. Spectacle-based high add powers for near
6. Visual assistive mobile applications (apps)
7. Computer software and accessibility features

Despite the growing interest in telerehabilitation, the lack of trials for people with low vision may reflect concerns about accessibility of the technology by individuals with low vision or long-term sustainability given limited payment reimbursement mechanisms for this type of service. Supportive evidence from randomized controlled trials of telerehabilitation for low vision could be used to help drive policy changes and implement programs that help provide payment to cover remotely delivered services via a telehealth platform.

ACKNOWLEDGEMENTS

We acknowledge Stephanie L Wykstra, who screened the retrieved papers and abstracts against the inclusion criteria, in addition to co-authors AKB, PDY, and TR. We acknowledge Lori Rosman, Information Specialist for Cochrane Eyes and Vision (CEV), who designed the electronic search strategies. We thank Karla Zadnik, Barbara Hawkins, and the CEV editorial group for their comments on previous drafts of this protocol and review. We also thank Angus Turner, Barbara Hawkins, and other peer reviewers for their comments on our manuscript.

The 2022 review update was managed by CEV@US and was signed off for publication by Tianjing Li and Gianni Virgili.

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* Indicates the major publication for the study

CHARACTERISTICS OF STUDIES

Characteristics of included studies *[ordered by study ID]*

Lorenzini 2021

Study characteristics	
Methods	**Study design:** parallel-group randomized controlled trial, multicenter **Number randomized:** 57 in total; 28 for telerehabilitation group and 29 for self-training group **Exclusions after randomization:** none reported **Losses to follow-up**: 20 in total; 7 for telerehabilitation group and 13 for self-training group **Unit of analysis:** participants **Number analyzed:** 57 in total; 28 for telerehabilitation group and 29 for self-training group **How were missing data handled?:** linear mixed-effects models with repeated-measures design and post hoc tests using Bonferroni correction ($P < 0.05$); otherwise not reported how missing data were handled
Participants	**Country:** Canada **Mean, age (SD):** 54.5 (16.7) years overall; 51.4 (20.1) years for telerehabilitation group and 57.6 (12.3) years for self-training group **Gender, n (%):** 14 (50%) men and 14 (50%) women in telerehabilitation group; 19 (66%) men and 10 (34%) women in self-training group **Participants' eye disease of interest:** various eye diseases (17 reported) **Inclusion criteria:** novice users of eSight Eyewear aged 18+ years with self-reported low vision who had a tablet, desktop, or laptop computer with internet access and recently bought (< 1 month) or were renting eSight Eyewear, and spoke English or French **Exclusion criteria:** currently using or prior users of the eSight device for more than 1 month, self-reported other severe sensory or cognitive impairment, or both, that interferes with communication, and unable to follow/understand a 20-minute phone conversation

Lorenzini 2021 *(Continued)*

	Equivalence of baseline characteristics: "Participant characteristics at randomization are presented in the parallel study and show comparable descriptive characteristics, albeit with more men in the control group and more retired participants in the control-renters subgroup."
Interventions	**Intervention 1 (telerehabilitation group):** 30 hours of personalized low vision training through telerehabilitation involving six 1-hour online training sessions within the first 2 weeks (6 hours), 12 additional hours of homework in parallel during the same 2 weeks, and an additional 12 hours of homework in the following 2 weeks. Telerehabilitation focused on the functional aspects of using eSight. In addition to distance vision and reading exercises, participants were trained on specific writing (i.e., crosswords, drawing, or painting) and other eye-hand co-ordination tasks, according to each person's needs (i.e., playing cards, sewing). Eye movement control and, if needed, eccentric fixation were trained using exercises extracted from standard/well-established clinical low vision guides. Participants in the telerehabilitation group trained themselves at home using the eSkills learning and training guide and additional personalized exercises extracted from 2 low vision guides **Intervention 2 (self-training group):** 30 hours of the self-training standard provided by eSight using the eSkills User Guide, completely self-administered at home by the participants for 1 hour per day for 1 month. The self-training focused on the technical aspects of using the eSight device and provided instructions about the settings for distance vision and reading as well as viewing techniques with other media (i.e. digital tablets, TV). **Length of follow-up:** planned: 2 weeks, 3 months, 6 months; actual: 2 weeks, 3 months, 6 months **Note:** in both groups, participants had optional access to standard support for technical issues available through eSight Corporation staff
Outcomes	**Primary outcomes:** quality of life using 2 standardized measures: 1) Psychosocial Impact of Assistive Devices Scale and 2) the Quebec User Evaluation of Satisfaction with Assistive Technology scale **Secondary outcomes:** open- and closed-ended questions specifically developed for this study, 1) Veterans Affairs Low-Vision Visual Functioning Questionnaire-48, 2) Simulator Sickness Questionnaire, and 3) a satisfaction survey **Intervals at which outcomes were assessed:** baseline, 2 weeks, 3 months, and 6 months
Notes	**Publication type:** published article and protocol **Funding sources:** Mitacs (IT08595 Grant; to M-CL) and Fonds de Recherche du Québec—Santé (Junior 2chercheur boursier Career Award No. 281454; to WW) **Disclosures of interest:** "None of the authors have reported a financial conflict of interest. The sponsor facilitated subject recruitment; however, the sponsor was not involved in study design, analyses, and interpretation. The authors were responsible for the preparation of this article and the decision to submit this article for publication. Each of the authors had access to the study data and takes full responsibility for his/her presentation in this article." **Trial registry:** none reported **Study period:** June 2018 to June 2019 **Subgroup analyses:** buyers versus renters in the experimental versus control groups **Publication language:** English

SD: standard deviation

Characteristics of excluded studies *[ordered by study ID]*

Study	Reason for exclusion
Al-Moujahed 2021	Wrong intervention
Amore 2018	Wrong intervention
Battistin 2021	Wrong study design
Battistin 2021a	Wrong study design
Bittner 2018	Wrong study design
Bittner 2018a	Wrong study design
Callisaya 2021	Wrong study design
Chang 2020	Wrong study design
Chia 2021	Wrong study design
Deemer 2020	Wrong intervention
Gothwal 2018	Wrong intervention
Islam 2020	Wrong study design
Kang 2020	Wrong patient population
Maeng 2018	Wrong comparator
Mintz 2020	Wrong study design
Morjaria 2020	Wrong intervention
NCT04238065	Wrong intervention
NCT04391166	Wrong study design
NCT04685824	Wrong intervention
NCT04736264	Wrong intervention
NCT04926974	Wrong comparator
Oeverhaus 2020	Wrong intervention
Salazar 2021	Wrong study design
Schmiedecke-Barbieri 2020	Wrong study design
Senjam 2021	Wrong study design
Thompson 2019	Wrong intervention
van der Aa 2017	Wrong intervention
van der Aa 2020	Wrong intervention

Study	Reason for exclusion
Wu 2021	Wrong study design

Characteristics of ongoing studies *[ordered by study ID]*

NCT03957980

Study name	Remote access: cortical visual impairment
Methods	Randomized cross-over trial
Participants	**Inclusion criteria:** 1. Children aged 12 months to 6 years 11 months with suspected or previously diagnosed cortical visual impairment. For children who had been previously diagnosed with cortical visual impairment and were under regular ongoing therapy related to vision, they should not be receiving more than 1 time/session a week at the time of recruitment. 2. Caregivers are cognitively able to provide meaningful consent or parent permission, or both 3. Home address must be in Ohio, Kentucky, West Virginia, or Indiana (due to occupational therapy licensure laws and telehealth) 4. English speaking **Exclusion criteria:** 1. Children who were not referred for an evaluation for cortical visual impairment 2. Children not living in Ohio, Kentucky, Indiana, or West Virginia 3. Children who are already receiving more than 1 therapy session related to vision a week
Interventions	**Intervention:** occupational therapy via telehealth for 12 weeks, then cross-over to receiving no intervention for 12 weeks **Comparison intervention:** no intervention in the first 12 weeks, then cross-over to receiving occupational therapy via telehealth for 12 weeks
Outcomes	**Primary outcome(s)**: functional vision **Secondary outcome(s):** individualized and function goals **Other outcome(s):** caregiver and therapist telehealth qualitative data; caregiver and therapist intervention questionnaire **Maximum follow-up:** 12 months
Starting date	May 2017 **Estimated study completion:** November 2018
Contact information	clinicaltrials.gov/show/NCT03957980
Notes	

NCT04066075

Study name	Beacon sensors and telerehabilitation for low vision

NCT04066075 *(Continued)*

Methods	Parallel-group randomized controlled trial
Participants	**Inclusion criteria:** 1. Any level of vision loss due to any ocular disease in individuals 18 years of age and older, who have received new magnification device(s) for the first time (i.e. hand-held optical magnifiers, portable electronic video magnifiers, some stand magnifiers and closed circuit televisions) from 1 of the participating sites **Exclusion criteria:** 1. Schedules not permitting participation in planned study visits (including planning to move or take extended vacation during study period) 2. Inability to understand study procedures or communicate responses to visual stimuli in a consistent manner (cognitive impairment as per Telephone Interview for Cognitive Status) 3. Substance abuse 4. Significant hearing loss (unable to hear communication by phone or via videoconferencing) 5. Significant medical condition likely to limit participation or life span, individuals who require other types of low vision rehabilitation training or intervention (e.g. technology/computer skills, psychosocial) 6. Magnifier device has features that would not work in conjunction with the beacon sensors: 1) hands-free and do not have a place where the patient's hand is holding the device during use (therefore they would not register a significant change in temperature) and/or 2) no surface area of at least 1" x 1" to which the beacon sensor could be attached without interfering with the device
Interventions	**Intervention 1:** telerehabilitation with low vision provider **Intervention 2:** telerehabilitation with low vision provider plus tele-extender **Comparison intervention:** usual care (in-office)
Outcomes	**Primary outcome(s)**: Activity Inventory (change from 1 month to 4 months after receiving a magnification device) **Secondary outcome(s):** 1. MNread (reading test) at baseline, 1 month, 4 months 2. Sustained Silent Reading Test at baseline, 1 month, 4 months 3. Geriatric Depression Scale at baseline, 1 month, 4 months 4. Hospital Anxiety and Depression Scale at baseline, 1 month, 4 months **Maximum follow-up:** 4 months
Starting date	August 2019 **Estimated study completion:** July 2022
Contact information	clinicaltrials.gov/show/NCT04066075
Notes	

RISK OF BIAS

Legend: Low risk of bias High risk of bias Some concerns

Risk of bias for analysis 1.1 Postintervention vision-related quality of life

	Bias					
Study	**Randomisation process**	**Deviations from intended interventions**	**Missing outcome data**	**Measurement of the outcome**	**Selection of the reported results**	**Overall**
Lorenzini 2021	✗	~	✗	✓	✓	✗

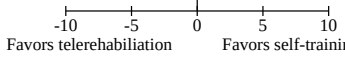
DATA AND ANALYSES

Comparison 1. Telerehabilitation versus self-training

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1.1 Postintervention vision-related quality of life	1		Mean Difference (IV, Fixed, 95% CI)	Totals not selected
1.2 Proportion of participants lost to follow-up	1		Risk Ratio (M-H, Fixed, 95% CI)	Totals not selected
1.2.1 Six months	1		Risk Ratio (M-H, Fixed, 95% CI)	Totals not selected
1.3 Proportion of participants with incomplete treatment	1		Risk Ratio (M-H, Fixed, 95% CI)	Totals not selected
1.3.1 Six months	1		Risk Ratio (M-H, Fixed, 95% CI)	Totals not selected
1.4 Proportion of participants reporting technical difficulties with the intervention	1		Risk Ratio (M-H, Fixed, 95% CI)	Totals not selected
1.5 Proportion of participants abandoning devices	1		Risk Ratio (M-H, Fixed, 95% CI)	Totals not selected
1.5.1 Six months	1		Risk Ratio (M-H, Fixed, 95% CI)	Totals not selected

Analysis 1.1. Comparison 1: Telerehabilitation versus self-training , Outcome 1: Postintervention vision-related quality of life

Study or Subgroup	Telerehabilitation Mean	SD	Total	Self-training Mean	SD	Total	Mean Difference IV, Fixed, 95% CI	Mean Difference IV, Fixed, 95% CI	Risk of Bias A B C D E F
Lorenzini 2021 (1)	2.535	4.623	28	2.397	4.456	29	0.14 [-2.22 , 2.50]		



Footnotes

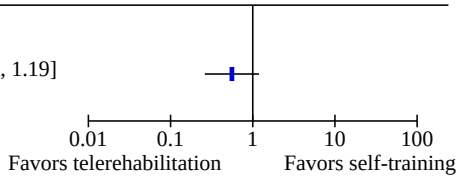
(1) This forest plot was created only for a presentation purpose of the risk of bias assessment for this primary outcome. As the study did not report standard deviations (SDs), we calc

Risk of bias legend

(A) Bias arising from the randomization process
(B) Bias due to deviations from intended interventions
(C) Bias due to missing outcome data
(D) Bias in measurement of the outcome
(E) Bias in selection of the reported result
(F) Overall bias

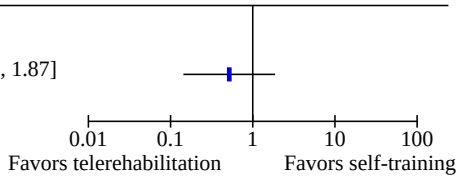
Analysis 1.2. Comparison 1: Telerehabilitation versus self-training , Outcome 2: Proportion of participants lost to follow-up

Study or Subgroup	Telerehabilitation Events	Total	Self-training Events	Total	Risk Ratio M-H, Fixed, 95% CI	Risk Ratio M-H, Fixed, 95% CI
1.2.1 Six months						
Lorenzini 2021	7	28	13	29	0.56 [0.26 , 1.19]	



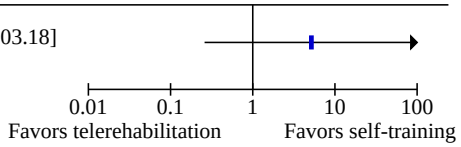
Analysis 1.3. Comparison 1: Telerehabilitation versus self-training , Outcome 3: Proportion of participants with incomplete treatment

Study or Subgroup	Telerehabilitation Events	Total	Self-training Events	Total	Risk Ratio M-H, Fixed, 95% CI	Risk Ratio M-H, Fixed, 95% CI
1.3.1 Six months						
Lorenzini 2021	3	28	6	29	0.52 [0.14 , 1.87]	

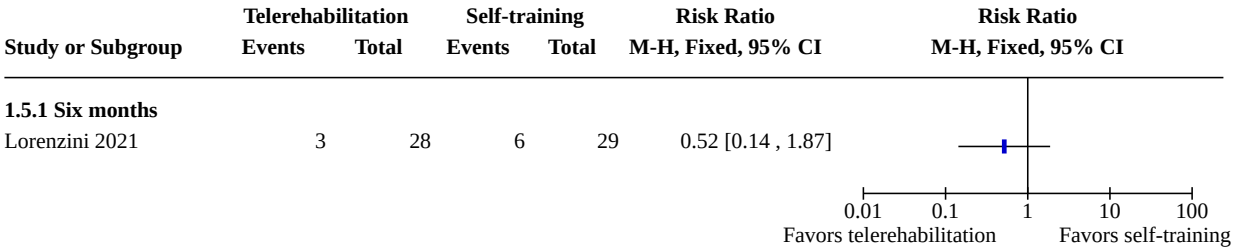


Analysis 1.4. Comparison 1: Telerehabilitation versus self-training , Outcome 4: Proportion of participants reporting technical difficulties with the intervention

Study or Subgroup	Telerehabilitation Events	Total	Self-training Events	Total	Risk Ratio M-H, Fixed, 95% CI	Risk Ratio M-H, Fixed, 95% CI
Lorenzini 2021	2	28	0	29	5.17 [0.26 , 103.18]	



Analysis 1.5. Comparison 1: Telerehabilitation versus self-training , Outcome 5: Proportion of participants abandoning devices



APPENDICES

Appendix 1. CENTRAL search strategy

#1 MeSH descriptor: [Vision, Low] explode all trees
#2 MeSH descriptor: [Vision Disorders] explode all trees
#3 MeSH descriptor: [Visually Impaired Persons] explode all trees
#4 ((low* or handicap* or subnormal* or impair* or partial* or disab* or reduce* or diminish* or decrease*) near/3 (vision or visual* or sight*))
#5 ((Vision or visual) near/2 loss)
#6 #1 or #2 or #3 or #4 or #5
#7 MeSH descriptor: [Telecommunications] this term only
#8 MeSH descriptor: [Telemedicine] explode all trees
#9 MeSH descriptor: [Telemetry] explode all trees
#10 MeSH descriptor: [Videoconferencing] explode all trees
#11 MeSH descriptor: [Wireless Technology] explode all trees
#12 MeSH descriptor: [Computer Communication Networks] explode all trees
#13 MeSH descriptor: [Decision Making, Computer-Assisted] explode all trees
#14 MeSH descriptor: [Computer-Assisted Instruction] explode all trees
#15 MeSH descriptor: [Computers] explode all trees
#16 MeSH descriptor: [User-Computer Interface] explode all trees
#17 (Telecommunication* or telemed* or tele-med* or telemetry or telerehab* or tele-rehab* or Telehealth* or tele-health* or Teleconsult* or tele-consult* or Teleconference* or tele-conference* or tele-home* or telehome* or tele-coach or telecoach* or tele-care* or telecare* or tele-ophthalm* or teleophthalm* or tele-screen* or telescreen* or tele-therap* or teletherap* or tele-diagnosis or telediagnosis or tele-mentor* or telementor*)
#18 (eHealth or e-health or eMedicine or e-medicine or eRehab* or e-rehab*)
#19 (Mobile health or mHealth)
#20 (information technolog* or information communication technolog* or ICT)
#21 ((web* or internet* or virtual* or remote* or wireless* or mobile or video* or computer* or online or on-line) near/5 (rehab* or therap* or treatment or communication* or consult* or care or specialist* or monitor* or educat* or counsel* or train* or asses*))
#22 #7 or #8 or #9 or #10 or #11 or #12 or #13 or #14 or #15 or #16 or #17 or #18 or #19 or #20 or #21
#23 #6 and #22 from 1980

Appendix 2. MEDLINE (Ovid) search strategy

1. exp vision, low/
2. exp vision disorders/
3. exp visually impaired persons/
4. ((low* or handicap* or subnormal* or impair* or partial* or disab* or reduce* or diminish* or decrease*) adj3 (vision or visual* or sight*)).tw.
5. ((Vision or visual) adj2 loss).tw.
6. or/1-5
7. Telecommunications/
8. exp telemedicine/
9. exp telemetry/

10. exp Videoconferencing/
11. exp Wireless Technology/
12. exp Computer Communication Networks/
13. exp Decision Making, Computer-Assisted/
14. exp Computer-Assisted Instruction/
15. exp computers/
16. exp User-Computer Interface/
17. (Telecommunication* or telemed* or tele-med* or telemetry or telerehab* or tele-rehab* or Telehealth* or tele-health* or Teleconsult* or tele-consult* or Teleconference* or tele-conference* or tele-home* or telehome* or tele-coach or telecoach* or tele-care* or telecare* or tele-ophthalm* or teleophthalm* or tele-screen* or telescreen* or tele-therap* or teletherap* or tele-diagnosis or telediagnosis or tele-mentor* or telementor*).tw.
18. (eHealth or e-health or eMedicine or e-medicine or eRehab* or e-rehab*).tw.
19. (Mobile health or mHealth).tw.
20. (information technolog* or information communication technolog* or ICT).tw.
21. ((web* or internet* or virtual* or remote* or wireless* or mobile or video* or computer* or online or on-line) adj5 (rehab* or therap* or treatment or communication* or consult* or care or specialist* or monitor* or educat* or counsel* or train* or asses*)).tw.
22. or/7-21
23. 6 and 22
24. limit 23 to yr="1980 -Current"

Appendix 3. Embase.com search strategy

#1 'visual impairment'/exp
#2 'low vision'/exp
#3 'visual disorder'/exp
#4 ((low* OR handicap* OR subnormal* OR impair* OR partial* OR disab* OR reduce* OR diminish* OR decrease*) NEAR/3 (vision OR visual* OR sight*)):ab,ti
#5 ((vision OR visual) NEAR/2 loss):ab,ti
#6 #1 OR #2 OR #3 OR #4 OR #5
#7 'telehealth'/exp
#8 'telemetry'/exp
#9 'telecommunication'/de
#10 'teleconference'/exp
#11 'mass communication'/de
#12 'internet'/exp
#13 'videoconferencing'/exp
#14 'webcast'/exp
#15 'wireless communication'/exp
#16 'computer network'/exp
#17 'decision support system'/exp
#18 'computer'/exp
#19 'computer interface'/exp
#20 'human computer interaction'/exp
#21 telecommunication*:ab,ti OR telemed*:ab,ti OR telemetry:ab,ti OR telerehab*:ab,ti OR telehealth*:ab,ti OR teleconsult*:ab,ti OR teleconference*:ab,ti OR telehome*:ab,ti OR telecoach*:ab,ti OR telecare*:ab,ti OR teleophthalm*:ab,ti OR telescreen*:ab,ti OR teletherap*:ab,ti OR telediagnosis:ab,ti OR telementor*:ab,ti
#22 (tele NEXT/1 (med* OR rehab* OR health* OR consult* OR conference* OR home* OR coach* OR care* OR ophthalm* OR screen* OR therap* OR diagnosis OR mentor*)):ab,ti
#23 ehealth:ab,ti OR 'e health':ab,ti OR emedicine:ab,ti OR 'e medicine':ab,ti
#24 (e NEXT/1 rehab*):ab,ti
#25 'mobile health':ab,ti OR mhealth:ab,ti
#26 'information technology':ab,ti OR 'information technologies':ab,ti OR 'information communication technology':ab,ti OR 'information communication technologies':ab,ti OR ict:ab,ti
#27 ((web* OR internet* OR virtual* OR remote* OR wireless* OR mobile OR video* OR computer* OR online OR 'on line') NEAR/5 (rehab* OR therap* OR treatment OR communication* OR consult* OR care OR specialist* OR monitor* OR educat* OR counsel* OR train* OR asses*)):ab,ti
#28 #7 OR #8 OR #9 OR #10 OR #11 OR #12 OR #13 OR #14 OR #15 OR #16 OR #17 OR #18 OR #19 OR #20 OR #21 OR #22 OR #23 OR #24 OR #25 OR #26 OR #27
#29 #6 AND #28
#30 #6 AND #28 AND [1980-2015]/py

Appendix 4. PubMed search strategy

#1 ((low[tiab] OR lower[tiab] OR handicap*[tiab] OR subnormal*[tiab] OR impair*[tiab] OR partial*[tiab] OR disab*[tiab] OR reduce*[tiab] OR diminish*[tiab] OR decrease*[tiab]) AND (vision[tiab] OR visual*[tiab] OR sight*[tiab])) NOT Medline[sb]
#2 ((Vision[tiab] OR visual[tiab]) AND loss[tiab]) NOT Medline[sb]
#3 #1 OR #2
#4 (Telecommunication*[tiab] OR telemed*[tiab] OR tele-med*[tiab] OR telemetry[tiab] OR telerehab*[tiab] OR tele-rehab*[tiab] OR Telehealth*[tiab] OR tele-health*[tiab] OR Teleconsult*[tiab] OR tele-consult*[tiab] OR Teleconference*[tiab] OR tele-conference*[tiab] OR tele-home*[tiab] OR telehome*[tiab] OR tele-coach[tiab] OR telecoach*[tiab] OR tele-care*[tiab] OR telecare*[tiab] OR tele-ophthalm*[tiab] OR teleophthalm*[tiab] OR tele-screen*[tiab] OR telescreen*[tiab] OR tele-therap*[tiab] OR teletherap*[tiab] OR tele-diagnosis[tiab] OR telediagnosis[tiab] OR tele-mentor*[tiab] OR telementor*[tiab]) NOT Medline[sb]
#5 (eHealth[tiab] OR e-health[tiab] OR eMedicine[tiab] OR e-medicine[tiab] OR eRehab*[tiab] OR e-rehab*[tiab]) NOT Medline[sb]
#6 (Mobile health[tiab] OR mHealth[tiab]) NOT Medline[sb]
#7 (information technolog*[tiab] OR information communication technolog*[tiab] OR ICT[tiab]) NOT Medline[sb]
#8 ((web[tiab] OR website[tiab] OR internet*[tiab] OR virtual*[tiab] OR remote*[tiab] OR wireless*[tiab] OR mobile[tiab] OR video*[tiab] OR computer*[tiab] OR online[tiab] OR on-line[tiab]) AND (rehab*[tiab] OR therap*[tiab] OR treatment[tiab] OR communication*[tiab] OR consult*[tiab] OR care[tiab] OR specialist*[tiab] OR monitor*[tiab] OR educat*[tiab] OR counsel*[tiab] OR train*[tiab] OR asses*[tiab])) NOT Medline[sb]
#9 #4 OR #5 OR #6 OR #7 OR #8
#10 #3 AND #9

Appendix 5. ClinicalTrials.gov search strategy

low vision AND (telemedicine OR internet OR website OR remote OR mobile rehabilitation)

Appendix 6. WHO ICTRP search strategy

vision AND telemedicine OR vision AND internet OR vision AND website OR vision AND remote OR vision AND mobile rehabilitation

WHAT'S NEW

Date	Event	Description
14 September 2021	New citation required and conclusions have changed	One study was newly included (Lorenzini 2021), and one ongoing study was newly identified (NCT04066075). Relevant sections have been updated.
14 September 2021	New search has been performed	Issue 9, 2021: Electronic database searches were updated.
27 February 2020	Amended	Declaration of interest statement added for author AVB.

HISTORY

Protocol first published: Issue 3, 2014
Review first published: Issue 8, 2015

Date	Event	Description
21 November 2019	New search has been performed	Electronic searches updated.
21 November 2019	New citation required but conclusions have not changed	Two ongoing studies identified; no eligible completed studies included.

CONTRIBUTIONS OF AUTHORS

Conceiving the review: AKB, PDY, TR, TL

Designing the review: AKB, PDY, TR, TL

Co-ordinating the review: AKB, TR

Screening search results: AKB, PDY, TR

Organizing retrieval of papers: TR

Screening retrieved papers against inclusion criteria: AKB, PDY, TR

Appraising quality of papers: PDY, TR

Extracting data from papers: AKB, TR

Writing to authors of papers for additional information: TR

Providing additional data about papers: TR

Obtaining and screening data on unpublished studies: TR

Data management for the review: TR

Entering data into Review Manager 5: TR

Analysis of data: TR

Interpretation of data: AKB, PDY, TR, TL

Writing the review: AKB, PDY, TR, TL

Critical revision: AKB, PDY, TR, TL

Performed previous work that was the foundation of the current study: AKB, PDY, TL

Guarantor of the review: AKB

DECLARATIONS OF INTEREST

One reason for conducting this systematic review was to establish a knowledge base to guide the design of future randomized controlled trials to evaluate the efficacy of telerehabilitation for a primarily elderly, visually impaired population. Along with this systematic review, Dr Tianjing Li has received funding to collect pilot data to demonstrate the feasibility of using telerehabilitation as a platform for delivering low vision rehabilitation services. The systematic review and the pilot data collected will lay the foundation for preparing randomized controlled trial applications.

Dr Bittner has received funding from the National Eye Institute, National Institutes of Health; the American Academy of Optometry Foundation; and Envision Research Institute to conduct pilot studies and randomized controlled trials of telerehabiliation for low vision, for which Dr Yoshinaga is a co-investigator.

TR has no conflicts of interest to declare.

SOURCES OF SUPPORT

Internal sources

- None, Other

  No internal source of support

External sources

- National Eye Institute, National Institutes of Health, USA

  Cochrane Eyes and Vision US Project, supported by grant UG1EY020522 (PI: Tianjing Li, MD, MHS, PhD)
- Public Health Agency, UK

The HSC Research and Development (R&D) Division of the Public Health Agency funds the Cochrane Eyes and Vision editorial base at Queen's University Belfast.

- National Eye Institute, National Institutes of Health, USA

Ava Bittner is supported by grant R21 EY029883, National Eye Institute, National Institutes of Health, USA, and by an unrestricted award from Research to Prevent Blindness to the Department of Ophthalmology at UCLA.

- Queen's University Belfast, UK

The work of Gianni Virgili, Co-ordinating Editor for Cochrane Eyes and Vision, is funded by the Centre for Public Health, Queen's University of Belfast, Northern Ireland.

DIFFERENCES BETWEEN PROTOCOL AND REVIEW

1. We did not follow all methods set forth in the protocol for the review as there was only single included study and thus no meta-analysis conducted.

2. We revised methods for future updates of this review to include, when possible, Cochrane's RoB 2 tool, GRADE assessment, and a summary of findings table.

INDEX TERMS

Medical Subject Headings (MeSH)

Activities of Daily Living; Blindness [rehabilitation]; Quality of Life; Telemedicine; *Telerehabilitation; *Vision, Low [rehabilitation]

MeSH check words

Adult; Humans; Middle Aged