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Protocol

Effects of home-based remote rehabilitation on children and adolescents with cystic fibrosis and non-cystic fibrosis bronchiectasis: a systematic review protocol

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ABSTRACT

Background: Home-based remote rehabilitation combining the use of new technological tools is an alternative way of rehabilitation when traditional center-based programs are limited or are not feasible. This systematic review aims to investigate the level of evidence for the effects of home-based remote rehabilitation on children and adolescents with cystic fibrosis (CF) and non-cystic fibrosis bronchiectasis (NCFB).
Methods: This systematic review will follow the preferred reporting items for systematic reviews and meta-analysis (PRISMA). Five databases will be searched from the period of the inception until March 2024: PubMed, Web of Science, Medline (via EBSCOhost), ACM Digital Library, and Scopus. Methodological quality will be assessed using the revised Cochrane Risk of Bias tool for randomized trials (RoB 2) and the risk of bias in non-randomized studies – of interventions (ROBINS-1) tool. The overall quality of the evidence will be assessed using the grading of recommendations assessment, development, and evaluation (GRADE) approach.
Conclusions: Evaluation of the level of evidence for the effects of home-based remote rehabilitation in children and adolescents with CF and NCFB is an important step in the context of telehealth, providing an alternative way of approaching pediatric patients, during the process of rehabilitation.
Trial registration: PROSPERO registration number is CRD42024498403.

Keywords: Adolescents, Bronchiectasis, Children, Cystic fibrosis, Home-based, Remote rehabilitation

INTRODUCTION

Cystic fibrosis (CF) and localized-to-diffuse non-cystic fibrosis bronchiectasis (NCFB) such as those caused by primary ciliary dyskinesia (PCD), chronic suppurative lung disease (CSLD), and protracted bacterial bronchitis (PBB) are chronic lung diseases that are characterized by abnormal sputum and persistent productive cough affecting the health-related quality of life (HRQoL).[1] Patients who report increased sputum production and worsening symptoms are those who have decreased pulmonary function and impaired HRQoL.[2] A recent systematic review and meta-analysis revealed that HRQoL is associated with subjective (dyspnea, fatigue) and objective (pulmonary function, exercise capacity) outcome measures.[3] In children and adolescents with CF and NCFB

exacerbations of the disease are related to increased respiratory symptoms, accelerated lung function decline, high rate of hospital admissions and financial resource use, absences from school, and impaired HRQoL.[4-6] Managing exacerbations is a key component of CF and NCFB care. Treatment focuses on pharmacological and non-pharmacological interventions for preventing infections, reducing symptoms, and improving HRQoL.[7]

In the context of the non-pharmacological approach, multiple home-based programs that include respiratory interventions such as chest physiotherapy, aerobic and strengthening exercises seem to be effective for several clinical outcomes in children and adolescents with CF. In a recent systematic review and meta-analysis, home-based rehabilitation was superior in improving pulmonary function, functional capacity, and HRQoL when compared to the control group, and equally effective when compared to conventional rehabilitation for the same variables.[8]

New technologies (applied for use in smartphones and tablets) are increasingly used in the context of telehealth as an effective method for saving travel time and delivering care from distance.[9] Especially, using new technology in telehealth seems to be an opportunity for improving clinical outcomes such as symptom control, adherence to treatment, reduction of hospitalizations, and HRQoL in children and adolescents with chronic lung diseases.[10]

Home-based remote rehabilitation combines the use of new technology and the home environment in the context of rehabilitation. When circumstances require the restriction of transports (e.g. during the COVID-19 pandemic), home-based remote rehabilitation provides a solution for high-risk patients who are about to attend a rehabilitation program, such as respiratory patients. Integrating new technology in the home-based rehabilitation field may help strengthen compliance with treatment at home and promote patients' engagement in therapy.[11]

This systematic review will aim to collect and present the effects of home-based remote rehabilitation on clinical outcomes in children and adolescents with CF and NCFB. The research question of this review is formulated as follows: "Is home-based remote rehabilitation an effective intervention for improving pulmonary function, functional capacity, HRQoL, or other outcomes in children and adolescents with cystic fibrosis and non-cystic fibrosis bronchiectasis, compared to conventional rehabilitation and/or usual care?".

METHODS

This systematic review will be conducted and reported in accordance with the preferred reporting items for systematic reviews and meta-analysis (PRISMA) guidelines.[12,13] The protocol is registered with the international prospective register of systematic reviews (PROSPERO: CRD42024498403).

Inclusion criteria

This review will focus on studies evaluating the effectiveness of home-based remote rehabilitation on pulmonary function, functional capacity, HRQoL, or other outcomes. Studies for review will be selected according to the following eligibility criteria, categorized by study design, population, type of intervention, comparisons, and outcomes. Any studies excluded will be reported on the PRISMA flow chart.[14]

Population

Children and adolescents (0-18 years) with CF and NCFB will be the population. If studies report on mixed samples, i.e., with different chronic diseases including the aforementioned, they will be included only if data for the populations mentioned above are reported and presented separately. There will be no restrictions on characteristics such as gender or ethnicity.

Types of interventions

This review will include studies that use home-based remote rehabilitation to promote clinical improvement in several parameters that are affected by the disease e.g., pulmonary function, functional capacity, and HRQoL. For this review, home-based remote rehabilitation will be defined as the remote delivery of pulmonary rehabilitation (exercise and education) services via information and communication technologies (telecommunication) and includes videoconferencing, active video games (including sensors for monitoring), and mobile applications. The intervention may be delivered or monitored by rehabilitation staff (e.g., physiotherapists). Studies that include telerehabilitation and in-person rehabilitation will be included only if at least 50% of the intervention (e.g., number of sessions) was delivered via telerehabilitation. Studies that use other methods of home-based rehabilitation delivery (telephone and/or email) will be excluded.

Comparisons or controls

In studies that include control or comparator groups, the type of approach for these groups can be any of the following: another type of intervention delivered in person, usual care, or no intervention. Usual care can be defined as the pharmacological and non-pharmacological intervention that would normally be received by patients with the above diseases as part of their treatment pathway.

Outcome measures

This review will include studies that focus on clinical outcomes. Clinical outcomes are any outcome that refers to physical components that are related to disease progression such as pulmonary function, functional capacity, and HRQoL. Additional outcomes will be referred to symptomatology, exacerbation frequency,

number of hospitalizations, number of non-scheduled health-care visits, and mortality.

Study design

Randomized controlled trials (RCTs), non-RCT interventional studies, and pilot studies will be included for a comprehensive overview of all the telerehabilitation approaches. For mixed-method studies, only the quantitative data will be used for analysis.

Exclusion criteria

Studies that include participants >18 years, have patients with other respiratory diseases (such as asthma), or the publication is not available in English will be excluded. Systematic reviews and meta-analyses, narrative reviews, observational studies, duplicate studies, editorial or opinion articles, grey literature, guidelines, protocols, and abstracts of conference presentations will also be excluded. However, relevant systematic reviews will be used for a hand-held search of additional eligible studies for inclusion. No restrictions regarding the time of publication will be applied.

Information sources

We will systematically search PubMed, Web of Science, Medline (via EBSCOhost), ACM Digital Library, and Scopus databases for the period from their inception until March 2024. Up-to-date and comprehensive search strategies will be adopted to ensure search effectiveness.

Search strategy

The initial search strategy will be developed in PubMed (Table 1). Key index terms will be determined through discussions between two researchers (AM and VS). The concepts and key index terms used in a preliminary search will later be adapted to the selected databases. Keywords will be in English and combined using Boolean logical operators (AND and OR).

Study selection

We will use a multistage process for study selection. Firstly, all retrieved studies will be imported into the Rayyan software package and duplicate studies will be removed through the program.[15] Two researchers (AM and VS) will independently screen all potential titles that generally appear to meet the inclusion/exclusion criteria. Then, the same researchers will independently evaluate all abstracts and identify studies for full-text review. Discrepancies at any stage of study selection will be resolved by a third independent researcher (EK). Any exclusion studies will be reported in the PRISMA flow chart.

Data extraction process

Two independent researchers (AM and VS) will extract data from eligible studies using a study-specific data extraction form. The form will focus on the following domains: author, year, study design, diagnosis, population, professional, intervention (type, delivery method, number of sessions, duration of sessions, duration of the program), control group (where applicable), and outcome measures (before and after treatment differences) (Table 2). This form will be reviewed by the research team to ensure that it is capturing the information accurately. For studies that are not fully available online or have incomplete data, additional communication with the authors will be sought. To ensure a timely delivery of this review, any additional data that have not been returned within 2 weeks from the request communication, will be excluded from analysis.

Table 1: Search strategy for PubMed.

S. no.	Search strategy
#1	"Respiratory Tract Diseases"[Mesh] OR "cystic fibrosis"[tw] OR "non-cystic fibrosis"[tw] OR "bronchiectasis"[tw] OR "primary ciliary dyskinesia"[tw] NOT "asthma"[tw]
#2	"Rehabilitation"[Mesh] OR "program"[tw] OR "intervention"[tw] OR "rehabilitation"[tw] OR "bronchial hygiene"[tw] OR "respiratory therapy"[tw] OR "chest physical therapy"[tw] OR "chest physiotherapy"[tw] OR "drainage"[tw] OR "exercise"[tw] OR "physiotherapy"[tw] OR "physical therapy"[tw] OR "airway clearance techniques"[tw] OR "non-pharmacological treatment"[tw]
#3	"Telemedicine"[Mesh] OR "Digital Technology"[Mesh] OR "mhealth"[tw] OR "m-health"[tw] OR "mobile health"[tw] OR "mobile application"[tw] OR "smartphone"[tw] OR "smart phone"[tw] OR "smartphone application"[tw] OR "cellphone"[tw] OR "cellular phone"[tw] OR "telerehabilitation"[tw] OR "tele-rehabilitation"[tw] OR "virtual rehabilitation"[tw] OR "remote rehabilitation"[tw] OR "remote intervention"[tw] OR "telehealth"[tw] OR "tele-health"[tw] OR "telemonitor"[tw] OR "ehealth"[tw] OR "e-health"[tw] OR "digital health"[tw] OR "mobile technolog*"[tw] OR "website"[tw] OR "web-site"[tw] OR "web-based"[tw] OR "tele-supervised"[tw] OR "teletherapy"[tw] OR "wireless technology"[tw] OR "telemetry"[tw] OR "videoconferencing"[tw] OR "home-based rehabilitation"[tw] OR "home exercise training"[tw] OR "tele-guidance"[tw] OR "e-coach"[tw] OR "e-coaching"[tw] OR "tele-advice"[tw] OR "games"[tw] OR "tele-physiotherapy"[tw] OR "tele-intervention"[tw] OR "teleintervention"[tw] OR "tele-education"[tw] OR "teletreatment"[tw] OR "teletraining"[tw] OR "telecoaching"[tw] OR "video games"[tw] OR "serious games"[tw]

Continued.

S. no.	Search strategy
#4	"Pediatrics"[Mesh] OR "newborn"[tw] OR "infant"[tw] OR "preschool child"[tw] OR "toddler"[tw] OR "child"[tw] OR "adolescent*"[tw]
#5	#1 AND #2 AND #3 AND #4

Table 2: Data extraction form.

Author, (Year)	Study design	Diagnosis	Population (n/age)	Professional	Intervention group					Control group					Outcomes a. primary b. secondary
					Intervention			Sessions		Intervention			Sessions		
					Type	Delivery (synchronous /asynchronous)	Program duration	Number	Duration	Type	Delivery (synchronous/ asynchronous)	Program duration	Number	Duration	

Risk of bias assessment

Assessing the quality of primary studies is an important part of a systematic review to assess the risk of bias. Understanding the diversity of study methods, quality will be assessed using both the revised Cochrane risk of bias tool for randomized trials (RoB 2) and the risk of bias in non-randomized studies – of interventions (ROBINS-1) tool, independently by two researchers (AM and VS). The RoB2 tool is used to assess and report the risk of bias for the following five domains: randomization process, deviations from intended interventions, missing outcome data, measurement of the outcome, and selection of the reported results. Each domain item is rated as "low risk", "high risk", or "some concerns" and can be summarized with an overall risk-of-bias judgment.[16] The ROBINS-1 tool is divided into three sections: pre-intervention, at-intervention, and post-intervention. This tool assesses and reports the risk of bias for seven domains: confounding, selection of participants in the study, classification of interventions, deviations from intended interventions, missing data, measurement of outcomes, and selection of the reported results. Each domain item is rated as "low risk", "moderate risk", "serious risk", "critical risk", or "no information" and can be summed up in an overall risk-of-bias judgment, similar to the RoB 2 tool.[17] Discrepancies between the two independent researchers will be resolved by a third independent researcher (EK).

Synthesis of results

A narrative descriptive synthesis of the quantitative findings will be conducted for each study's outcomes. Differences referred to methodological characteristics of the included studies will be investigated and discussed. The overall quality of the evidence will be assessed using the grading of recommendations assessment, development, and evaluation (GRADE) approach.[18] The GRADE approach includes the following domains of assessment: risk of bias, inconsistency, publication bias, indirectness of study results, and imprecision.[19] The quality of evidence is rated as "high", "moderate", "low", or "very low".

DISCUSSION

To our knowledge, this is the first systematic review that aims to investigate and present the effects of home-based remote rehabilitation on pulmonary function, functional capacity, and HRQoL in children and adolescents with CF and NCFB. A recent systematic review investigated the effectiveness of mobile health applications in children with chronic diseases.[20] The results indicated that mHealth uses may be effective in improving health outcomes that affect self-management of chronic disease, with the recommendation of further research to make definitive conclusions about the preferred target population of these telehealth interventions.[20]

In children and adolescents with chronic lung diseases, telehealth interventions may contribute to improvements in HRQoL, treatment adherence, and better control of symptoms.[10] Consequently, they could also lead to better self-management of chronic lung diseases and prevention of exacerbations, thus preventing a decline in lung function.[1]

Recently, a systematic review of seven RCTs reported the effectiveness of home-based rehabilitation on pulmonary function, functional capacity, and HRQoL in children and adolescents (6 to 20 years) with CF, emphasizing that home-based rehabilitation may be an alternative way of rehabilitation when conventional center-based programs are not able to be conducted for several reasons.[8] In our systematic review, we will include studies with home-based remote interventions for children and adolescents (0 to 18 years) not only with CF but also for those with NCFB. With the development of technology being rapid in the area of rehabilitation, in this systematic review, we go further in the context of home-based rehabilitation.

As care of children and adolescents is usually provided by the same services it is important to systematically review

and analytically present the effects of home-based remote rehabilitation on clinical outcomes in children and adolescents with CF and NCFB.[21] Our aim is to present all the studies that deliver pulmonary rehabilitation through the use of remote technological tools in the home setting and identify the possible effects of this treatment based on all the outcomes that are evaluated.

Our review will identify the possible effects of home-based remote rehabilitation in children and adolescents with CF and NCFB, including outcomes such as pulmonary function, functional capacity, HRQoL, adherence to treatment, and other secondary outcomes. Furthermore, this systematic review will help to define the age-target population for these remote interventions, providing useful information for further research on this pediatric population.

Strengths and limitations

We are expecting heterogeneity in study designs, demographic characteristics, measurement tools, and intervention type, based on the tool used (platform, and mobile applications). We will try to remove all bias that will result from the studies and discuss the possible comparisons between them.

This systematic review contains limitations. We will accept non-RCT and pilot interventional studies, which affects the level of evidence. Furthermore, studies that are not in English will be excluded, which may restrict studies that could contribute to the evidence base. The strength of this study is the assessment of the methodological quality of evidence and the risk of bias using the ROBINS-1 and RoB2. This protocol was written following the recommendations provided by PRISMA.[12,13]

Implications

We expect that this systematic review will provide the evidence base for the possible effects of home-based remote rehabilitation. The results might support clinicians in addressing service needs and identifying solutions for rehabilitative interventions tailored to pediatric patients' needs using telehealth.

CONCLUSION

Nowadays, home-based remote rehabilitation has become one of the most important areas of telehealth, providing an alternative way of approaching pediatric patients, during the process of disease management. We prospect that this work will highlight the possible effects of home-based remote rehabilitation approaches on pulmonary function, functional capacity, and HRQoL in the pediatric population with CF and NCFB.

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