



## Remote exercise services for people with cystic fibrosis: experiences and perceptions from people with cystic fibrosis and members of cystic fibrosis multidisciplinary teams

Yue Qin, Katy Hamana & Nichola Gale

**To cite this article:** Yue Qin, Katy Hamana & Nichola Gale (13 Nov 2024): Remote exercise services for people with cystic fibrosis: experiences and perceptions from people with cystic fibrosis and members of cystic fibrosis multidisciplinary teams, *Disability and Rehabilitation*, DOI: [10.1080/09638288.2024.2420832](https://doi.org/10.1080/09638288.2024.2420832)

**To link to this article:** <https://doi.org/10.1080/09638288.2024.2420832>




© 2024 The Author(s). Published by Informa UK Limited, trading as Taylor & Francis Group



Published online: 13 Nov 2024.



[Submit your article to this journal](#) 



[View related articles](#) 



[View Crossmark data](#) 

RESEARCH ARTICLE



# Remote exercise services for people with cystic fibrosis: experiences and perceptions from people with cystic fibrosis and members of cystic fibrosis multidisciplinary teams

Yue Qin, Katy Hamana and Nichola Gale

School of Healthcare Sciences, Cardiff University, Cardiff, UK

## ABSTRACT

**Purpose:** This study aimed to explore the experiences and perceptions of people with cystic fibrosis (PwCF) and multidisciplinary team (MDT) members on remote exercise services (RES) and to inform recommendations for future RES.

**Methods:** Participants were recruited from an adult CF centre and through social media. Individual online semi-structured interviews were conducted. Interviews were recorded, transcribed verbatim, and thematically analysed.

**Results:** Themes from MDT members: *Accessibility and convenience offered by remote exercise services; Enhanced connections between MDT members and PwCF; Perceived health and wellness benefits of remote exercise services for PwCF; Barriers to engagement; and Suggested improvements for future remote exercise services.* Themes from PwCF: *Remote exercise enables activity with multifaceted benefits; Perceived limitations of remote exercise services; and Enhancing participation.*

**Conclusions:** Participants' overall perceptions towards RES were positive, and perceived benefits of RES included time and cost saving, improving work efficiency, and having peer support. Perceived barriers to RES were largely technological or related to lacking visual cues. Perceived recommendations to future RES included personalising exercise options, developing user-friendly platforms, and providing funding for buying equipment.

## ARTICLE HISTORY

Received 28 November 2023

Revised 16 October 2024

Accepted 18 October 2024

## KEYWORDS

Cystic fibrosis; exercise; physical activity; remote exercise; telehealth

## > IMPLICATIONS FOR REHABILITATION

- The positive experiences of multidisciplinary team members and people with cystic fibrosis on remote exercise services highlight the value of integrating remote exercise services into routine cystic fibrosis care. However, it should not be limited to this service.
- Remote exercise services need to be considered as an option for people with cystic fibrosis, especially for those who have difficulties with in-person exercise due to geographical constraints or social needs.
- Collaboration among cystic fibrosis care teams, technology developers, infrastructure providers, and policymakers is vital to overcome barriers, including poor internet, lack of visual cues, time constraints, and safety concerns, and to further develop remote exercise services.

## Background

Cystic fibrosis (CF) is an inherited condition affecting more than 100 000 people globally [1]. Exercise is an important part of CF management, with the benefits of improving exercise capacity [2], enhancing airway clearance [3], reducing respiratory infections [4], and helping to preserve lung function [5]. Exercise can also maintain and improve the quality of life (QoL) and has significant psychological effects (e.g., improving confidence and symptoms of depression, anxiety, and distress) in PwCF [5–7]. It was predicted that the advent of modulator therapies could increase the average life expectancy for PwCF from 33.5 to 71.6 years [8]. Exercise remains a crucial focus in CF care, offering opportunities to address age-related comorbidities and promote healthier behaviour [9]. Despite the benefits, adherence to exercise in the CF population is often poor [10,11], with self-reported adherence of 56% [12].

This may be because exercise is considered to be boring and repetitive by some PwCF [13]. Other barriers included fatigue, lack of time, not feeling well, bad weather, lack of motivation, and lack of peer/social support due to the danger of cross-infection [14,15]. Not remembering to exercise and feeling embarrassed were also identified as barriers [11]. Common motivations and facilitators to exercise were perceived to be physical benefits, enjoyment (psychological), social interaction (including having someone to exercise with and being encouraged by others), and convenience [10,15,16].

Recent studies have shown that it is possible to deliver exercise remotely using online technology. The development and implementation of remote exercise interventions have accelerated due to the COVID-19 pandemic [17]. The terminology of remotely delivered exercise differed in previous studies (e.g., “remote exercise,” “telerehabilitation,” “tele exercise”). In this specific study, “Remote Exercise Services (RES)” was used, and it refers to

structured exercise sessions provided by members of MDTs through real-time videoconferencing delivered to PwCF in their home settings. Existing quantitative evidence suggested that RES, including Taichi, cycling, running, and strength training, for PwCF was a promising approach for preserving lung function [18,19] and exercise capacity [20,21], as well as improving leg muscle strength [22] and body composition [21,22]. However, the evidence regarding the impact of RES on improving QoL among PwCF remains limited [17,19,23]. Qualitative evidence showed a generally positive perception of RES among PwCF and MDT members (e.g., physiotherapists and programme directors) [24–28]. PwCF appreciated the convenience, flexibility, and peer support of RES, while MDTs valued the increased attendance of PwCF. Both PwCF and MDT members highlighted the value of RES during the COVID [25,27,28]. However, concerns about internet connectivity, teaching quality, and lack of personal interaction were raised [24,27].

None of the previous studies explored the experiences and perceptions of multiple MDT members, including physiotherapists, dieticians, psychologists, and social workers. It is important to address this as successful remote interventions for PwCF benefit from the collective efforts of a diverse MDT [29]. Physiotherapists are the prominent MDT members responsible for delivering remote exercise. In supporting physiotherapists, dieticians will address the nutritional needs, and psychologists will help motivate PwCF [30]. The implementation of effective and evidence-based practice depends on behaviour change [31]. However, no studies to date have applied theories of behaviour change to support understanding of RES for PwCF.

The Behaviour Change Wheel (BCW) [32] (Figure 1) is a synthesis of 19 frameworks. Central to the BCW is the Capability, Opportunity, Motivation, and Behaviour (COM-B) model. The BCW also consists of nine intervention functions that can affect one

or more of the underlying factors of behaviour and seven policy categories that can support executing intervention functions. The BCW has been successfully used to understand behaviour change in exercise and has been applied to develop RES for people with chronic lung conditions [33,34]. In turn, the BCW could have the utility of helping understand RES for PwCF. In consideration of this, the BCW was used to guide and underpin this research.

This study aimed to explore the experiences and perceptions of PwCF and MDT members on RES and to inform recommendations for future services.

## Methods

### Study design

A qualitative design was used as this approach is commonly used to explore and understand experiences, health behaviours, and healthcare needs and inform the design of interventions [35].

### Setting

An adult CF centre in the UK developed a Virtual Leisure Centre (VLC) to deliver specialised exercise classes remotely through an online platform designed for people with chronic health conditions, providing live and on-demand classes (BEAM: <https://www.beamfeelgood.com/home>). The VLC classes include body conditioning, stretching, spin, and aerobics, with 12 to 20 sessions run each week by physiotherapists from the CF centre. To enhance recruitment, other MDT members who did not deliver RES but supported PwCF were included. PwCF with experience in RES were recruited both in the VLC and outside of the VLC.

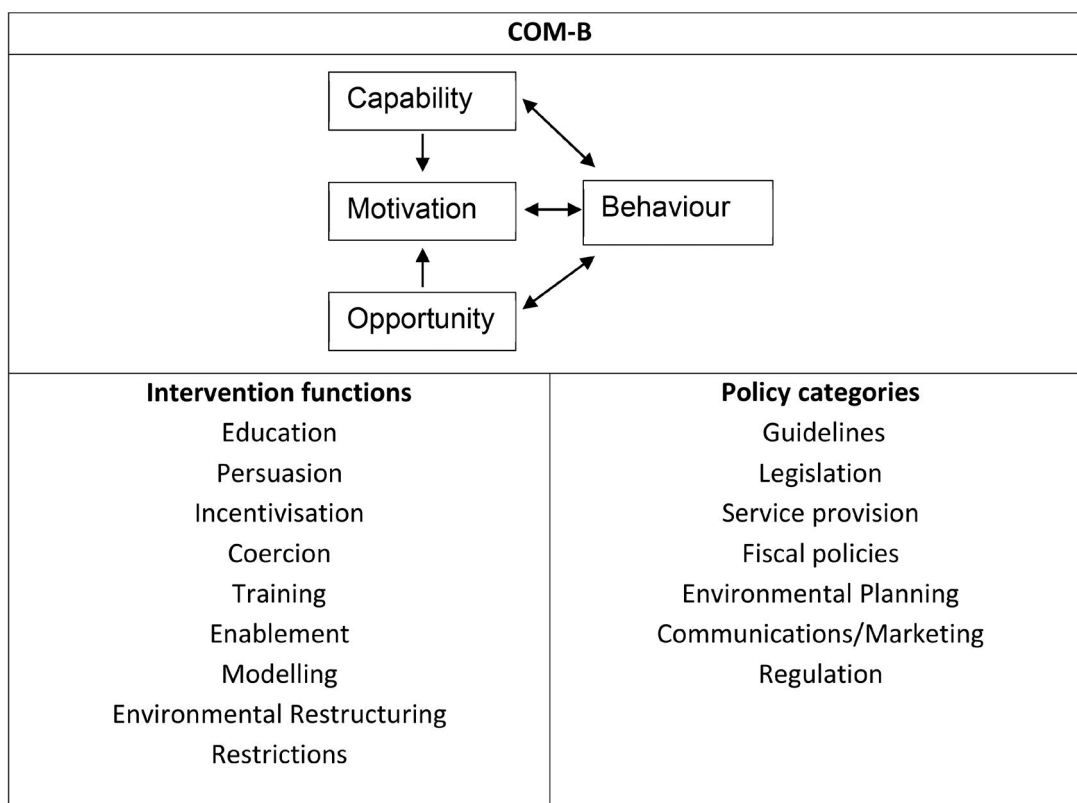


Figure 1. Adapted from the BCW [32].

## Participants

A sample size of 12 MDT members and 12 PwCF was planned [36] unless data saturation was achieved. Convenience sampling was used to recruit participants (MDT members and PwCF) through the CF centre and social media (e.g., Facebook and Twitter). Potential participants (both PwCF and MDT members) were screened using the inclusion and exclusion criteria (by two members of staff at the CF centre who agreed to recruit and act as gatekeepers or by YQ if they identified themselves *via* social media). All the potential participants (PwCF and MDT members) were provided with an information sheet about the study and were asked to contact the researcher if they were interested in participating. Consent forms were obtained before the interviews. An interview was arranged at a time convenient for each participant.

*Inclusion criteria for MDT members were:* physiotherapists, occupational therapists, psychologists, dieticians, social workers, nurses, physiotherapy technicians, and exercise therapists who had more than two years' experiences in CF. MDT members who had <2 years' experiences in PwCF and were not able to be interviewed *via* the Internet were excluded.

*Inclusion criteria for PwCF were:* adults diagnosed with CF who had experience using RES through any online platform (e.g., BEAM, Zoom) or social media (e.g., Facebook). PwCF who could not participate in RES were excluded. Exclusion for RES was a history of co-morbid conditions, including uncontrolled diabetes, severe liver, kidney, or thyroid dysfunction or other severe medical conditions, including acute limb injuries, unstable or progressive heart disease.

## Data collection

One-to-one, semi-structured interviews were conducted with MDT members and PwCF by YQ. The research team was not involved in the delivery of the RES, and participants were not known to the researcher. Interviews were guided by an interview schedule based on the Acceptability, Practicability, Effectiveness, Affordability, Spill-over effects, and Equity (APEASE) criteria, which are designed for assessing interventions and are recommended by the BCW guideline to look beyond the BCW and investigate more feasibility issues [31,37] (Appendix A). Pilot interviews were conducted to ensure the interview questions were understandable, relevant, and within the scope of the research question. Demographic data were collected: profession, duration of working with CF (MDT members), and age, occupation, and distance from the CF centre (PwCF).

## Data analysis

Data were analysed thematically according to Braun and Clark [38], following six steps of familiarisation, generating initial codes, searching for themes, reviewing, defining, and writing up. Open coding was used to identify codes inductively and ensure all data were explored. All the study results (subthemes) were then deductively mapped into the APEASE criteria to understand RES systematically and thoroughly [39,40]. Subthemes were also mapped into intervention functions and policy categories of the BCW to identify which intervention functions and policy categories are described in the data that are important for future RES design. This could help address the unique challenges and needs of PwCF and consider the behavioural changes required across multiple levels, including PwCF, MDT members, and policymakers involved in RES.

This study employed interpretivism with a relativist ontological approach to recognise multiple truths of RES perceived by both PwCF and MDT members. It was recognised that a reflexive approach to the research was important to support the rigour of the study, given that the researcher's own biases and past experiences could influence decision-making [41]. A rigorous data analysis process using member checking was implemented in this study to enhance trustworthiness [42]. YQ coded the data and developed initial themes, which were discussed, refined, and agreed upon with NG and KH. Investigator triangulation was used to support trustworthiness, confirm the findings, and introduce different perspectives on the interview data [43]. The confirmability of the results was supported by conducting a focus group, which included one person with CF and three physiotherapists who were not involved in the interviews to avoid bias. YQ presented the findings from the interviews and how these were arrived at. Focus group participants were then asked to discuss and reflect on the findings to demonstrate that they were based on and reflective of what had been shared by participants in the interviews and were not subject to the researcher's own biases and interpretations.

## Ethical considerations

National Health Service ethics committee (21/NI/0163) and local Research and Development approval (22/JAN/8321) were gained. Informed consent was obtained before conducting each interview. Transcripts were anonymised, and participants were asked to choose their pseudonyms. Pseudonyms were allocated to those participants who did not have a preference.

## Results

### Descriptive data: MDT members

In total, 12 MDT members, including seven physiotherapists, two psychologists, two CF exercise specialists, and one social worker, were recruited and interviewed (Table 1). Most MDT members ( $n=10$ , 83%) worked with PwCF in the UK and 2 (17%) in Australia. To deliver RES, MDT members used different technologies, including the platform BEAM ( $n=10$ ), Facebook ( $n=1$ ), and Zoom ( $n=1$ ). Work experience in CF ranged from two to 21 years, with a mean of six years. The interview duration ranged from 15 to 50 min.

Table 1. Descriptive data of MDT members.

Participant	Pseudonym	Occupation	Years of experience with PwCF	Country
1	Anna	Physiotherapist	20 years	Australia
2	Amy	Physiotherapist	5 years	UK
3	Beth	Physiotherapist	21 years	Australia
4	Ella	Physiotherapist	2 years	UK
5	Charlotte	Physiotherapist	12 years	UK
6	Alison	Physiotherapist	18 years	UK
7	Matthew	CF exercise specialist	16 years	UK
8	Sofia	Psychologist	11 years	UK
9	Jessica	Social worker	10 years	UK
10	Rhys	Psychologist	5 years	UK
11	Joshua	CF exercise specialist	6 years	UK
12	Helen	Physiotherapist	11 years	UK

### Key themes and subthemes: MDT members

Five key themes and 12 subthemes were identified from the analysis of the interviews with MDT members (Table 2).

#### Key theme 1: Accessibility and convenience offered by RES

This theme highlights MDT members' views on the accessibility and convenience of RES. RES was perceived to reach a broader range of PwCF with varying schedules and fitness levels. MDT members also mentioned that RES could eliminate the need for travel, saving time and costs for PwCF.

##### Flexible accessibility

MDT members noted that RES offered flexible exercise options, including types, locations, times, equipment requirements, and group or one-to-one settings for PwCF.

*"...and they could vary any of those types of exercise whether it was Pilates session, it could be a core-based session, it could be a HITT type of session, maybe it's just a spin session..." (Matthew, CF exercise specialist)*

Another recurring topic among MDT members was the flexibility of time. They noted that PwCF could access on-demand classes of RES at their convenience, especially accommodating those with work commitments.

*"We obviously work from 8, 30 to 4, 30. So if a patient is really interested in doing classes in the evening after work, then there is another availability...there are the on-demand classes." (Charlotte, physiotherapist)*

##### Efficiency/convenience

MDT members emphasised that RES was time- and cost-effective for PwCF, compared to traditional in-person exercise, as it eliminated the need for hospital visits, saved time and reduced expenses, including parking or public transportation. This convenience was perceived to benefit PwCF, especially those who lived far from the CF centres.

*"They don't have to come up to the CF centre and try to park their car, and then go home that adds another hour on possibly. That means that people who don't live near us can access exercise." (Sofia, psychologist)*

#### Key theme 2: Enhanced connections between MDT members and PwCF

This theme highlights RES benefitted MDTs by improving work efficiency and maintaining connections with PwCF. It also captures the potential of RES as a contingency plan during COVID-19.

##### Improvement in work efficiency

RES was perceived to improve working efficiency and reduce staff burden, as it enabled MDT members to see more than one patient at a time. It was also mentioned that RES enabled some PwCF who might not have had enough time to engage in the in-person

Table 2. Key themes and subthemes from MDT members.

Themes	Subthemes
Theme 1: Accessibility and convenience offered by remote exercise services	Flexible accessibility Efficiency/convenience
Theme 2: Enhanced connections between MDT members and people with CF	Improvement in working efficiency Contingency (for pandemics)
Theme 3: Perceived health and wellness benefits of remote exercise services for people with CF	Physical benefits Psychological and social benefits
Theme 4: Barriers to engagement	Time constraints Technological issues Lack of visual cues It can be a challenge for less confident people with CF
Theme 5: Suggested improvements for future remote exercise services	Perceived facilitators for remote exercise services Personalised education and support

exercise classes previously to join. MDT members were therefore able to get to know them more.

*"Maybe if you're lucky enough to get three or four people on screen... it is really working well for saving on manpower..." (Matthew, CF exercise specialist)*

*"Sometimes life just gets in the way because they have jobs, they have children, they have all these things going on, whereas we were given that brief moment... (RES) it was people that I would never necessarily have expected to engage with us. So, we were able to learn things about them that we hadn't been able to before. It's not something you can measure in numbers, but it was some engaging in a way and getting to know patients in a way that we hadn't been able to before." (Rhys, psychologist)*

MDT members also noted that RES offered an innovative way for MDTs to monitor and connect with PwCF. These services were preferred over phone calls due to the importance of visual cues and direct observation during exercise delivery.

*"Also, we found that using telehealth (RES) is much better than a phone call because then we're able to see patients face-to-face." (Amy, physiotherapist)*

MDT members also noted that RES could save costs, especially during the COVID pandemic, by eliminating the need for protective equipment (PPE) when working with PwCF.

*"We're not needing to wear PPE when we're doing that (RES), because they (PwCF) 're not in the room with us." (Anna, physiotherapist)*

##### Contingency (for pandemics)

MDT members perceived the use of RES during the COVID-19 to be a "silver lining." A common view was that RES had helped PwCF cope with the impact of COVID and maintain exercise during lockdowns. It also enabled MDT members to keep in touch with PwCF.

*"I do think it's (RES) got some really strong positives. And it's a great option. I'm a big believer of it. I think it was just silver lining through COVID." (Anna, physiotherapist)*

However, as engagement has declined since the lockdowns ended, some MDT members expressed that they were considering reverting to in-person exercise training.

*"Now we probably have last patients using it because they're out doing things in the real world." (Ella, physiotherapist)*

### Key theme 3: Perceived health and wellness benefits of RES for PwCF

This theme comprises two subthemes that describe the perceptions of MDT members on how RES could benefit PwCF.

#### Physical benefits

It was mentioned that RES could help PwCF keep exercising, improve their exercise tolerance, and maintain their health status. In addition, RES could avoid the risk of infection as PwCF did not need to come to the hospitals.

*"We did see some changes in muscle mass in a couple of the participants. Lung function, what we noticed was no decline, so at least we deemed, it was safe... we opted to do a one-minute set to stand, because at least they could do that again virtually, and we could assess them. And I think overall we saw either it remained the same, or some improvement on all participants." (Anna, physiotherapist)*

#### Psychological and social benefits

Some MDT members commented that RES could help PwCF improve self-management skills. MDT members also perceived that RES could help PwCF overcome the barriers of not being able to exercise together and provide some peer support, which may generate camaraderie, reduce isolation, and increase confidence, and this may extend beyond RES.

*"It helps them build connections with other PwCF, helping to overcome issues of isolation, and boosting people's mood. And building people's confidence to try things offline as well." (Beth, physiotherapist)*

### Key theme 4: Barriers to engagement

MDT members identified several barriers to RES.

#### Time constraints

MDT members highlighted time conflicts as a barrier to RES, as both MDTs and PwCF work during regular office hours, making daytime participation challenging for those PwCFs with work commitments. Although there were suggestions to increase the range of times offered, some were unsure how to arrange this in practice. International MDT members identified that time differences across continents limited access to other countries. For example, they observed that as one RES platform was mainly based on UK and US time, it could be difficult for Australians to attend the live classes.

*"We certainly tried to make the exercise sessions work for them...although I do know that was probably a bit of a barrier because they had to work also around our work times." (Sofia, psychologist)*

*"At the moment, with BEAM (an online exercise platform), a lot of the times are UK and US based. So, I think that can sometimes be difficult for Australians to attend the live classes." (Anna, physiotherapist)*

#### Technical difficulties

Technical difficulties, including poor internet connection and problems using some platforms, were common issues identified by

MDT members. Other difficulties included poor sound or image quality, problems logging in and reconnection, and inability to live stream music when using some online exercise platforms. MDT members reported that accessing RES was challenging for PwCF who were not used to technology or lived in remote areas and had internet problems. There were concerns about the retention of PwCF due to technical difficulties.

*"Some of our clients (PwCF) have actually struggled to link onto the platform in the first instance... I'm a little bit more clued into the IT type of usage... But for those not so IT-savvy people, it was a bit challenging for them. (Matthew, CF exercise specialist)*

#### Lack of visual cues

MDT members perceived the lack of visual cues as a barrier. They expressed that RES limited their ability to observe and evaluate PwCF effectively.

*"...we (Members of MDTs) need a visual of them (PwCF) as well. Obviously, that's one drawback for us. We need that. We can't get an insight into how they're managing the exercise quite as well as if they were here in the building." (Charlotte, physiotherapist)*

Many MDT members reflected that some PwCF did not want to turn their cameras on, which they felt was a potential safety risk.

*"I'm sure there will be some patients who don't want to be seen, and again, that's their choice. So, it's making them aware of the potential impact that they might have. And if that's their choice at the end of the day, make them aware of the risks to minimise those risks." (Matthew, CF exercise specialist)*

MDT members observed that there was potential for drop-out caused by lack of visual cues as PwCF could not see demonstrations as clearly as they would have in person.

*"Doing it at home you've got something more imaginatively about the exercise that I guess that might put people off." (Sofia, psychologist)*

Zoom fatigue was also mentioned by one member, Alison (physiotherapist).

*"Everyone's kind of been a bit 'zoomed out', and everyone's going to get it back to what we call a normal life." (Alison, physiotherapist)*

#### It can be a challenge for less confident PwCF

MDT members mentioned that PwCF might feel anxious and worried about starting online exercise, possibly due to concerns about performance or keeping pace. They also noted that RES could be challenging for those lacking confidence, especially in group settings as group settings might induce self-consciousness.

*"And the other challenges might be...trying to participate in a group session. So that must be the real challenge for them, for those less confident people." (Matthew, CF exercise specialist)*

### Key theme 5: Suggested improvements for future RES

This theme reflects MDT members' views on PwCF's motivation to join RES more and how RES can be improved.

Table 3. Descriptive data of PwCF.

Participant	Pseudonym	Country	Age categories (years)	Distance from CF centre (miles)	Employment status	Types of technology used to join remote exercise
1	Nathan	Belgium	31–35	120	Not employed	Phone
2	Rachel	America	41–45	90	Part-time	Laptop
3	Sam	UK	41–45	40	Full time	Phone
4	Sarah	America	21–25	45	Not employed	Phone
5	Jack	UK	36–40	70	Full time	Laptop and phone
6	James	UK	31–35	25	Full time	Laptop and phone
7	Ruth	UK	NA	48	Full time	Laptop
8	Ben	UK	26–30	1	Full time	Desktop
9	Claire	UK	21–25	5	Not employed	Laptop
10	Rebecca	UK	NA	1	Not employed	Tablet

NA: not available.

Key themes and subthemes: PwCF.

### Perceived facilitators for RES

MDT members emphasised that motivation was key to the success of RES. Peer support and having family members or friends to exercise with were perceived by MDT members to promote RES participation. MDT members also suggested that being able to stream music could motivate PwCF. Working with PwCF to further develop RES was also suggested. Technological improvements were suggested, including having a “one-touch button” to connect or reconnect to RES. MDT members also recommended frequently changing exercise options to maintain the interest of PwCF in RES. Showing PwCF the outcomes and results of their remote exercise sessions was also mentioned.

*“Just keeping everything changing so that they don't get bored.” (Charlotte, physiotherapist)*

*“There are lots of different things (that can encourage PwCF), for example, people being incentivised and seeing results and outcomes.” (Beth, physiotherapist)*

However, one MDT member mentioned that MDT members could not force patients to engage in RES as it was a personal choice.

*“It's up to them to do it. You can't force them to do it. Nothing is going to encourage them. It's up to them.” (Joshua, CF exercise specialist)*

### Personalised education and support

It was suggested that more help and education based on individual needs should be offered to PwCF. It was suggested that MDT members could introduce the RES platform when PwCF was in the hospital to encourage engagement. Additional support, including support for funding to buy necessary equipment and technical assistance, was also suggested.

*“It is quite useful to be able to at least show them the platform when they're here in hospital because sometimes it's that first step that's quite hard towards getting on the exercise wheel.” (Charlotte, physiotherapist)*

## Results from PwCF

### Descriptive data

Although 12 participants were planned, it was only possible to recruit 10 PwCF due to difficulties during the COVID (Table 3). The majority of the participants were based in the UK ( $n=7$ ), with two from America and one from Belgium. PwCF received RES via two platforms: BEAM ( $n=8$ ) and Zoom ( $n=2$ ). Participants either

Table 4. Themes and subthemes from PwCF.

Themes	Subtheme
Theme 1: Remote exercise enables activity with multifaceted benefits	Keeping active Convenience Inclusivity Cost-effectiveness
Theme 2: Perceived limitations of remote exercise services	Equipment/technology issues Lack of commitment to remote exercise
Theme 3: Enhancing participation	Internal factors External factors

worked full-time ( $n=4$ ), part-time ( $n=2$ ), or were unemployed ( $n=4$ ). Distance from home to their CF centres ranged from 1 to 120 miles (mean 45 miles). To join RES sessions, participants used laptops ( $n=4$ ), smartphones ( $n=2$ ), laptops and smartphones ( $n=2$ ), a tablet ( $n=1$ ), and smartphones and tablets ( $n=1$ ).

Three key themes and eight subthemes were generated from the interviews with PwCF (Table 4).

### Key theme 1: RES enables activity with multifaceted benefits

All PwCF in this study expressed high satisfaction with using RES and recognised the multifaceted benefits of RES.

#### Keeping active

PwCF highlighted RES as an excellent way to exercise. Some PwCF also perceived RES to be their primary choice for exercise.

*“I'll keep using online exercise. It will be my first line of exercise choice. And then, yeah, other things would be secondary... I don't think I'd realise how devastated I would be unless it (RES) went away.” (Rachel)*

Jack (a person with CF) also noted that RES should have been introduced much sooner and encouraged for their wider and more rapid distribution.

*“I feel this (RES) is something we should have been doing with CF a long time before now... We should share things widely enough, quickly enough.” (Jack)*

#### Convenience

The convenience of RES was shown in many ways, as PwCF did not need to go to the gyms or hospitals. Also, by exercising remotely at home, they could save energy and spend it more effectively and efficiently. Moreover, some PwCF

mentioned that RES needed less preparation and could be fitted into daily activities easily, which enabled PwCF to do more of other things.

*"Convenience. It's all about convenience. I think an important thing to remember is a lot of people with CF probably are working. I think a lot of people will feel like they don't have the energy to exercise... (but with RES) they can just exercise at home. They save their energy. You know the energy is expended in a much more effective and efficient way. So does that as well, I guess convenience factors in many multifaceted ways." (Jack)*

### **Inclusivity**

PwCF highlighted that RES was suitable for PwCF at any fitness level and particularly beneficial for those feeling uncomfortable with traditional gym environments. They noted the psychological barriers, such as body insecurity, that might discourage exercising at gyms and emphasised that RES could help overcome these challenges. Additionally, RES provided a solution for participation even when they were not feeling well.

*"If you're not feeling so well, you can stay in pyjamas. (You) don't have to have the camera on, and you can still get on with it (RES)." (Rebecca)*

### **Cost-effectiveness**

Participants acknowledged the cost-effectiveness of RES, noting the reduced financial burden compared to traditional hospital visits or gym memberships, primarily due to reduced travel expenses and membership fees.

*"It's 100% more affordable. If you think about it, you don't have to drive there and then, it's not. It's not really the cost." (James)*

*"I feel like, it (RES) has been my biggest 'Aha'(amazing) these last few years, not just with BEAM, but like knowing that I might never need a gym membership again." (Rachel)*

RES was seen to be beneficial for lung function and boosting morale, especially through the COVID, by many PwCF.

*"I am very glad they've (members of the MDT) been able to come up with these remote exercises for us because it is an ahead to progressing with our health in our lungs." (Sarah)*

## **Key theme 2: Perceived limitations of RES**

Some challenges to RES were identified by PwCF.

### **Equipment/technology issues**

PwCF raised concerns about technology issues with RES, primarily poor internet connection and user-unfriendly platforms. Limited equipment was also a common challenge. However, some PwCF mentioned that they did not need any equipment as they could utilise their home environment.

*"To over being able to adapt and overcome those (lack of equipment) (is) easy enough to do, because they (Members of MDTs) give you variations and things. Some of the exercises... you could use stairs in your house and do step ups and things." (Ben)*

It was also pointed out by one person with CF, Rachel, that some classes, like dancing, could not be accessed on demand due to some music licencing restrictions.

### **Lack of commitment to RES**

Some PwCF said that exercising remotely was less formal than in-person, therefore, they might feel less accountable to MDT members and be less committed to engaging. This had a negative impact on their motivation. Not being able to see MDT members properly was also identified as a barrier to motivation. PwCF also reported that their attendance post-pandemic was less, as life was busier after, and it was harder for people to join the same online sessions.

*"The disadvantage would probably be lack of motivation. Really, I think, if you can't really be bothered. This is just easy, whereas if you were scheduled to turn up at the class, you'd be more inclined to turn up, perhaps. So, you wouldn't want to let people down, but when it's remote, and it's under your own steam, easily brushed aside, and you could do something else instead. That's obviously the downside of it, but it's down to obviously the motivation of the person as well." (Sam)*

## **Key theme 3: Enhancing participation**

There was a clear thread across the participant dataset regarding enablers to enhance participation.

### **Internal factors**

PwCF highlighted the health benefits and progress from RES as significant motivators. They also suggested that tailoring RES to individual goals could boost motivation and participation among RES.

*"My motivation for exercise, it was just basically I wanted to get fit." (James)*

### **External factors**

PwCF emphasised the importance of variety and novelty in RES, noting that different types of exercise keep them motivated. PwCF also mentioned that MDT members could offer more help in choosing which on-demand videos to use.

Many PwCF mentioned that having peer support could facilitate social interaction with others and promote a sense of accountability to their peers, which might enhance motivation. Alternatively, one participant suggested that peer support may limit an individual's potential to become internally motivated if they became accustomed to reliance on external sources of motivation.

*"I think it (peer support) could be a huge motivation... in a positive way that could be a really huge motivation. (But) If you really want to build up something, I think it's the wrong kind of motivation to keep going. But is the perfect motivation to start and find the enjoyment in exercise. And then, if you wanna build it up to become an athlete, or really become better, then you have to find some extra reasons." (Nathan)*

All the subthemes were mapped into the APEASE criteria (Appendix B), and the intervention functions and policy categories of the BCW (Appendix C). Five intervention functions (Enablement, Incentivisation, Education, Training, Persuasion) and five policy categories (Service Provision, Fiscal Measures, Environment/Social Planning, Guidelines, Legislation) were selected.

## **Discussion**

The aim of this study was to explore the experiences and perceptions of both MDT members and PwCF on RES and to inform



future RES. For the first time, perceptions of both PwCF and multiple MDT members regarding the delivery of and participation in RES for PwCF have been identified. Further, the factors relating to future RES implementation were explored using BCW as a lens. This provides important insights and a better understanding of RES to support the future provision of more patient-centred RES to PwCF.

The interview results showed that the overall experiences and perceptions of RES were positive. Both MDT members and PwCF perceived RES simplified the way PwCF access exercise as PwCF did not need to go to CF centres or gyms. This especially benefitted those PwCF who lived far from CF centres. This agrees with findings from MDT members and PwCF in other studies [24,26–28]. The elimination of travel needs was perceived to save PwCF costs on gym membership fees and travel fees. This too was noted by PwCF in other studies [17] as well as people with COPD [44]. RES was also reported to be cost-saving on PPE during the COVID for MDT members in this present study. The views on the cost saving of RES varied in the previous studies. Some healthcare professionals perceived RES could save costs (e.g., on upkeeping facilities and specialised equipment) [27,45], while some healthcare professionals mentioned that RES might increase costs (e.g., on setup and maintenance of technology used in RES) [46]. Future studies on the long-term economic evaluation of RES in the CF population are needed.

Another agreement between PwCF and MDT members was that RES could save time. Improving working efficiency facilitated by RES could be an added benefit of saving time. Due to the danger of cross-infection, MDT members are not recommended to treat PwCF in the same room at the same time [47]. RES allowed MDT members to overcome this barrier, as they were able to see more than one PwCF at once. Similarly, Tomlinson et al. [17] indicated that delivering exercise remotely could make efficient use of clinical time. Evidence also suggests that remotely delivered interventions facilitate an increase in job satisfaction of MDT members concerning its improvement of working efficiency [48]. In contrast, a study that aimed to explore the experiences of psychotherapists in delivering interventions remotely showed that some psychotherapists pointed out a loss of job satisfaction due to some technical issues and lack of personal contact [49].

Another add-on benefit of no need to travel is the avoidance of cross-infection in PwCF. This could also eliminate PwCF's concerns about the cleanliness of local gyms and coughing when exercising in public. Other perceived physical benefits, including maintaining lung health and fitness of PwCF, were also mentioned by MDT members and PwCF. This is also confirmed in some quantitative studies investigating the effectiveness of RES for PwCF, which showed that RES was promising in preserving lung function [18,19] and exercise capacity [20,21], and improving leg muscle strength [22] and body composition [21,22].

The value of RES during the COVID was especially highlighted. The value of RES and widespread adaption to RES during the COVID was also highlighted in previous studies exploring RES in PwCF [24,27,28] and in people with other chronic respiratory diseases [50]. However, some MDT members in this present study expressed their uncertainty about whether to continue RES or move back to in-person after the lockdown was eased. This was also mentioned by other healthcare professionals in other studies [25,27,28] and some also showed their preferences for a hybrid model [25,28].

Some barriers to RES, including technical issues, lack of equipment, and time constraints, were mentioned in the present study. Similar barriers were also mentioned in other studies [17,51]. Poor internet connection will likely be resolved in the future as the UK

government is increasing investment in internet infrastructure [17]. It is also advised that PwCF check the internet bandwidth before the RES to make sure there is adequate resolution [51]. Time constraints were mentioned as barriers to RES, which were also perceived to be barriers to exercise in general [14,15]. Although the barrier of "time constraint" could be eliminated by offering services outside standard working hours, this might increase MDT members' workload. This might, therefore, increase the risk of reduced job performance and have a negative impact on MDT members themselves [52]. Having access to some on-demand exercise videos could also enable PwCF to exercise outside their working hours. However, it should be noted that the presence or absence of MDT members could influence perceptions of RES [25,26,53]. Incorporating follow-up check-ins or consultations with MDT members could help support PwCF and address concerns arising from on-demand videos.

Having a user-friendly platform (an APP) was suggested by both MDT members and PwCF to minimise the barriers of technical issues, which was also mentioned by PwCF in the study of Poulsen et al. [26]. MDT members, therefore, should consider collaborating with other stakeholders in the development of RES APPs to facilitate RES participation in PwCF.

Lack of visual cues due to the limited camera angles and PwCF being reluctant to turn on their cameras was also mentioned as a barrier. This was perceived to cause concerns about patient safety and the quality of exercise. Similar concerns were also raised by other CF care MDT members [25,27]. Some monitoring devices (e.g., telespirometry) were reported to be promising and accepted by PwCF [54]. Therefore, these devices could be integrated into RES to monitor health continuously and provide real-time feedback.

MDT members highlighted the crucial role of family members in encouraging PwCF to participate in RES. Making exercise enjoyable and involving families/friends can transform RES from a necessary treatment into an enjoyable experience, consequently enhancing motivation and long-term commitment [9,55]. Both PwCF and MDT members in this study also mentioned that having peer support can create accountability and, thus, facilitate PwCF to exercise more. It was also perceived to eliminate the barriers of feeling isolated when exercising in the CF population and provide access to social and emotional support. Chen et al. [51] demonstrated comparable results, indicating that accountability in peer support plays a significant role in maintaining RES. However, MDT members should be aware that although peer support can work as an external facilitator, research is needed to identify further strategies to sustain motivation in this population with regard to RES.

Having goals and goal-specific exercises was suggested by most of the PwCF. Previous evidence suggests that goal setting was related to exercise promotion, and it is recommended by the National Institute for Health and Care Excellence that it be present in any behaviour change intervention to promote exercise engagement [56]. It acts as a motivational tool to encourage positive behaviour change towards remote exercise [57], aligning with the reflective motivation aspect of the COM-B model. When PwCF set clear goals, they are more likely to track their progress and stay motivated to achieve them. Nevertheless, it should be noted that setting specific and challenging goals might also have negative consequences on long-term engagement in exercise and result in negative feelings and reduced self-efficacy [58]. It is therefore recommended that MDT members should provide extra education and support to PwCF alongside goal setting. In this study, PwCF also mentioned that they would be motivated to participate in RES more by seeing progress and benefits, such as improvement

in health status. However, previous studies indicated that relying solely on having better health is unlikely to effectively motivate patients to exercise more [16,59]. Moreover, some patients who perceived exercise as directly linked to their overall health were less inclined to engage in exercise. This can be attributed to the fact that if there is any decline in their health or lack of progress, they might be viewed as deterioration in their health and decrease their motivation to exercise [59,60].

Both MDT members and PwCF highlighted the need for personalised and comprehensive support for PwCF during their participation in RES. Some MDT members suggested assisting PwCF in obtaining funding for home exercise equipment. This could act as an environmental facilitator [15] but also could serve as a financial incentive to encourage participation in remote exercise. This was also suggested by Vagg et al. [29], who recommended financial support for essential equipment in remote CF care. Offering technical assistance for PwCF was also suggested. Some people with chronic conditions mentioned that it was challenging for them to manage new technology when engaging in RES [61], which was not mentioned by the participants in this study. This might be due to the age differences; the mean age of the participants in the study of Hedbom et al. was 64.8 years, while the age of all the PwCF in this present study ranged from 21 to 45 years. However, with the increasing life expectancy of PwCF due to the modulator therapies [8], offering technical support is becoming increasingly important to ensure older PwCF can engage with RES. Some other suggestions, including providing PwCF with a preview of RES platforms and helping them choose on-demand videos, were also mentioned by the participants in this present study. The COM-B model highlights that Capability and Opportunity are vital in impacting Motivation, the key mediator for behaviour change. MDT support for PwCF creates a supportive environment (Physical Opportunity) and boosts self-efficacy, reducing anxiety and enhancing engagement in RES (Capability). Providing personalised support and education could address various components of the COM-B to facilitate behaviour change and improve outcomes for PwCF.

### Recommendations for future RES

For CF MDT members, there should be a focus on providing education and training on goal-setting, safety, and selecting on-demand exercise videos, alongside providing technical support. It is also essential to diversify and personalise exercises by offering a variety of exercise types and schedules, offering goal-oriented exercises to boost motivation, and integrating wearable devices to monitor health metrics.

For technology developers, there should be a focus on developing user-friendly platforms with easy connection features and integrated captions. Improving internet infrastructure to resolve connectivity issues is also vital.

For policymakers, providing financial support to help PwCF buy necessary equipment is essential. There is also a need to develop policies for managing emergencies during RES outside working hours and address music copyright concerns through legislation.

### Strength and limitations

This qualitative study used semi-structured interviews and aimed to provide a more comprehensive understanding of RES for PwCF. Strategies were employed throughout this study to enhance

trustworthiness. However, this study is not without limitations. All of the researchers have physiotherapy backgrounds, which may have influenced the research process and interpretation of data. However, a reflexive approach to the research helped to identify potential bias and mitigate this. Convenience sampling of this study might limit the transferability of the study results [62]. Another limitation is that those PwCF who participated in this study may have better IT skills than other PwCF as they were able to receive RES. It was unclear how physically active the included PwCF were, and it is possible that those PwCF who have been engaging RES were already more motivated to exercise than others, so the results might not reflect the wider CF population. As all of the interviews in this study were conducted online, this study limited participation to MDT members and PwCF who had access to the internet. A total of 12 PwCF were planned to be recruited. Although data saturation could not be fully confirmed, recurring themes indicated that saturation was being approached.

### Conclusion

This study highlighted the benefits and barriers of RES in the CF population perceived by PwCF and MDT members, indicating that RES is a useful adjunct to CF care, which should be integrated into the existing services. The findings from this study indicated that MDT members could play an important role in improving the adherence and motivation of PwCF to improve RES participation. Recommendations for future RES include MDT members offering a wider variety of personalised exercise options, having goal-specific exercises, providing equipment or funding for equipment, technology developers developing user-friendly RES platforms, and policymakers establishing safety guidelines and resolving music copyright concerns.

### Acknowledgements

The authors wish to thank all the participants who volunteered to participate in this study.

### Disclosure statement

No potential conflict of interest was reported by the author(s).

### Funding

The author(s) reported there is no funding associated with the work featured in this article.

### References

- [1] Allen L, Carr SB, et al. Future therapies for cystic fibrosis. *Nat Commun.* 2023;14(1):693–693. doi: [10.1038/s41467-023-36244-2](https://doi.org/10.1038/s41467-023-36244-2).
- [2] Radtke T, Haile SR, Dressel H, et al. COVID-19 pandemic restrictions continuously impact on physical activity in adults with cystic fibrosis. *PLOS One.* 2021;16(9):e0257852. doi: [10.1371/journal.pone.0257852](https://doi.org/10.1371/journal.pone.0257852).
- [3] Saynor Z, Cunningham S, Morrison L, et al. P217 Exercise as Airway Clearance Therapy (ExACT) in cystic fibrosis: a UK-based e-Delphi survey of patients, caregivers and health

- professionals. *J Cyst Fibros.* 2022;21:s127. doi: [10.1016/S1569-1993\(22\)00546-X](https://doi.org/10.1016/S1569-1993(22)00546-X).
- [4] van de Weert-van Leeuwen PB, Arets HGM, van der Ent CK, et al. Infection, inflammation and exercise in cystic fibrosis. *Respir Res.* 2013;14(1):32. doi: [10.1186/1465-9921-14-32](https://doi.org/10.1186/1465-9921-14-32).
- [5] Dwyer TJ, Elkins MR, Bye PTP. The role of exercise in maintaining health in cystic fibrosis. *Curr Opin Pulm Med.* 2011;17(6):455–460. doi: [10.1097/MCP.0b013e32834b6af4](https://doi.org/10.1097/MCP.0b013e32834b6af4).
- [6] Williams CA, Núñez-Camara M, Schneiderman JE, et al. Expert guidelines on exercise and physical activity for people with cystic fibrosis. *Br J Hosp Med.* 2023;84(3):1–3. doi: [10.12968/hmed.2023.0050](https://doi.org/10.12968/hmed.2023.0050).
- [7] Singh B, Olds T, Curtis R, et al. Effectiveness of physical activity interventions for improving depression, anxiety and distress: an overview of systematic reviews. *Br J Sports Med.* 2023;57(18):1203–1209. doi: [10.1136/bjsports-2022-106195](https://doi.org/10.1136/bjsports-2022-106195).
- [8] Lopez A, Daly C, Vega-Hernandez G, et al. Elexacaftor/tezacaftor/ivacaftor projected survival and long-term health outcomes in people with cystic fibrosis homozygous for F508del. *J Cyst Fibros.* 2023;22(4):607–614. doi: [10.1016/j.jcf.2023.02.004](https://doi.org/10.1016/j.jcf.2023.02.004).
- [9] Gruet M, Saynor ZL, Urquhart DS, et al. Rethinking physical exercise training in the modern era of cystic fibrosis: a step towards optimising short-term efficacy and long-term engagement: rethinking physical exercise training in CF. *J Cyst Fibros.* 2022;21(2):e83–e98. doi: [10.1016/j.jcf.2021.08.004](https://doi.org/10.1016/j.jcf.2021.08.004).
- [10] Hurley N, Moyna NM, Kehoe B, et al. Factors influencing physical activity in adults with cystic fibrosis. *BMC Pulm Med.* 2021;21(1):113. doi: [10.1186/s12890-021-01482-x](https://doi.org/10.1186/s12890-021-01482-x).
- [11] Burnett DM, Barry AN, Mermis JD. Physical activity level and perception of exercise in cystic fibrosis. *Respir Care.* 2020;65(4):500–506. doi: [10.4187/respcare.07193](https://doi.org/10.4187/respcare.07193).
- [12] Hebestreit H, Kriemler S, Schindler C, et al. Effects of a partially supervised conditioning program in cystic fibrosis: an international multicenter, randomized controlled trial (ACTIVATE-CF). *Am J Respir Crit Care Med.* 2022;205(3):330–339. doi: [10.1164/rccm.202106-1419OC](https://doi.org/10.1164/rccm.202106-1419OC).
- [13] Swisher PT, KA, Pt EM. Perceptions of physical activity in a group of adolescents with cystic fibrosis. *Cardiopulm Phys Ther J.* 2008;19(4):107–114. doi: [10.1097/01823246-200819040-00002](https://doi.org/10.1097/01823246-200819040-00002).
- [14] Chen Y-W, Wang C-Y, Lai Y-H, et al. Home-based cardiac rehabilitation improves quality of life, aerobic capacity, and readmission rates in patients with chronic heart failure. *Medicine.* 2018;97(4):e9629. doi: [10.1097/MD.00000000000009629](https://doi.org/10.1097/MD.00000000000009629).
- [15] Ladune R, Filleul V, Falzon C, et al. Perceptions of barriers to and facilitators of physical activity in adults with cystic fibrosis. *Physiother Theory Pract.* 2023;39(1):117–127. doi: [10.1080/09593985.2021.2005201](https://doi.org/10.1080/09593985.2021.2005201).
- [16] Denford S, Cox NS, Mackintosh KA, et al. Physical activity for cystic fibrosis: perceptions of people with cystic fibrosis, parents and healthcare professionals. *ERJ Open Res.* 2020;6(3):00294–2019. doi: [10.1183/23120541.00294-2019](https://doi.org/10.1183/23120541.00294-2019).
- [17] Tomlinson OW, Shelley J, Trott J, et al. The feasibility of online video calling to engage patients with cystic fibrosis in exercise training. *J Telemed Telecare.* 2020;26(6):356–364. doi: [10.1177/1357633X19828630](https://doi.org/10.1177/1357633X19828630).
- [18] Benz C, Middleton A, Elliott A, et al. Physiotherapy via telehealth for acute respiratory exacerbations in paediatric cystic fibrosis. *J Telemed Telecare.* 2023;29(7):552–560. doi: [10.1177/1357633X21998205](https://doi.org/10.1177/1357633X21998205).
- [19] Bass R, Bourke S, Doe S, et al. WS18-3 is “Pactster” an acceptable tool to promote exercise participation in the adult cystic fibrosis community, with and without physiotherapy support? *J Cyst Fibros.* 2019;18:s34. doi: [10.1016/S1569-1993\(19\)30225-5](https://doi.org/10.1016/S1569-1993(19)30225-5).
- [20] Layton AM, Irwin AM, Mihalik EC, et al. Telerehabilitation using fitness application in patients with severe cystic fibrosis awaiting lung transplant: a pilot study. *Int J Telemed Appl.* 2021;2021:6641853. doi: [10.1155/2021/6641853](https://doi.org/10.1155/2021/6641853).
- [21] Holmes CJ, Racette SB, Symonds L, et al. Feasibility and efficacy of telehealth-based resistance exercise training in adolescents with cystic fibrosis and glucose intolerance. *Int J Environ Res Public Health.* 2022;19(6):3297. doi: [10.3390/ijerph19063297](https://doi.org/10.3390/ijerph19063297).
- [22] Sosa-Pedreschi A, Donadio MVF, Iturriaga-Ramírez T, et al. Effects of a remotely supervised resistance training program on muscle strength and body composition in adults with cystic fibrosis: randomized controlled trial. *Scand Med Sci Sports.* 2024;34(1):e14564. doi: [10.1111/sms.14564](https://doi.org/10.1111/sms.14564).
- [23] Carr SB, Ronan P, Lorenc A, et al. Children and Adults Tai Chi Study (CF-CATS2): a randomised controlled feasibility study comparing internet-delivered with face-to-face Tai Chi lessons in cystic fibrosis. *ERJ Open Res.* 2018;4(4):00042–2018. doi: [10.1183/23120541.00042-2018](https://doi.org/10.1183/23120541.00042-2018).
- [24] Ronan P, Mian A, Carr SB, et al. Learning to breathe with Tai Chi online – qualitative data from a randomized controlled feasibility study of patients with cystic fibrosis. *Eur J Integr Med.* 2020;40:101229. doi: [10.1016/j.eujim.2020.101229](https://doi.org/10.1016/j.eujim.2020.101229).
- [25] Wickerson L, Grewal R, Singer LG, et al. Experiences and perceptions of receiving and prescribing rehabilitation in adults with cystic fibrosis undergoing lung transplantation. *Chron Respir Dis.* 2023;20:14799731221139293. doi: [10.1177/14799731221139293](https://doi.org/10.1177/14799731221139293).
- [26] Poulsen M, Holland AE, Button B, et al. Preferences and perspectives regarding telehealth exercise interventions for adults with cystic fibrosis: a qualitative study. *Pediatr Pulmonol.* 2024;59(5):1217–1226. doi: [10.1002/ppul.26889](https://doi.org/10.1002/ppul.26889).
- [27] Van Citters AD, Dieni O, Scalia P, et al. Barriers and facilitators to implementing telehealth services during the COVID-19 pandemic: a qualitative analysis of interviews with cystic fibrosis care team members. *J Cyst Fibros.* 2021;20:23–28. doi: [10.1016/j.jcf.2021.09.004](https://doi.org/10.1016/j.jcf.2021.09.004).
- [28] Vasilopoulou A. Exploring physiotherapists’ experiences in delivering care remotely to adults with cystic fibrosis during the COVID-19 pandemic in the United Kingdom. *ACPRC J.* 2024;56(1):20–28. doi: [10.56792/KHPR1321](https://doi.org/10.56792/KHPR1321).
- [29] Vagg T, Shanthikumar S, Ibrahim H, et al. Telehealth in cystic fibrosis. A systematic review incorporating a novel scoring system and expert weighting to identify a ‘top 10 manuscripts’ to inform future best practices implementation. *J Cyst Fibros.* 2023;22(4):598–606. doi: [10.1016/j.jcf.2023.05.012](https://doi.org/10.1016/j.jcf.2023.05.012).
- [30] Tomlinson OW, Shelley J, Denford S, et al. Promotion of exercise in the management of cystic fibrosis – summary of national meetings. *Eur J Pers Cent Healthc.* 2018;6(2):196–2052. doi: [10.5750/ejpc.v6i2.1430](https://doi.org/10.5750/ejpc.v6i2.1430).
- [31] Michie S, Atkins L, West R. *The behaviour change wheel: a guide to designing interventions.* Sutton: Silverback Publishing; 2014.
- [32] Michie S. *The behaviour change wheel: a guide to designing interventions.* Sutton: Silverback Publishing; 2014.
- [33] Peel J, Webb J, Jones AW. A remote behaviour change service for increasing physical activity in people with chronic lung conditions: intervention development using the behaviour change wheel. *Perspect Public Health.* 2020;140(1):16–21. doi: [10.1177/1757913919880928](https://doi.org/10.1177/1757913919880928).

- [34] Webb J, Baker A, Palmer T, et al. The barriers and facilitators to physical activity in people with a musculoskeletal condition: a rapid review of reviews using the COM-B model to support intervention development. *Public Health Pract.* 2022;3:100250. doi: [10.1016/j.puhip.2022.100250](https://doi.org/10.1016/j.puhip.2022.100250).
- [35] Renjith V, Yesodharan R, Noronha JA, et al. Qualitative methods in health care research. *Int J Prev Med.* 2021;12(1):20. doi: [10.4103/ijpvm.IJPVM\\_321\\_19](https://doi.org/10.4103/ijpvm.IJPVM_321_19).
- [36] Guest G, Bunce A, Johnson L. How many interviews are enough?: An experiment with data saturation and variability. *Field Methods.* 2006;18(1):59–82. doi: [10.1177/1525822X05279903](https://doi.org/10.1177/1525822X05279903).
- [37] Cadogan CA, Ryan C, Francis JJ, et al. Development of an intervention to improve appropriate polypharmacy in older people in primary care using a theory-based method. *BMC Health Serv Res.* 2016;16(1):661–661. doi: [10.1186/s12913-016-1907-3](https://doi.org/10.1186/s12913-016-1907-3).
- [38] Braun V, Clarke V. *Thematic analysis: a practical guide.* Los Angeles (CA): SAGE Publications Ltd.; 2022.
- [39] Brierley ML, Smith LR, Bailey DP, et al. Evaluating a multi-component intervention to reduce and break up office workers' sitting with sit-stand desks using the APEASE criteria. *BMC Public Health.* 2022;22(1):458–458. doi: [10.1186/s12889-022-12794-w](https://doi.org/10.1186/s12889-022-12794-w).
- [40] Charlton J, Gréaux M, Kulkarni A, et al. UK paediatric speech and language therapists' perceptions on the use of telehealth in current and future clinical practice: an application of the APEASE criteria. *Int J Lang Commun Disord.* 2024;59(3):1163–1179. doi: [10.1111/1460-6984.12988](https://doi.org/10.1111/1460-6984.12988).
- [41] Ponterotto JG. Qualitative research in counseling psychology: a primer on research paradigms and philosophy of science. *J Counsel Psychol.* 2005;52(2):126–136. doi: [10.1037/0022-0167.52.2.126](https://doi.org/10.1037/0022-0167.52.2.126).
- [42] Lincoln YS, Guba EG. *Naturalistic inquiry.* Newbury Park (CA): Sage Publications; 1985.
- [43] Denzin NK. *Sociological methods: a sourcebook.* London: Butterworths; 1970.
- [44] Tsai LLY, McNamara RJ, Dennis SM, et al. Satisfaction and experience with a supervised home-based real-time video-conferencing telerehabilitation exercise program in people with chronic obstructive pulmonary disease (COPD). *Int J Telerehabil.* 2016;8(2):27–38. doi: [10.5195/ijt.2016.6213](https://doi.org/10.5195/ijt.2016.6213).
- [45] Batalik L, Filakova K, Sladeckova M, et al. The cost-effectiveness of exercise-based cardiac telerehabilitation intervention: a systematic review. *Eur J Phys Rehabil Med.* 2023;59(2):248–258. doi: [10.23736/S1973-9087.23.07773-0](https://doi.org/10.23736/S1973-9087.23.07773-0).
- [46] Bearne LM, Gregory WJ, Hurley MV. Remotely delivered physiotherapy: can we capture the benefits beyond COVID-19? *Rheumatology.* 2021;60(4):1582–1584. doi: [10.1093/rheumatology/keab104](https://doi.org/10.1093/rheumatology/keab104).
- [47] O'malley CA. Infection control in cystic fibrosis: cohorting, cross-contamination, and the respiratory therapist. *Respir Care.* 2009;54(5):641–657. doi: [10.4187/aarc0446](https://doi.org/10.4187/aarc0446).
- [48] Haydon HM, Snoswell CL, Thomas EE, et al. Enhancing a community palliative care service with telehealth leads to efficiency gains and improves job satisfaction. *J Telemed Telecare.* 2021;27(10):625–630. doi: [10.1177/1357633X211048952](https://doi.org/10.1177/1357633X211048952).
- [49] Mcbeath AG, Plock S, Bager-charleson S. The challenges and experiences of psychotherapists working remotely during the coronavirus pandemic. *Couns Psychother Res.* 2020;20(3):394–405. doi: [10.1002/capr.12326](https://doi.org/10.1002/capr.12326).
- [50] Holland AE, Malaguti C, Hoffman M, et al. Home-based or remote exercise testing in chronic respiratory disease, during the COVID-19 pandemic and beyond: a rapid review. *Chron Respir Dis.* 2020;17:1479973120952418. doi: [10.1177/1479973120952418](https://doi.org/10.1177/1479973120952418).
- [51] Chen JJ, Cooper DM, Haddad F, et al. Tele-exercise as a promising tool to promote exercise in children with cystic fibrosis. *Front Public Health.* 2018;6:269. doi: [10.3389/fpubh.2018.00269](https://doi.org/10.3389/fpubh.2018.00269).
- [52] Caruso CC. Negative impacts of shiftwork and long work hours. *Rehabil Nurs.* 2014;39(1):16–25. doi: [10.1002/rnj.107](https://doi.org/10.1002/rnj.107).
- [53] Killingback C, Thompson M, Nettleton M, et al. Telerehabilitation for patients who have been hospitalised with covid-19: a qualitative study. *Disabil Rehabil.* 2024;46(1):150–158. doi: [10.1080/09638288.2022.2159075](https://doi.org/10.1080/09638288.2022.2159075).
- [54] Yap T, Jones A. The feasibility and efficacy of telespirometry for pulmonary monitoring of cystic fibrosis: a systematic review. *Int J Allied Health Sci Pract.* 2022;20(3):1–17. Available from: <https://search.ebscohost.com/login.aspx?direct=true&db=rzh&AN=158405773&site=ehost-live&scope=site>
- [55] Denford S, van Beurden S, O'Halloran P, et al. Barriers and facilitators to physical activity among children, adolescents, and young adults with cystic fibrosis: a systematic review and thematic synthesis of qualitative research. *BMJ Open.* 2020;10(2):e035261. doi: [10.1136/bmjopen-2019-035261](https://doi.org/10.1136/bmjopen-2019-035261).
- [56] Excellence TNIFHAC. Behaviour change: individual approaches; 2014 [cited 2014 Sep 16]. Available from: <https://www.nice.org.uk/guidance/ph49>
- [57] Koestner R. Reaching one's personal goals: a motivational perspective focused on autonomy. *Can Psychol.* 2008;49(1):60–67. doi: [10.1037/0708-5591.49.1.60](https://doi.org/10.1037/0708-5591.49.1.60).
- [58] Swann C, Rosenbaum S, Lawrence A, et al. Updating goal-setting theory in physical activity promotion: a critical conceptual review. *Health Psychol Rev.* 2021;15(1):34–50. doi: [10.1080/17437199.2019.1706616](https://doi.org/10.1080/17437199.2019.1706616).
- [59] Segar ML, Guérin E, Phillips E, et al. From a vital sign to vitality: selling exercise so patients want to buy it. *Curr Sports Med Rep.* 2016;15(4):276–281. doi: [10.1249/JSR.0000000000000284](https://doi.org/10.1249/JSR.0000000000000284).
- [60] Thomas DM, Kyle TK, Stanford FC. The gap between expectations and reality of exercise-induced weight loss is associated with discouragement. *Prev Med.* 2015;81:357–360. doi: [10.1016/j.ypmed.2015.10.001](https://doi.org/10.1016/j.ypmed.2015.10.001).
- [61] Hedbom T, Liljeroos M, Thylén I, et al. Expectations of tele-yoga in persons with long-term illness: qualitative content analysis. *J Med Internet Res.* 2023;25(1):e36808. doi: [10.2196/36808](https://doi.org/10.2196/36808).
- [62] Johnson JL, Adkins D, Chauvin S. A review of the quality indicators of rigor in qualitative research. *Am J Pharm Educ.* 2020;84(1):7120. doi: [10.5688/ajpe7120](https://doi.org/10.5688/ajpe7120).

**Appendix A: Interview questions****For MDT members**

**Affordability:** An intervention is affordable if within an acceptable budget it can be delivered to, or accessed by, all those for whom it would be relevant of benefit.



**Question for MDT member:**  
What is your cost/time required for the service?

**Practicability:** An intervention is practicable to the extent that it can be delivered as designed through the means intended to the target population.



**Question for MDT members:**  
How could the RES be improved (classes, delivery frequency)?  
What might encourage PwCF take part in the RES more?

**Effectiveness and cost-effectiveness:** Effectiveness refers to the effect size of the intervention in relation to the desired objectives in a real-world context



**Question for MDT members:**  
How does taking part in the RES affect PwCF in your aspect?

**Acceptability:** Acceptability refers to the extent to which an intervention is judged to be appropriate by relevant stakeholder.



**Question for MDT members:**  
What do you think about the RES strengths for PwCF and you?  
And for other MDT members?

**Side effects/safety:** An intervention maybe effective and practical but have unwanted side-effects or unintended consequences.



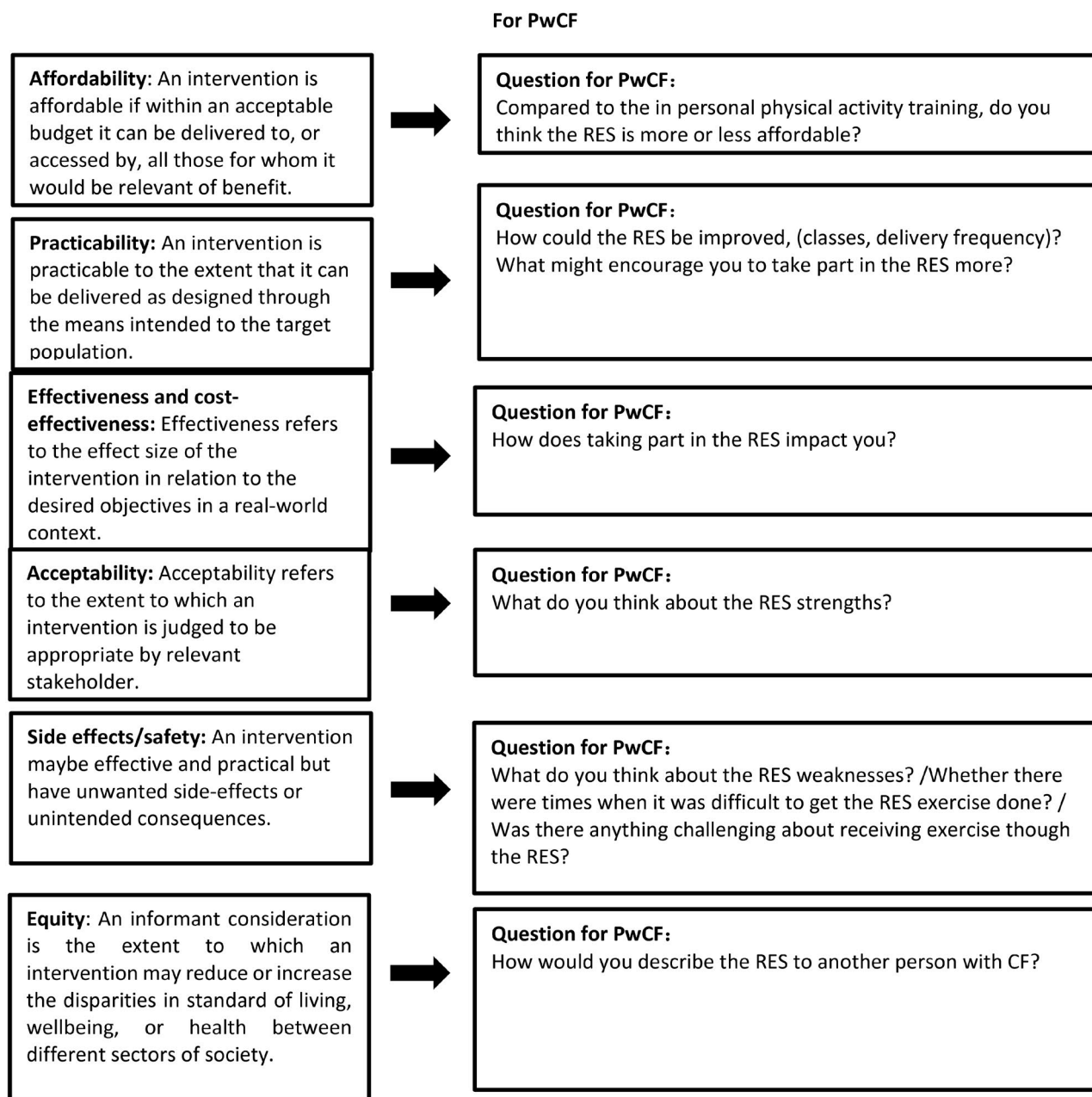
**Question for MDT members:**  
What do you think about the RES weaknesses? /Whether there were times when it was difficult to get the RES exercise done? / Was there anything challenging about receiving exercise though the RES?

**Equity:** An informant consideration is the extent to which an intervention may reduce or increase the disparities in standard of living, wellbeing, or health between different sectors of society.



**Question for MDT member:**  
How could accessibility of the RES be improved?

(Continued)

**Appendix A: Continued.**

**Appendix B: Mapping study results into the APEASE criteria**

APEASE	Subthemes from MDT members		Subthemes from MDT members	
	Facilitators	Barriers	Facilitators	Barriers
Acceptability	<ul style="list-style-type: none"> <li>- Flexible accessibility</li> <li>- Efficiency/convenience</li> <li>- Perceived facilitators for remote exercise services</li> <li>- Personalised education and support</li> </ul>	<ul style="list-style-type: none"> <li>- It can be a challenge for less confident people with CF</li> </ul>	<ul style="list-style-type: none"> <li>- An excellent way to stay active online</li> <li>- Convenience</li> </ul>	<ul style="list-style-type: none"> <li>- Lack of commitment to remote exercise</li> </ul>
Practicability	<ul style="list-style-type: none"> <li>- More flexible exercise options</li> <li>- Efficient convenience</li> <li>- Improvement in work efficiency</li> <li>- Contingency (for pandemics)</li> <li>- Perceived facilitators for remote exercise services</li> <li>- Personalised education and support</li> </ul>	<ul style="list-style-type: none"> <li>- Time constraints</li> <li>- Technical difficulties</li> </ul>	<ul style="list-style-type: none"> <li>- Keeping active</li> <li>- Convenience</li> <li>- Internal factors</li> <li>- External factors</li> </ul>	<ul style="list-style-type: none"> <li>- Lack of commitment to remote exercise</li> </ul>
Effectiveness	<ul style="list-style-type: none"> <li>- Physical benefits</li> <li>- Psychological and social benefits</li> </ul>	None	<ul style="list-style-type: none"> <li>- Cost-effectiveness</li> </ul>	None

(Continued)

**Appendix B: Continued.**

APEASE	Subthemes from MDT members		Subthemes from MDT members	
	Facilitators	Barriers	Facilitators	Barriers
Affordability	- Efficient convenience - Personalised education and support	None	- Cost-effectiveness	None
Side-effects	None	- Lack of visual cues - Technical difficulties	None	None
Equity	- Flexible accessibility - Personalised education and support	- It can be a challenge for less confident people with CF	- Inclusivity	- Equipment/technology issues

**Appendix C: Mapping study results into the intervention functions and policy categories of behaviour change wheel**

Intervention functions	Subthemes from MDT members	Subthemes from people with CF	Policy categories	Subthemes from MDT members	Subthemes from people with CF
Education	- It can be a challenge for less confident people with CF - Lack of visual cues - Personalised education and support	- Lack of commitment to remote exercise - External factors	Communication	None	None
Persuasion	- Personalised education and support	- Internal factors	Guidelines	- Lack of visual cues	None
Incentivisation	- Perceived facilitators for remote exercise services - Personalised education and support	- Lack of commitment to remote exercise - Internal factors - External factors	Fiscal measures	- Personalised education and support	- Equipment/technology issues
Coercion	None	- External factors	Regulation Legislation	None - Technical difficulties	None - Equipment/technology issues
Training	- Lack of visual cues - Personalised education and support	None	Environmental/Social Planning	- Technical difficulties - Lack of visual cues - Personalised education and support	- Equipment/technology issues - External factors
Restriction	None	None	Service provision	- Technical difficulties - Time constraints - Personalised education and support	- External factors
Environmental restructuring	- Lack of visual cues	None			
Modelling	None	None			
Enablement	- Technical difficulties - Perceived facilitators for remote exercise services - Personalised education and support	- Equipment/technology issues - External factors			