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## **Telerehabilitation and exercise for chronic conditions: development of a disease-agnostic telerehabilitation intervention for people with chronic conditions**

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**UNIVERSITY OF  
LIMERICK  
OLLSCOIL LUIMNIGH**

**Telerehabilitation and Exercise for Chronic Conditions:  
Development of a disease-agnostic telerehabilitation intervention  
for people with chronic conditions**

**Caoimhe Barry Walsh, BSc Physiotherapy**

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Thesis submitted to the University of Limerick, in fulfilment of the  
requirements for the degree of Doctor of Philosophy

Submitted to University of Limerick, September 2024



## **Abstract**

**Title:** Telerehabilitation and Exercise for Chronic Conditions: Development of a disease-agnostic telerehabilitation intervention for people with chronic conditions.

**Author:** Caoimhe Barry Walsh

**Background:** Chronic conditions, including chronic obstructive pulmonary disease, multiple sclerosis, and arthritis, are a leading cause of death and disability worldwide and pose significant challenges for our healthcare service. Rehabilitation has been identified as an integral aspect of chronic condition management, promoting self-management of patients' health and well-being, increasing their physical function, and improving quality of life. Telerehabilitation, the delivery of rehabilitation remotely via telecommunication technologies, has the potential to increase service accessibility by overcoming the traditional barriers to in-person rehabilitation. Telerehabilitation offers significant advantages for chronic condition management, particularly in rural and remote locations. Its scalability allows healthcare providers to extend service delivery to these populations without the need for expansion of infrastructure, facilitating patient uptake and engagement with rehabilitation programmes. Despite the diversity in the underlying medical conditions, rehabilitation programmes for various chronic conditions are remarkably similar, typically including progressive exercise training and education. Therefore, recent evidence supports the development of disease-agnostic group rehabilitation programmes which encompass a wide range of chronic conditions, rather than condition-specific programmes. However, previous telerehabilitation research has focused on condition-specific rehabilitation programme delivery, such as cardiac telerehabilitation solely for cardiac populations, or pulmonary rehabilitation for respiratory cohorts only. Therefore, there is uncertainty regarding the optimal content and delivery of telerehabilitation programmes for various chronic conditions

and the feasibility of a disease-agnostic telerehabilitation programme for mixed-condition groups. **Aim:** To identify delivery strategies and content to develop a disease-agnostic group telerehabilitation programme for people with mixed chronic conditions. **Methods:** This research was guided by the Medical Research Council framework for developing and evaluating complex interventions and involved a mixed-methods approach. A systematic research strategy was undertaken, comprising;

- A systematic review (**Chapter Two**) of existing literature examining the psychometric properties of performance-based measures of physical function administered via telehealth among people with chronic conditions;
- Qualitative investigations of stakeholder's perspectives, including people with chronic conditions (**Chapter Three**) and clinicians, in this case physiotherapists, involved in rehabilitation delivery (**Chapter Four**), towards group-based telerehabilitation, their acceptability of disease-agnostic telerehabilitation programmes for mixed-condition groups, and their preferences for future programmes;
- The design and development (**Chapter Five**) of a disease-agnostic telerehabilitation programme for mixed-condition groups underpinned by the previous findings and input from key stakeholders to guide intervention refinement, and;
- A feasibility trial (**Chapter Six**) to evaluate of the feasibility and acceptability of the developed disease-agnostic telerehabilitation programme for mixed-condition groups.

**Results:** (i) The systematic review (**Chapter Two**) identified a wide range of performance-based measures across various physical function domains that have been administered via telehealth to people with chronic conditions. Although several of these measures demonstrated sufficient reliability and validity when administered via telehealth, the quality

of evidence was low and there was a significant lack of information regarding the measurement error, responsiveness, feasibility, and interpretability of these measures. This reinforced the need for further research in the area and that there was no clear measurement instrument that could be recommended for use in the subsequent feasibility trial.

(ii) Qualitative results demonstrated that both people with chronic conditions (**Chapter Three**) and physiotherapists (**Chapter Four**) value the role of telerehabilitation, while acknowledging that barriers and challenges exist which limit telerehabilitation uptake and participation. Preferences for future telerehabilitation programmes across both groups involved hybrid delivery models including both telerehabilitation and in-person rehabilitation, synchronous modes of delivery with some recorded content, and the inclusion of exercise, education, and social components in future programmes.

(iii) The acceptability of disease-agnostic telerehabilitation programmes for mixed-condition groups was unclear and varied, with some apprehension evident. Nevertheless, most were open to considering this delivery method. The preferences expressed by stakeholders informed the development of a disease-agnostic telerehabilitation programme for a mixed-condition group, known as the Telerehabilitation and Exercise for Chronic Conditions (TECC) programme (**Chapter Five**). Some of the findings from the feasibility study (**Chapter Six**) were promising and suggest that the TECC programme, a six-week disease-agnostic physiotherapy-led telerehabilitation programme, delivered online, could be a feasible, safe and acceptable intervention among people with chronic conditions. However, significant amendments and refinements to the intervention are required. In particular, consideration needs to be given to improving recruitment, retention and adherence rates, particularly concerning engagement with the social component of the intervention.

**Conclusion:** These findings add to the existing literature on the design and delivery of telerehabilitation for people with chronic conditions, and the feasibility of disease-agnostic telerehabilitation programmes for mixed-condition groups. Although further evaluation is required, future iterations of the TECC intervention could be a pragmatic and sustainable method of healthcare service delivery for people with chronic conditions. Ultimately, this thesis serves to inform future telerehabilitation service delivery strategies and contribute to the optimisation of healthcare services for people with chronic conditions.

## Declaration

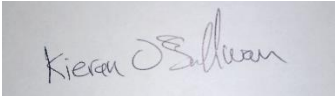
I hereby declare that the work contained in this thesis is my own and was completed under the supervision of Associate Professor Róisín Cahalan and Professor Kieran O' Sullivan, of the School of Allied Health, University of Limerick. This work has not been submitted for any academic award at this, or any other, third-level institution.

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Date: September 2024

## **Acknowledgements**

I would first like to express my sincere thanks to the dream supervisory team, Associate Professor Róisín Cahalan and Professor Kieran O' Sullivan. I want to express my appreciation and gratitude for the support, guidance, and opportunities you gave me throughout the PhD journey. I am in awe of the work that you do, your efficiency, and your ability to always provide support when needed. I couldn't have asked for better supervisors, and I am truly grateful for your time and everything that you have done for me.

A special thank you to Professor Rana Hinman, University of Melbourne for your invaluable feedback, expertise and support which has helped to guide this research.

Thank you to those who participated in the focus groups and the feasibility trial for your time, participation, and contributions which helped to develop the TECC intervention and thesis.

Thank you to Dr Ray O'Connor, Julie Sugrue, Dr Anne Griffin, Abigail Browne, Dr Jennifer McMahon and Fatma Omar for delivering the TECC education sessions for the feasibility trial. Thank you to all who helped with participant recruitment at various stages of this research project, particularly to Niamh Julian and colleagues in South Tipperary Community Services, HSE who helped with recruitment for the feasibility trial.

Thank you to my colleagues and staff at the University of Limerick, particularly in the School of Allied Health and the Health Research Institute for all your support along the way.

To my family and friends, in particular, Mom, Dad and Dara, for your encouragement, support, friendship and love. Without you, I wouldn't have been able to undertake this journey, and I am forever grateful to you all.

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## List of Publications

**Barry Walsh, C., Cahalan, R., Hinman, R.S. & O'Sullivan, K. (2022)** 'Psychometric properties of performance-based measures of physical function administered via telehealth among people with chronic conditions: A systematic review', *PLOS ONE*, 17(9), p.e0274349.

**Barry Walsh, C., Cahalan, R., Hinman, R.S. and O'Sullivan, K. (2024)** 'Exploring attitudes of people with chronic health conditions towards the use of group-based telerehabilitation: A qualitative study', *Clinical Rehabilitation*, 38(1), pp.130-142.

**Barry Walsh, C., Cahalan, R., Hinman, R.S. and O'Sullivan, K. (2024)** 'Exploring attitudes of physiotherapists towards the delivery of group-based telerehabilitation and their acceptability of mixed-condition group programmes for people with chronic health conditions: A qualitative study' *Manuscript submitted for publication*.

**Barry Walsh, C., Cahalan, R., Hinman, R.S. and O'Sullivan, K. (2024)** 'A physiotherapy-led disease-agnostic telerehabilitation programme for people with chronic health conditions: a mixed-methods feasibility trial' *Manuscript submitted for publication*.

## List of Conference Presentations

### Oral Presentations

**Barry Walsh, C., Cahalan, R., Hinman, R.S. & O’Sullivan, K. (2022)** ‘Psychometric properties of performance-based measures of physical function administered via telehealth among people with chronic conditions: A systematic review’. Irish Society of Chartered Physiotherapists Annual Conference 2022, October 14<sup>th</sup>, online.

**Barry Walsh, C., Cahalan, R., Hinman, R.S. & O’Sullivan, K. (2023)** ‘Exploring attitudes of clinicians towards the delivery of group-based telerehabilitation for people with chronic health conditions: A qualitative study’. Irish Society of Chartered Physiotherapists Annual Conference 2023, October 13<sup>th</sup>, online.

**Barry Walsh, C., Cahalan, R., Hinman, R.S. & O’Sullivan, K. (2023)** ‘Exploring attitudes of people with chronic conditions towards telerehabilitation: A qualitative study’. Chartered Society of Physiotherapists Annual Conference 2023, November 7<sup>th</sup>, Belfast, Northern Ireland (abstract published in *Physiotherapy*, 123, e51-e52).

**Barry Walsh, C., Cahalan, R., Hinman, R.S. & O’Sullivan, K. (2023)** ‘Exploring attitudes of clinicians towards the delivery of group-based telerehabilitation for people with chronic health conditions: A qualitative study’. International Society for Research on Internet Interventions 12<sup>th</sup> Annual Conference 2024, 2<sup>nd</sup>-5<sup>th</sup> June, Limerick, Ireland.

### Poster Displays

**Barry Walsh, C., Cahalan, R., Hinman, R.S. & O’Sullivan, K. (2023)** ‘Exploring attitudes of people with chronic conditions towards telerehabilitation: A qualitative study’. 16<sup>th</sup>

European Public Health Conference, November 9<sup>th</sup>, Dublin, Ireland (abstract published in *European Journal of Public Health*, 33(Supplement\_2), pp. ckad160-1140).

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## **List of Abbreviations**

CAL- Clinically Acceptable Limits

CASP – Critical Appraisal Skills Programme

CI – Confidence Intervals

COREQ- Consolidated Criteria for Reporting Qualitative Research

COSMIN- Consensus-based Standards for the Selection of Health Measurement Instruments

CR- Cardiorespiratory

F- Female

FEV1- Forced Expiratory Volume in one second

FIM- Functional Independence Measure

G- Gerontology

HDI- Human Development Index

HSE- Health Service Executive

ICC- Intraclass Correlation Coefficient

ICT- Information and Communication Technology

IQR – Inter-Quartile Range

IR – Incidence Rate

LoA- Limits of Agreement

M- Male

MAD- Mean Absolute Difference

MD- Mean Difference

MRC- Medical Research Council

MSK- Musculoskeletal

n-sample size

N- Neurological

OECD- Organisation for Economic Co-operation and Development

OR – Odds Ratio

P- Participant

PRISMA – Preferred Reporting Items for Systematic Reviews and Meta-Analyses

RPE – Rate of Perceived Exertion

RR – Response Rate

SD – Standard Deviation

SDG- Sustainable Development Goal

SPIRIT- Standard Protocol Items: Recommendations for Interventional Trials

TECC- Telerehabilitation and Exercise for Chronic Conditions

TIDieR- Template for Intervention Description and Replication

TUGT- Timed Up and Go Test

UN- United Nations

UPDRS- Unified Parkinson's Disease Rating Scale

WHO – World Health Organisation

6MWT- 6-Minute Walk Test

%EA- Percent Exact Agreement

%A±1- Percent Agreement within one point on ordinal scale

## **Chapter 1. Introduction**

## **1.1 Chapter Outline**

The aim of this chapter is to introduce the research and provide information on the topic, aims and structure of the overall doctoral thesis. A review of current literature will provide the relevant background information that is required to understand the subsequent chapters of the thesis. This chapter will present the current evidence, key uncertainties, and the need for further research and the development of the Telerehabilitation and Exercise for Chronic Conditions (TECC) intervention. The aims and structure of the thesis, and an outline of the subsequent chapters are also presented in this chapter.

## **1.2 Background**

### **1.2.1 Chronic Conditions**

Chronic conditions, spanning cardiovascular, respiratory, neurological and musculoskeletal conditions, as defined by the World Health Organisation (WHO) (1993) International Classification of Diseases 10<sup>th</sup> Revision, Clinical Modification (ICD-10-CM), are conditions that last longer than 12 months and result in the need for ongoing medical intervention and limit self-care, independent living and social interaction. These conditions, such as Chronic Obstructive Pulmonary Disease (COPD), Multiple Sclerosis (MS), arthritis and cancer, are major contributors to disability and mortality levels worldwide, contributing to 74% of all deaths globally (World Health Organisation 2023). The prevalence of chronic conditions has steadily increased in recent years and is predicted to continue to rise due to ageing populations and the increasing prevalence of various risk factors for these conditions. Estimations suggest that by 2030, chronic conditions will account for 89% of diseases in high-income countries, and 54% in low- and middle-income countries (Savva and McDaid 2011). The socioeconomic burden of these conditions both on individuals and healthcare

systems is substantial, contributing to increased healthcare service activity and expenditure (Sav *et al.* 2017; Hacker 2024). Chronic conditions contribute to limited physical abilities, and chronic pain, and require ongoing medical management, which can lead to emotional distress and significantly impact quality of life (Megari 2013). The burden associated with these conditions not only diminishes the individual's ability to engage in daily activities and social interactions but also contributes to a sense of helplessness and increased suffering. With the estimated increase in the incidence of chronic conditions, it is reasonable to anticipate an ever-increasing demand on our healthcare services in the coming years. Therefore, it is crucial to prioritise effective management strategies to alleviate the burden and prevalence of chronic conditions.

Given the significant socioeconomic burden and impact of chronic conditions on individuals and society, the management and prevention of these conditions has become a key priority for Irish government and healthcare services in recent years (Health Service Executive 2020; Department of Health Ireland 2023). The Department of Health Statement of Priorities in Health and Social Care Research 2023-2025 highlighted the detection and management of non-communicable diseases as a research priority area (Department of Health Ireland 2023). Key strategies identified by the National Framework for the Integrated Prevention and Management of Chronic Disease in Ireland 2020-2025 emphasise the importance of optimally integrated and sustainable healthcare (Health Service Executive 2020). By prioritising research on understanding, detecting, preventing, and managing chronic conditions, the government and healthcare services have demonstrated their commitment to addressing the ongoing challenges and improving healthcare service delivery for these populations. This also aligns with the United Nations (UN) Sustainable Development Goal 3 (SDG 3) 'Good Health and Well-being' which focuses on ensuring healthy living and

promoting well-being. Marmot (2015) has previously highlighted the significant influence of social determinants on health, specifically how residing in disadvantaged areas leads to an increased risk of chronic conditions. Social exclusion and inequality create stressors that negatively impact both physical and mental health, resulting in higher incidences of chronic conditions. Therefore, policy and healthcare service reforms aimed at addressing disparities to improve health outcomes for marginalised populations are required.

### **1.2.2 Rehabilitation for Chronic Conditions**

Rehabilitation, defined as “a set of interventions designed to optimize functioning and reduce disability in individuals with health conditions in interaction with their environment” (World Health Organisation 2024), is an integral aspect of chronic disease management. Rehabilitation programmes, particularly those which include physical exercise training and self-management education facilitate self-management of health and improve the physical function of individuals with chronic conditions (Bolton *et al.* 2013; National Institute for Health and Care Excellence 2014; Stucki *et al.* 2018; Long *et al.* 2019). The benefits of these programmes for individuals with chronic conditions include increased exercise capacity, physical function and quality of life, improved symptom management and reduced hospitalisation and healthcare service usage (Rochester *et al.* 2015; Richardson *et al.* 2019). Although these evidence-based programmes have been identified as a cornerstone component of management strategies for various chronic conditions, uptake and engagement with these programmes is often poor (Jones *et al.* 2017; Hinde *et al.* 2019). This can be attributed to various obstacles, including logistical barriers such as time and financial limitations, reduced service accessibility and lack of capacity for service delivery (Desveaux *et al.* 2016; Cox *et al.* 2017; Oates *et al.* 2019; Resurrección *et al.* 2019).

Traditionally, rehabilitation programmes have been delivered to condition-specific cohorts, such as cardiac rehabilitation programmes delivered to groups of people with chronic cardiac conditions, or pulmonary rehabilitation programmes delivered to groups of people with chronic respiratory conditions. However, it has been recognised that people with different chronic conditions experience similar concerns and challenges and generally benefit from similar rehabilitation programmes encompassing exercise training and self-management education (Desveaux *et al.* 2014; Mulligan *et al.* 2019). Previous research has highlighted the similarities between rehabilitation programmes delivered to cohorts with different chronic conditions, despite variability in their underlying diseases. The potential efficiency of generic (disease-agnostic) rehabilitation programmes delivered to mixed-condition groups (i.e., groups of people with various chronic conditions) has been recently recognised (Health Information Quality Authority 2015; Barker *et al.* 2018; Hevey *et al.* 2020). Given the increasing prevalence of chronic conditions and multimorbidity globally, disease-agnostic rehabilitation programmes may act as a more sustainable and pragmatic approach to rehabilitation delivery. Previous research has focused on the delivery of disease-agnostic self-management education programmes, such as the Stanford Chronic Disease Self-Management Programme, and these have typically been delivered in face-to-face settings (Hevey *et al.* 2020). These interventions were found to be successful when delivered in traditional in-person clinical settings, resulting in improved health outcomes and reduced healthcare service utilisation for people with chronic conditions. This supports the development and testing of disease-agnostic rehabilitation services delivered remotely through a virtual environment reaping the benefits of telehealth service delivery.

### **1.2.3 Telerehabilitation**

The recent COVID-19 pandemic and its associated social distancing and isolation requirements for vulnerable populations including people with chronic conditions forced a rapid adoption of the use of telehealth to deliver healthcare services. Telehealth refers to the remote delivery of healthcare services using information and communication technologies (ICT), such as videoconferencing and telephone calls. However, telerehabilitation, defined as “the remote delivery of rehabilitation services via telecommunications technologies including the telephone, the internet, and videoconference communication” (Matsumoto *et al.* 2021), has the potential to act as a long-term, sustainable method of healthcare delivery beyond the COVID-19 pandemic potentially increasing service accessibility for patients by overcoming barriers to traditional in-person rehabilitation services. Furthermore, previous research examining telerehabilitation effectiveness is promising, showing that it is as clinically effective as traditional in-person rehabilitation for various chronic populations, while also being a safe and cost-effective method of service delivery (Hwang *et al.* 2023; Hinman *et al.* 2024). Despite the evidence supporting the efficacy of telerehabilitation, a resistance to the uptake and engagement of both service providers and service users to telerehabilitation has been demonstrated (Kruse *et al.* 2017). This has previously been attributed to various factors including perceived inferiority when compared to in-person services, and limitations relating to technological access and literacy (Kruse *et al.* 2018; Fang *et al.* 2022).

### **1.2.4 Development and Testing of Complex Interventions**

The Medical Research Council (MRC) framework for developing and evaluating complex interventions has been instrumental in guiding this research (Skivington *et al.* 2021). This

framework provides a systematic approach to the design, development, and evaluation of complex healthcare interventions. Interventions are considered complex based on a variety of factors including the number of components involved, the range of behaviours targeted, the expertise and skills required to deliver and receive the intervention, the number of groups, settings or levels targeted, or the degree of flexibility associated with the intervention itself. This framework is applicable for the TECC intervention outlined within this doctoral thesis, given the number of components involved in the intervention, the range of behaviours targeted across the various chronic populations, the skills required to deliver and engage with the telerehabilitation intervention, and the number of different chronic groups and functional levels targeted by the intervention. The framework consists of four key stages including development or identification, feasibility or piloting, evaluation, and implementation of the intervention (See Figure 1.1). Across all four stages of the framework, emphasis is placed on the importance of understanding the context in which the intervention will be delivered, theoretical underpinnings, engaging with key stakeholders, identifying uncertainties, refining the intervention, and economic considerations. Complex intervention research may begin at any of the four stages depending on the key uncertainties regarding the intervention being examined.

### **1.2.5 Gaps in the Existing Literature**

The rapid advancements in telerehabilitation have transformed the landscape of healthcare delivery, particularly regarding rehabilitation for people with various chronic conditions. Despite the growing interest in the value of disease-agnostic rehabilitation, there remains a significant gap in the literature relating to the delivery and feasibility of such programmes. To our knowledge, little research has investigated the feasibility or efficacy of disease-agnostic rehabilitation programmes delivered remotely via telerehabilitation. Chronic

conditions often present complex and multifaceted challenges. Therefore, research examining the feasibility and potential effectiveness of a disease-agnostic telerehabilitation programme requires comprehensive development.

Previous research largely focuses on disease-specific telerehabilitation, leaving limitations in understanding how telerehabilitation can be effectively standardized across various chronic conditions. Key uncertainties that exist include the optimal outcome measures, content and methods of delivery for disease-agnostic telerehabilitation programmes, and the acceptability of this novel healthcare service delivery method to service users and providers.

A key component of evidence-based rehabilitation and clinical practice is the use of standardized performance-based measures to monitor progress and the effectiveness of the intervention (Van Peppen *et al.* 2007; Sullivan *et al.* 2013; Mani *et al.* 2017). However, the perceived difficulty of conducting remote patient assessments, particularly performance-based measures, and the uncertainty surrounding the accuracy of these measures when administered remotely via telehealth, limits telerehabilitation uptake (Mani *et al.* 2017; Bennell *et al.* 2021; Malliaras *et al.* 2021). Although previous research has explored the administration of outcome measures via telehealth in condition-specific cohorts (Mani *et al.* 2017; Grona *et al.* 2018; Holland *et al.* 2020; Houchen-Wolloff *et al.* 2020; Zischke *et al.* 2021), there is limited consensus regarding the most relevant performance-based measures for disease-agnostic telerehabilitation for a mixed-condition group of people with different conditions.

Incorporating insights and experiences of key stakeholders, including service users and service providers, facilitates a codesign approach tailored to the needs and preferences of users ensuring the development of more effective, patient-centred rehabilitation interventions (Gualandi *et al.* 2021). Previous literature has explored the perspectives and experiences of

condition-specific patient groups including people with chronic musculoskeletal (Hinman *et al.* 2017), cardiac (Hwang *et al.* 2017a; Knudsen *et al.* 2021), neurological (Tyagi *et al.* 2018) conditions, and physiotherapists (Cottrell *et al.* 2017b; Damhus *et al.* 2018; Malliaras *et al.* 2021) involved in the delivery of telerehabilitation to condition-specific groups, including cardiorespiratory (Damhus *et al.* 2018), neurological and musculoskeletal (Cottrell *et al.* 2017b; Malliaras *et al.* 2021) populations. There is limited research exploring the attitudes of patient groups and physiotherapists involved in service delivery to diverse patient groups. Furthermore, research exploring the acceptability of disease-agnostic programmes, particularly disease-agnostic telerehabilitation programmes, among key stakeholders is sparse. Therefore, the preferences of these key stakeholders for future telerehabilitation programmes are not clear and there is a lack of consensus regarding the optimal content and delivery methods for future disease-agnostic telerehabilitation programmes. An understanding of the varied experiences and perspectives of people with different chronic conditions and physiotherapists involved in the delivery of rehabilitation to diverse patient groups with different chronic conditions is crucial to ensure that future interventions are inclusive and effective for all service users.

### **1.2.6 Thesis Outline**

Considering the objectives listed below, this doctoral thesis is largely situated in the development and feasibility stages of the framework. The thesis begins with an exploration of the existing evidence base and the identification of key uncertainties. The initial stages of the thesis concentrate on the development stage of the framework, with a particular focus on planning the development process, involving key stakeholders (including those who will deliver, use and benefit from the intervention), reviewing existing evidence, drawing on existing theories, and designing the intervention (O'Cathain *et al.* 2019). The thesis

progresses to assess the feasibility and acceptability of interventions and evaluation of the design to make decisions regarding progression to the next stage of the framework involving a full-scale evaluation of the intervention (Skivington *et al.* 2021).

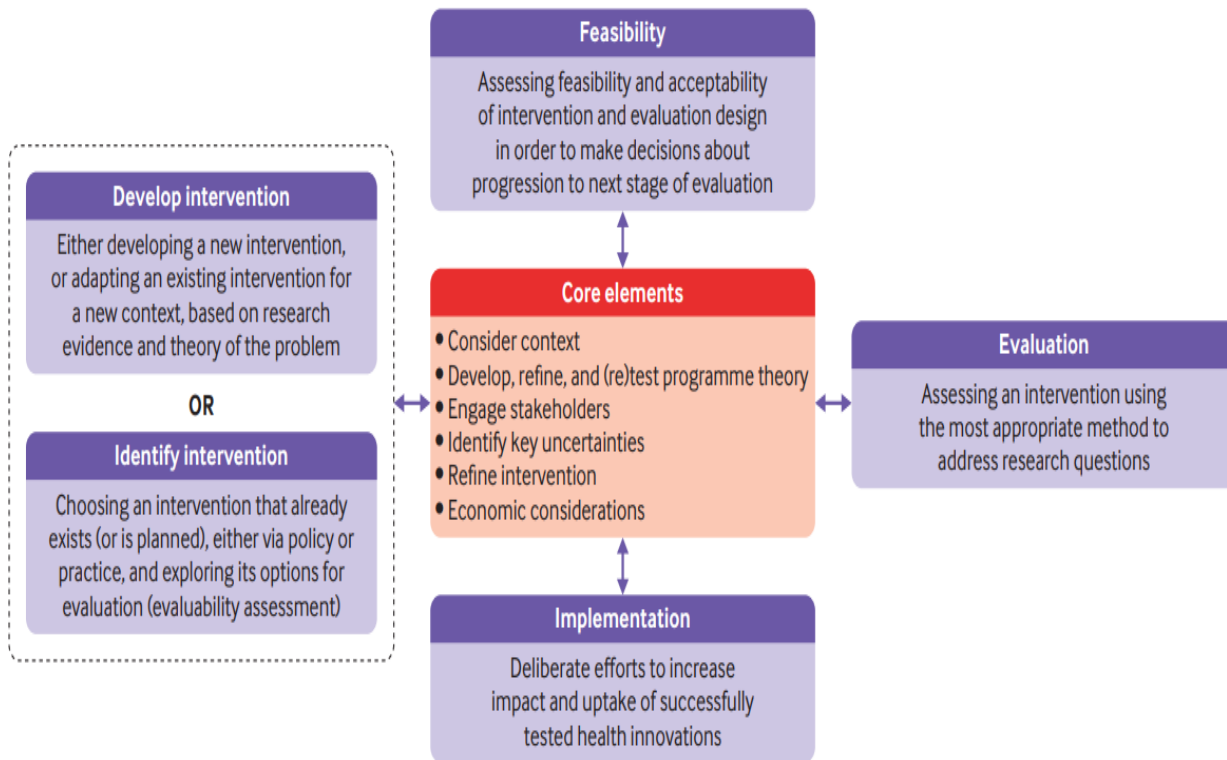


Figure 1.1 Medical Research Council (MRC) Framework for the developing and evaluating complex interventions (Skivington *et al.* 2021)

### 1.3 Thesis Aims

The aim of this doctoral thesis was to identify delivery strategies and content and develop a disease-agnostic group telerehabilitation programme for people with mixed chronic conditions.

To achieve this aim, specific objectives were set as outlined below:

- (i) To review the existing evidence exploring the psychometric properties of performance-based measures of physical function administered via telehealth among chronic populations (**Chapter Two**).
- (ii) To explore the perspectives and experiences of people with chronic conditions towards the use of telerehabilitation, including views of both those who have and have not previously participated in telerehabilitation (**Chapter Three**).
- (iii) To explore the perspectives and experiences of physiotherapists involved in rehabilitation delivery towards the delivery of telerehabilitation, including inputs of both those who have and have not previously delivered telerehabilitation programmes (**Chapter Four**).
- (iv) To design and develop a disease-agnostic group telerehabilitation programme for a group of people with mixed chronic conditions, known as the TECC programme (**Chapter Five**).
- (v) To evaluate the feasibility and acceptability of the TECC programme including the identification of factors to improve any future iteration of the programme. (**Chapter Six**).

## **1.4 Thesis Structure**

The current chapter has provided a brief introduction for the overall thesis, highlighting the rationale, aims and objectives of this research. A systematic programme of research was developed and undertaken to achieve the aims and objectives outlined in this chapter. This research programme was divided into four work packages, guided by the MRC Framework for developing and evaluating complex interventions, and discussed in detail in Chapters Two-Six.

Firstly, **Chapter Two** provides a review of the existing literature examining the psychometric properties of performance-based measures of physical function administered via telehealth among people with chronic conditions (Barry Walsh *et al.* 2022). This chapter identifies several measures across various domains of physical function that may have sufficient reliability and validity when administered via telehealth. This chapter also highlights the lack of high-quality studies that have previously been conducted and a paucity of information regarding the interpretability and feasibility of these measures was also identified, making strong recommendations for the use of certain performance-based measures of physical function via telehealth unfeasible.

**Chapter Three** explores the attitudes of people with chronic conditions towards the use of group-based telerehabilitation (Barry Walsh *et al.* 2024b). This chapter identifies the barriers, facilitators and optimal design and content of group telerehabilitation programmes as perceived by people with various chronic conditions.

**Chapter Four** investigates the attitudes of physiotherapists, towards the delivery of group-based telerehabilitation for people with chronic conditions (Barry Walsh *et al.* 2024a). Chapters Three and Four also provide insight into the acceptability of a disease-agnostic group telerehabilitation programme for mixed-condition cohorts as perceived by patients with chronic conditions and physiotherapists.

Building on the information gained in the previous chapters, **Chapter Five** describes the design and development of the TECC programme, a disease-agnostic group telerehabilitation programme, designed for a group of people with mixed chronic conditions.

The feasibility and acceptability of this programme are explored in **Chapter Six**.

Finally, **Chapter Seven** presents a discussion of the research presented in this doctoral thesis within the context of the existing evidence and discusses the potential impact and limitations of this research, future recommendations and conclusions.

**Chapter 2. Psychometric properties of performance-based measures of physical function administered via telehealth among people with chronic conditions: A systematic review.**

This chapter has been published in '*PLOS ONE*'; Q1, Impact Factor 3.7.

Barry Walsh, C., Cahalan, R., Hinman, R.S. & O'Sullivan, K. (2022) 'Psychometric properties of performance-based measures of physical function administered via telehealth among people with chronic conditions: A systematic review', *PLOS ONE*, 17(9), p. e0274349.

## **2.1 Chapter Outline**

The current chapter provides a comprehensive review of studies that examined the psychometric properties of performance-based measures of physical function when administered via telehealth among people with various chronic conditions. By conducting the review of the available evidence, several measurement instruments administered via telehealth among chronic populations were identified. The reliability and validity of these measures were reported, however limited information regarding the measurement error and responsiveness of these measures when administered via telehealth was identified. The results of this review addressed a gap in the literature and also provided an evidence-based direction for this doctoral thesis. However, there was limited research examining the interpretability and feasibility of the measures when administered via telehealth, thus highlighting the need for further research in this area. It also identified a paucity of high-quality research in this area. The findings of this chapter serve to guide the overall research and content of subsequent chapters, and the design of the intervention developed for this doctoral thesis.

## **2.2 Abstract**

### **Background**

Telehealth could enhance rehabilitation for people with chronic health conditions. This review examined the psychometric properties of performance-based measures of physical function administered via telehealth among people with chronic health conditions using the Consensus-Based Standards for the Selection of Health Measurement Instruments (COSMIN) approach.

## **Methods**

This systematic review was registered with Prospero (Registration number: CRD42021262547). Four electronic databases were searched up to June 2022. Study quality was evaluated by two independent reviewers using the COSMIN risk of bias checklist. Measurement properties were rated by two independent reviewers in accordance with COSMIN guidance. Results were summarised according to the COSMIN approach and the modified GRADE approach was used to grade quality of the summarised evidence.

## **Results**

Five articles met the eligibility criteria. These included patients with Parkinson's Disease (n = 2), stroke (n = 1), cystic fibrosis (n = 1) and chronic heart failure (n = 1). Fifteen performance-based measures of physical function administered via videoconferencing were investigated, spanning measures of functional balance (n = 7), other measures of general functional capacity (n = 4), exercise capacity (n = 2), and functional strength (n = 2). Studies were conducted in Australia (n = 4) and the United States (n = 1). Reliability was reported for twelve measures, with all twelve demonstrating sufficient inter-rater and intra-rater reliability. Criterion validity for all fifteen measures was reported, with eight demonstrating sufficient validity and the remaining seven demonstrating indeterminate validity. No studies reported data on measurement error or responsiveness.

## **Conclusions**

Several performance-based measures of physical function across the domains of exercise capacity, strength, balance and general functional capacity may have sufficient reliability and criterion validity when administered via telehealth. However, the evidence is of low-very low quality, reflecting the small number of studies conducted and the small sample sizes included

in the studies. Future research is needed to explore the measurement error, responsiveness, interpretability and feasibility of these measures administered via telehealth.

## 2.4 Introduction

Chronic health conditions, defined as conditions that last greater than 12 months and result in the need for ongoing medical intervention and limits self-care, independent living and social interaction (World Health Organization 1993), such as COPD, multiple sclerosis, arthritis and cancer, have the potential to lead to significant levels of disability, mortality and reduced quality of life (Darker *et al.* 2015). In 2019, on average, more than one-third of adults aged 16 and above in 26 OECD (Organisation for Economic Co-operation and Development) countries reported living with a chronic health condition [2]. The ageing nature of the Western world and the increasing prevalence of chronic conditions presents a significant socioeconomic burden and will continue to persistently challenge health care services (Balanda *et al.* 2010; Hernández *et al.* 2019). Rehabilitation programmes, which typically include physical exercise training and self-management education, have been identified as an integral aspect of chronic condition management, to facilitate people living with chronic health problems to independently manage their condition and improve their physical function and quality of life (Bolton *et al.* 2013; National Institute for Health and Care Excellence 2014; Stucki *et al.* 2018; Long *et al.* 2019). Although in-person rehabilitation is considered the default service delivery method, healthcare services lack the capacity required to meet the increasing demand for these programmes. Also, uptake levels among patients have traditionally been poor due to different barriers, such as travel and time limitations (Desveaux *et al.* 2016; Oates *et al.* 2019). Offering rehabilitation services remotely via information and communication technologies, also known as telerehabilitation (Matsumoto *et al.* 2021), may increase service accessibility and overcome barriers to traditional face-to-face programmes. Furthermore, telerehabilitation is as clinically effective as face-to-face rehabilitation for several different chronic populations (Bourne *et al.* 2017; Cottrell *et al.* 2017a; Jiang *et al.*

2018). The recent COVID-19 pandemic presented challenges for rehabilitation service providers, resulting in a dramatic increase in the use of telehealth. This accelerated shift towards the use of an alternative method of service delivery allowed health care services to maintain service accessibility and ensure continuity of patient care. Despite the evidence supporting its efficacy, resistance to the adoption of telehealth has been demonstrated by both patients and healthcare providers (Kruse *et al.* 2017). One of the challenges which has limited the adoption of telehealth is the perceived difficulty of assessing patients remotely, particularly the administration of performance-based measures via telehealth platforms and the uncertainty regarding the accuracy and reliability of these measures (Mani *et al.* 2017; Bennell *et al.* 2021; Malliaras *et al.* 2021). The use of standardised performance-based measures in clinical assessment is an important element of evidence-based rehabilitation and clinical practice (Van Peppen *et al.* 2007; Sullivan *et al.* 2013) to inform diagnosis, clinical decision making, intervention planning and goal setting (Russell 2007; Mani *et al.* 2017). The regular measurement of parameters of performance-based physical function during rehabilitation programmes therefore facilitates objective monitoring and evaluation of the effectiveness of the intervention. The reliability and validity of measures administered via telehealth has been explored in recent systematic, scoping, and rapid reviews in musculoskeletal (Mani *et al.* 2017; Grona *et al.* 2018), as well as chronic cardiac and respiratory (Holland *et al.* 2020; Houchen-Wolloff *et al.* 2020) populations. Zischke *et al.* (2021) also conducted a review examining various clinical assessments conducted via telehealth. Overall, these reviews supported the feasibility of assessment via telehealth, and highlighted the reliability and validity of several performance-based measures across domains such as range of motion, strength, endurance, aerobic capacity, balance, gait, and functional assessments. However, the existing evidence exploring performance-based

measures is limited, with a tendency to focus on the use of measures in specific patient cohorts, rather than considering all domains across all populations with chronic conditions. Furthermore, some of the existing reviews included patient-reported outcomes such as pain intensity, or pain response during special orthopaedic tests. While evidence demonstrates that electronic patient-reported measures are equivalent to paper-based self-reported measures when administered in various chronic populations (Gwaltney *et al.* 2008; Campbell *et al.* 2015; Muehlhausen *et al.* 2015; Aiyegbusi *et al.* 2021), there is limited evidence exploring the psychometric properties and equivalence of performance-based measures administered via telehealth when compared to face-to-face administration. Therefore, a comprehensive overview of a wide range of performance-based measures relevant to a variety of chronic neurological, respiratory, and musculoskeletal conditions administered via telehealth is required. To our knowledge, this is the first review using the Consensus-Based Standards for the Selection of Health Measurement Instruments (COSMIN) approach to evaluate the reliability and validity of performance-based measures of physical function across a broad range of chronic health conditions.

## **2.5 Methods**

This systematic review protocol was registered with Prospero (Registration number: CRD42021262547) (Appendix 8.1.1). This review was conducted in accordance with COSMIN methodology which is a robust approach that aims to improve the selection of measurement instruments using transparent methodology.

### **2.5.1 Search Strategy**

A comprehensive search strategy was developed, reviewed and refined by the authors, with the assistance of a health librarian, in accordance with the Preferred Reporting Items for

Systematic Reviews and Meta-Analyses (PRISMA) guidelines (Page *et al.* 2021) (Appendix 8.1.2). An electronic database search of PubMed, EMBASE, CINAHL and PsycINFO via EBSCOhost was conducted on the 28th of June 2022. Key search terms were developed using four individual search filters. These filters included: 1. Population: chronic conditions OR chronic disease OR chronic health OR chronic illness OR long term illness OR long term disability OR long term condition 2. Construct: physical function OR physical performance OR functional capacity OR physical capacity 3. Measurement Instrument: assessment OR evaluation OR outcome OR measure OR test 4. Context: telehealth OR telerehabilitation OR telemedicine OR e-health These individual filters were combined with the COSMIN search filter for measurement properties (Mokkink *et al.* 2010) to create the search strategy outlined in Appendix 8.1.3. Hand-searching of the reference lists of the included articles was also performed to identify additional relevant articles.

### **2.5.2 Eligibility Criteria**

Studies were included in the review if they met the following criteria:

1. Population: adults ( $\geq 18$  years) diagnosed with any chronic health condition, as defined by the ICD-10-CM (World Health Organization 1993) as a condition that lasts greater than 12 months and results in the need for ongoing medical intervention and limits self-care, independent living and social interaction. Studies including a mixed sample of acute and chronic populations were included if at least 80% of the sample had a chronic diagnosis.
2. Construct: the evaluated measure was a performance-based measure of physical function, as defined by the World Health Organisation (WHO) International Classification of Functioning, Disability and Health (ICF) framework (2001) as activities which relate to the ability to move around and perform daily activities e.g., strength, balance, etc.

3. Measurement instrument: an established performance-based measure of physical function, commonly used in clinical practice, which was evaluated synchronously by a tester as the activity was being performed by the individual. This usually involved evaluation by timing, counting or distance methods (Kroman *et al.* 2014).

4. Setting: the evaluated measure was administered by a tester located remotely from the patient using any telehealth platform, as defined by WHO as “the delivery of health care services, where patients and providers are separated by distance. Telehealth uses information and communication technologies (ICT) for the exchange of information for the diagnosis and treatment of diseases and injuries.”.

5. Measurement properties: In our pre-registered protocol, we highlighted studies must have reported one or more of the psychometric measurement properties from the COSMIN taxonomy (Mokkink *et al.* 2010). For studies examining the validity of the measurement instrument administered via telehealth, the comparator was a face-to-face administration of the same measurement instrument. Since the comparator was always face-to-face administration of the same measure, when extracting data from the selected studies the measurement properties of interest were reliability, measurement error and criterion validity. Therefore, the remaining measurement properties outlined in the COSMIN taxonomy including other forms of validity and interpretability were not considered to be outcomes of interest in this review.

Studies were excluded if (1) the evaluated measure was a self-reported measure of physical function, or a laboratory value (e.g., VO<sub>2</sub> max, spirometry, etc.) indirectly used to assess physical function, or a self-administered measure that did not involve administration and evaluation by an independent tester; or (2) the study population consisted of post-operative

patients since post-operative pain and disability levels differ in magnitude and stability from chronic conditions.

A sample of 30% of abstracts from the database search were initially screened by two independent reviewers (CBW & RC) to determine potential eligibility. As good agreement (>80%) was achieved, the remaining abstracts were screened by one reviewer (CBW). Thereafter, a sample of 30% of full texts of potentially eligible studies were reviewed to determine eligibility by two independent reviewers (CBW & RC). Any disagreements were resolved through discussion with a third reviewer (KOS). As above, good agreement was achieved, and the remaining studies were reviewed by one reviewer (CBW).

### **2.5.3 Data Extraction**

Data were extracted by two independent authors (CBW & KOS) using a table created by the authors following COSMIN guidance (Mokkink *et al.* 2020). Firstly, the characteristics of the included studies and the performance-based measures evaluated within the studies were extracted. Thereafter, data relating to the evaluation of the methodological quality of the included studies and the evaluation of the measurement properties (i.e., strength of correlations/associations) were also extracted. The included performance-based measures were categorised according to the domain of physical function that they measured. These domains included exercise capacity, functional strength, functional balance, and general functional capacity.

### **2.5.4 Methodological quality of included studies**

The methodological quality of each of the included studies was evaluated by two independent authors (CBW & KOS) using the COSMIN risk of bias checklist and scores were determined by consensus (Mokkink *et al.* 2020). This tool contains separate standards for each

measurement property (i.e., reliability, measurement error and criterion validity) that can be used to determine the trustworthiness of the result. Each of the standards were rated and the ‘worst-score-counts’ method was applied to determine the overall quality of each measurement property reported in the included studies (Mokkink *et al.* 2020).

### **2.5.5 Evaluation of the measurement properties reported in the included studies**

The COSMIN methodology was used to evaluate the measurement property results reported in each of the included studies (Mokkink *et al.* 2020). These results were evaluated according to the criteria for good measurement properties (strength of correlations/associations with the reference standard face-to-face administration of the measure) to give a rating of sufficient (+), indeterminate (?) or insufficient (-) for each measurement property, as described by Prinsen *et al.* (2018) (Appendix 8.1.4). For the reliability domain, inter-rater and intra-rater reliability were evaluated by comparing the scores for the measure when administered via telehealth between different raters and also when administered by the same rater at two different time points. As recommended, a threshold of 0.70 on the intraclass correlation (ICC) or weighted kappa was used to evaluate the reliability of the measure administered via telehealth (Mokkink *et al.* 2020). If the correlation was  $\geq 0.70$  the reliability received a sufficient rating. If the ICC or weighted kappa was not reported it received an indeterminate rating for reliability. The reliability of the measure was rated as insufficient if the ICC or weighted kappa score was  $< 0.70$ . For the criterion validity domain, the measure administered via telehealth was compared to the same measure administered in a face-to-face environment. A correlation of 0.70 with the reference standard (Mokkink *et al.* 2020), which for the purpose of this review was the measure administered in a face-to-face environment, was the threshold. The validity of the measure was rated as sufficient if the correlation was  $\geq 0.70$ .

The validity was rated as indeterminate if correlations were not reported. The validity was rated as insufficient if the correlation with the reference standard was  $< 0.70$ .

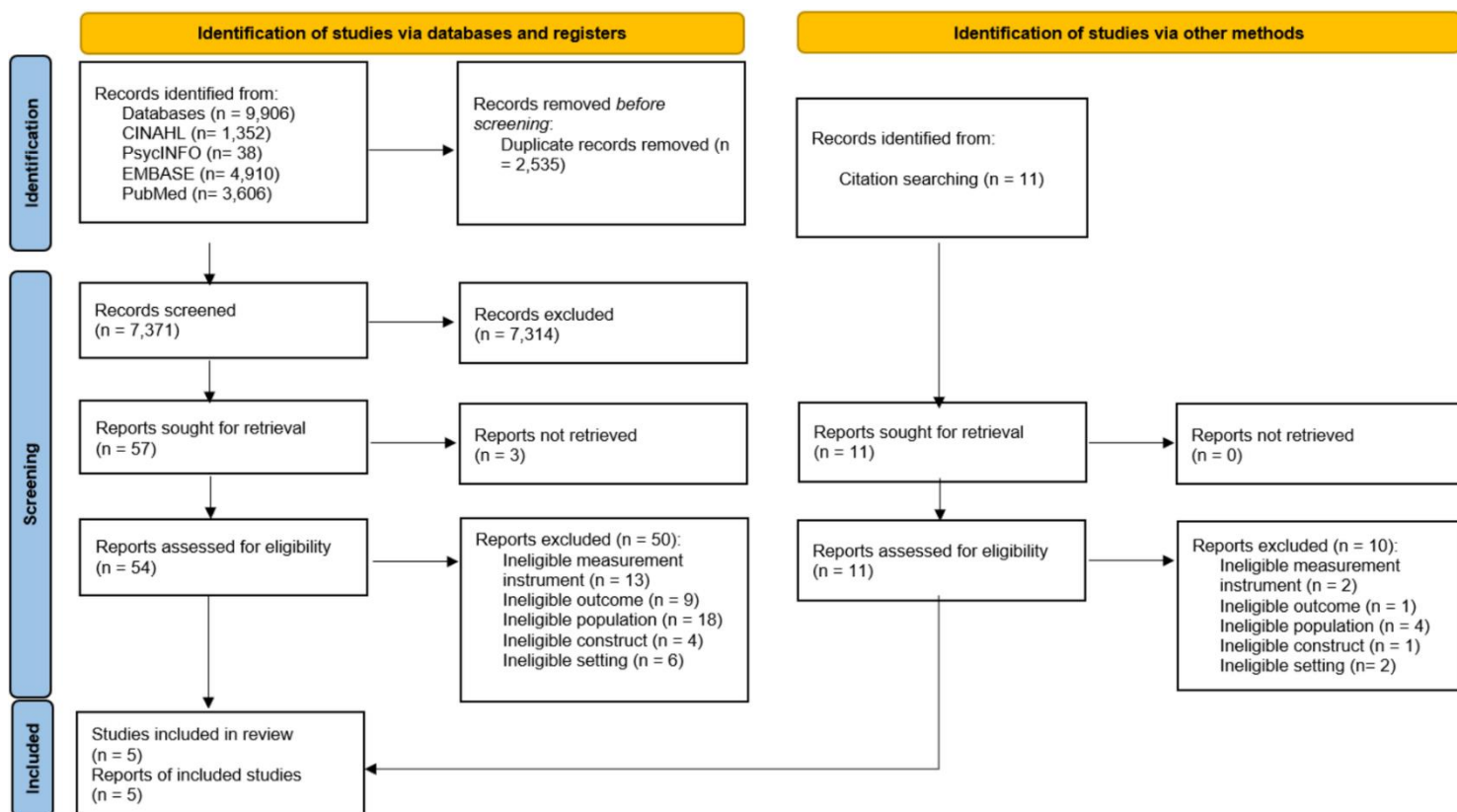
### **2.5.6 Data synthesis and analysis**

To synthesise the results, the evidence was summarised per measurement property (e.g., reliability, validity) per outcome measure to come to an overall conclusion regarding the reliability and validity of the measures. If multiple studies examined the same measure, the results of the studies were synthesised to achieve an overall result. In the case of inconsistency in the results between studies (e.g., both sufficient and insufficient results were found), explanations for the inconsistency were explored. When inconsistent results likely existed due to varying study quality as previously described, the results of lower quality studies were omitted and only the higher quality results were used to determine the overall rating and the quality of summarised evidence was downgraded due to inconsistency. If no logical explanation was found which could explain the inconsistency, the results were considered inconsistent. The modified GRADE approach was used by two independent reviewers and disagreements were resolved by consensus to summarise how confident we can be that the summarised evidence is trustworthy (Prinsen *et al.* 2018). The summarised evidence was graded as high, moderate, low or very low based on the following four criteria: 1. Risk of Bias (quality of the studies); 2. Inconsistency (of the results of the studies); 3. Imprecision (total sample size of the studies) and 4. Indirectness (evidence from different populations than the population of interest). Detailed instructions on the use of the modified GRADE approach to grade the quality of the summarised evidence can be found in Appendix 8.1.5. The starting point assumed that the summarised result was of high quality and was downgraded by one, two or three levels depending on the risk of bias. The summarised result was further downgraded depending on the inconsistency, imprecision and indirectness

associated with the summarised result as appropriate. When inconsistency existed between the results of the included studies examining the same measurement instrument, the results were summarised as sufficient or insufficient and the quality of the evidence was downgraded for inconsistency with one or two levels depending on the severity of the inconsistency. As the severity of inconsistency between results is context dependent, the level of severity was discussed and decided by the review team in each situation. For imprecision, the evidence was downgraded one level if the sample size was 50–100 individuals. If the sample size was less than 50 individuals the evidence was downgraded two levels. As this review included studies in which the >80% of the population had a chronic diagnosis, the risk of bias associated with indirectness did not exist and therefore the evidence was not downgraded for indirectness.

## **2.6 Results**

The initial search yielded 9,906 articles, of which 7,377 remained after duplicates were removed. Five articles met the inclusion criteria and were deemed eligible for inclusion in the review. Figure 2.1 outlines the search results and screening process using a PRISMA flow diagram (Page *et al.* 2021).



**Figure 2.1** Process of identification, screening, and exclusion of studies according to PRISMA statement (Moher et al. 2009).

### 2.6.1 Study characteristics

A summary of the descriptive characteristics of each included study and the included performance-based measures is presented in Table 2.1. Four of the included studies were conducted in Australia (Hoffmann *et al.* 2008; Cox *et al.* 2013; Russell *et al.* 2013; Hwang *et al.* 2017b), with the remaining study conducted in the United States (Palsbo *et al.* 2007). A total of 77 individuals were included in the review with sample sizes ranging from 10–26 participants. Two studies included patients with Parkinson’s Disease (Hoffmann *et al.* 2008; Russell *et al.* 2013) and the remaining three studies included patient cohorts with stroke, cystic fibrosis and heart failure respectively (Palsbo *et al.* 2007; Cox *et al.* 2013; Hwang *et*

*al.* 2017b). Measurement properties of 15 performance-based physical function measures were investigated in the included studies. Inter-rater and intra-rater reliability were reported for 12 of the measures, while the criterion validity of all 15 measures was reported. No studies reported data on measurement error or responsiveness. Of the 15 performance-based measures, seven assessed balance (Timed Up and Go Test, functional and lateral reach tests, Berg Balance Scale, step test, steps in 360 degree turn, and timed stance test) (Palsbo *et al.* 2007; Russell *et al.* 2013; Hwang *et al.* 2017b), two assessed exercise capacity (3 minute step test and 6 minute walk test) (Cox *et al.* 2013; Hwang *et al.* 2017b) and two assessed functional strength (grip and pinch strength) (Hoffmann *et al.* 2008; Hwang *et al.* 2017b). The remaining four measures assessed diverse aspects of functional capacity including the Functional Independence Measure (FIM) (Hoffmann *et al.* 2008), of which only the motor components were assessed (bathing, dressing, toileting, walking, stairs, eating, grooming, bladder management, toilet transfers, bowel management bed/chair transfers, tub/shower transfers), the Unified Parkinson's Disease Rating Scale (UPDRS) (Hoffmann *et al.* 2008), of which relevant items were assessed (posture, gait, sensory complaints, falling, freezing when walking, tremor, tremor at rest, salivation, facial expression, bradykinesia, speech, action or postural hand tremor, handwriting), the Nine Hole Peg Test (Hoffmann *et al.* 2008) and the European Stroke Scale (Palsbo *et al.* 2007).

Table 2.1 Characteristics of included studies

Study	Country	Performance Measure	Physical Function Domains	Telehealth Environment	Equipment Required	Participant Population	Mean age $\pm$ SD (range)	Rater Population	Measurement Properties Assessed
(Cox <i>et al.</i> 2013)	Melbourne, Australia	3-minute step test	Exercise capacity	Administered using synchronous videoconferencing platform by clinician in separate room to the participant within the same building	15cm high step, metronome, pulse oximeter	N= 10 adults with cystic fibrosis recruited prospectively on admission to hospital, N= 5 males, N= 5 females, mean FEV1= 55.4% of predicted (range= 38-90% of predicted)	32 years $\pm$ 7 years	Not reported	Criterion validity
(Hoffmann <i>et al.</i> 2008)	Queensland, Australia	FIM (motor components), UPDRS (selected items), Nine Hole Peg Test, Grip strength, Pinch strength	Functional strength, functional capacity	Administered using synchronous videoconferencing platform by clinician in a separate room to the participant	Hand-held dynamometer, Pinch gauge	N=12 community-dwelling participants with Parkinson's Disease, adequate cognitive status to participate in assessment tasks, N= 6 males, N= 6 females, N=6 tested in	66.1 years $\pm$ 8.5 years	N= 3 assessors	Inter-rater reliability, intra-rater reliability, criterion validity

<b>(Hwang <i>et al.</i> 2017b)</b>	Brisbane, Australia	TUGT, 6MWT, grip strength	Functional balance and mobility, exercise capacity, functional strength	Administered using synchronous videoconferencing by clinician in a separate room within the same hospital building	TUGT: stopwatch, 45cm highchair with armrests, 3m walk track, regular footwear ± mobility aid 6MWT: 30m track, stopwatch, automatic sphygmomanometer, finger pulse oximeter, lap counter Grip strength: Hand-held dynamometer	telehealth, N=6 tested face-to-face N= 17 patients with chronic heart failure, 88% males, 12% females	69 years ± 12 years	N=4 hospital physiotherapists with an average of 11.5 years of work experience in physiotherapy	Inter-rater reliability, intra-rater reliability, criterion validity
<b>(Palsbo <i>et al.</i> 2007)</b>	United States of America	European Stroke Scale, Functional Reach Test	Functional capacity, functional balance	Administered using synchronous videoconferencing platform by clinician in a separate room to the participant	European Stroke Scale: examination table Functional Reach Test: large yardstick	N= 26 patients with a history of stroke including both inpatients and outpatients, N= 18 males, N= 18 females, time since stroke range 2 months-15 years, mean= 2.7 years	Median age= 64 years	N=4 physiotherapists from rehabilitation hospitals, all had at least 2 years of experience using telehealth to support onsite physiotherapists for a variety of patient assessments	Criterion validity
<b>(Russell <i>et al.</i> 2013)</b>	Queensland, Australia	TUGT, step test, steps in 360-degree	Functional balance	Administered using synchronous videoconferencing	TUGT: stopwatch Lateral and Functional Reach	N= 12 people with Parkinson's	66.1 years ± 8.5	N= 1 final year physiotherapy and N= 2	Inter-rater reliability, intra-rater

turn, timed and platform by Tests: calibrated Disease, years occupational reliability, stance test, mobility clinician in a assessment tool adequate (45-76 therapy students criterion Berg Balance separate room to cognitive years) validity Scale, lateral the participant status to reach test, functional participate in reach test functional assessment tasks, N= 6 males, N= 6 females, mean age at time of diagnosis= 53.5 years, SD= 9.0, range= 38-69 years, average number of years since diagnosed with Parkinson's= 6.8 years, SD= 4.4, range 2-15 years
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**FIM= Functional Independence Measure, UPDRS= Unified Parkinson's Disease Rating Scale, TUGT= Timed Up and Go Test, 6MWT= 6 Minute Walk Test, FEV1= Forced Expiratory Volume in one second, N= sample size, SD= standard deviation; cm= centimetres, m= metres**

### **2.6.2 Methodological quality of included studies**

The COSMIN risk of bias scores for the measurement properties of the measures in each included study are displayed in Table 2.2. Of the studies that reported the reliability of the included measures, ten measures demonstrated adequate quality while three demonstrated inadequate quality. Of the studies that reported criterion validity of the measures, eight measures demonstrated very good quality and ten demonstrated inadequate quality. Many of the studies reporting the criterion validity of the included measures received an inadequate quality rating as per COSMIN guidance as the correlation with the reference standard was not calculated (Mokkink *et al.* 2018) (e.g., mean differences between measures administered via telehealth compared to face-to-face administration were reported as opposed to correlations).

Table 2.2 Measurement properties of performance-based measures

Performance-based Measure	Reliability					Criterion Validity		
	Result	Design	Time Interval	COSMIN Risk of Bias Score	Overall Rating	Result	COSMIN Risk of Bias Score	Overall Rating
<b>Exercise Capacity</b>								
6MWT (Hwang <i>et al.</i> 2017b)	ICC <sub>2,1</sub> >0.99 ICC <sub>1,1</sub> >0.99	Inter-rater Intra-rater	Same day	Inadequate Inadequate	+ +	ICC <sub>1,1</sub> (95%CI) 0.90 (0.74-0.96) MD (95%CI) 4 (-25 to 17 metres)	Very good	+
3 min Step Test (Cox <i>et al.</i> 2013)						MD lowest SpO <sub>2</sub> 0.2% (LoA -3.4 to 3.6%), MD rate of perceived exertion 0.5 points (LoA -1.1 to 2.1 points) MD heart rate -0.6 beats/min (LoA -11.3 to 10.1 beats/min)	Inadequate	?
<b>Strength Tests</b>								
Grip Strength (Hoffmann <i>et al.</i> 2008)						Authors report “no differences” observed	Inadequate	?
Grip Strength (Hwang <i>et al.</i> 2017b)	ICC <sub>2,1</sub> >0.99 ICC <sub>1,1</sub> >0.99	Inter-rater Intra-rater	Same day	Inadequate Inadequate	+ +	Right hand: ICC <sub>1,1</sub> (95%CI) 0.94 (0.84-0.98) Left hand: ICC <sub>1,1</sub> (95%CI) 0.96 (0.89-0.98)	Very good	+
Pinch Strength (Hoffmann <i>et al.</i> 2008)						Authors report “no differences” observed	Inadequate	?

Performance-based Measure	Reliability					Criterion Validity			
	Result	Design	Time Interval	COSMIN Risk of Bias Score	Overall Rating	Result	COSMIN Risk of Bias Score	Overall Rating	
<b>Balance Tests</b>									
Berg Balance Scale (Russell <i>et al.</i> 2013)	ICC <sub>2,1</sub> ≥0.96 ICC <sub>2,1</sub> ≥0.98	Inter-rater Intra-rater	2 months	Adequate Adequate	+ +	Kappa 0.94, %EA 16.7, %A ±1 75.0	Very good	+	
TUGT (Hwang <i>et al.</i> 2017b)	ICC <sub>2,1</sub> 0.95 (0.86-0.98) ICC <sub>1,1</sub> 0.96 (0.90-0.99)	Inter-rater Intra-rater	Same day	Inadequate Inadequate	+ +	ICC <sub>1,1</sub> (95%CI) 0.85 (0.64-0.94) MD (95%CI) 0.24 (-0.56 to 1.03) seconds	Very good	+	
TUGT (Russell <i>et al.</i> 2013)	ICC <sub>2,1</sub> ≥0.96 ICC <sub>2,1</sub> ≥0.98	Inter-rater Intra-rater	2 months	Adequate Adequate	+ +	LoA 1.25 to 1.24 Clinically acceptable limit 5.00 MD -0.01, SD 0.63 MAD 0.47	Inadequate	?	
Step Test (Russell <i>et al.</i> 2013)	ICC <sub>2,1</sub> ≥0.96 ICC <sub>2,1</sub> ≥0.98	Inter-rater Intra-rater	2 months	Adequate Adequate	+ +	Right foot: Kappa 0.97, %EA 75.0, %A ±1 83.3 Left foot: Kappa 0.95, %EA 66.7, %A ±1 83.3	Very good Very good	+ +	
Functional Reach Test (Russell <i>et al.</i> 2013)	ICC <sub>2,1</sub> ≥0.96 ICC <sub>2,1</sub> ≥0.98	Inter-rater Intra-rater	2 months	Adequate Adequate	+ +	LoA -2.71 to 0.69 Clinically acceptable limit 4.74 MD -1.01, SD 0.87 MAD 1.01	Inadequate	?	

Performance-based Measure	Reliability					Criterion Validity		
	Result	Design	Time Interval	COSMIN Risk of Bias Score	Overall Rating	Result	COSMIN Risk of Bias Score	Overall Rating
Functional Reach Test (Palsbo <i>et al.</i> 2007)						No significant difference between results (Z= -0.239, p>0.05) 92% of participants scored within 95% agreement limits	Inadequate	?
Steps in 360 degrees turn (Russell <i>et al.</i> 2013)	ICC <sub>2,1</sub> ≥0.96 ICC <sub>2,1</sub> ≥0.98	Inter-rater Intra-rater	2 months	Adequate Adequate	+ +	Right foot: Kappa 0.98, %EA 75.0, %A ±1 100.0 Left foot: Kappa 0.97, %EA 66.7, %A ±1 91.7	Very good Very good	+ +
Lateral Reach Test (Russell <i>et al.</i> 2013)	ICC <sub>2,1</sub> ≥0.96 ICC <sub>2,1</sub> ≥0.98	Inter-rater Intra-rater	2 months	Adequate Adequate	+ +	MD -0.79, SD 0.66, LoA -2.09 to 0.51, clinically acceptable limit 4.74, MAD 0.82	Inadequate	?
Timed Stance Test (Russell <i>et al.</i> 2013)	ICC <sub>2,1</sub> ≥0.96 ICC <sub>2,1</sub> ≥0.98	Inter-rater Intra-rater	2 months	Adequate Adequate	+ +	LoA -4.17 to 5.06, clinically acceptable limit 8.00, MD 0.44, SD 2.35, MAD 1.58	Inadequate	?
<b>Functional Capacity Tests</b>								
FIM (motor components) (Hoffmann <i>et al.</i> 2008)	ICC <sub>2,1</sub> 0.95 ICC <sub>2,1</sub> 0.94	Inter-rater Intra-rater	1 week 2 months	Adequate Adequate	+ +	Kappa 0.93, %EA 91.6%, %A ±1 98.7%	Very good	+

Performance-based Measure	Reliability					Criterion Validity		
	Result	Design	Time Interval	COSMIN Risk of Bias Score	Overall Rating	Result	COSMIN Risk of Bias Score	Overall Rating
UDPRS (selected items) (Hoffmann <i>et al.</i> 2008)	ICC <sub>2,1</sub> 0.80	Inter-rater	1 week	Adequate	+	Kappa 0.81, %EA 73.4%, %A ±1 95.2%	Very good	+
	ICC <sub>2,1</sub> 0.84	Intra-rater	2 months	Adequate	+			
European Stroke Scale (Palsbo <i>et al.</i> 2007)						No significant difference between results (Z= -0.239, p>0.05)	Inadequate	?
Nine Hole Peg Test (Hoffmann <i>et al.</i> 2008)	ICC <sub>2,1</sub> 0.99	Inter-rater	1 week	Adequate	+	Right hand: MD 0.25 seconds (SD 0.90), LoA - 2.02 to 1.52, MAD 0.68 seconds Left hand: MD 0.14 seconds, SD 0.61, LoA - 1.34 to 1.05, MAD 0.45 seconds	Inadequate	?
	ICC <sub>2,1</sub> 0.99	Intra-rater	2 months	Adequate	+			

FIM= Functional Independence Measure, UPDRS= Unified Parkinson's Disease Rating Scale, TUGT= Timed Up and Go Test, 6MWT= 6 Minute Walk Test, %EA= Percent exact agreement, %A ±1= Percent agreement within one point on ordinal scale, SD= Standard deviation, MAD= Mean absolute difference, ICC= intraclass correlation coefficient, MD= Mean difference, LoA= Limits of agreement, += sufficient rating, ?= indeterminate rating

### 2.6.3 Overall rating and quality of evidence

A summary of the overall rating and quality of evidence per measurement property of the included measures is presented in Table 2.3. These scores were developed from the information displayed in Table 2.2 which included the rating and the COSMIN risk of bias score. Twelve measures received ‘sufficient’ overall ratings for reliability, with a ‘very low’ quality of evidence score. Eight measures received ‘sufficient’ overall ratings and seven received ‘indeterminate’ ratings for criterion validity and were all scored as ‘low’ or ‘very low’ quality of evidence. For example, the Six Minute Walk Test (6MWT) demonstrated sufficient reliability ( $ICC > 0.70$ ) with a ‘very low’ quality of evidence score due to the inadequate COSMIN risk of bias rating of the included study and the small sample size (correlation with face-to-face  $> 0.70$ ) with a ‘low’ quality of evidence score due to the ‘very good’ COSMIN risk of bias rating of the included study and the low sample size ( $n < 50$ ). The 3-minute step test demonstrated ‘indeterminate’ validity as no correlation with the reference standard (face-to-face administration) was reported, which was insufficient information reported to provide a ‘sufficient’ rating according to the COSMIN guidance. The summary scores for the validity of the Timed Up and Go Test (TUGT) and grip strength reflect adjustments that were made to allow for inconsistencies in the results reported in the included studies. For example, the validity of the TUGT was reported in two studies and received an overall ‘sufficient’ validity rating (correlation  $> 0.70$ ) (Hwang *et al.* 2017b), with ‘very low’ quality of evidence due to the inadequate COSMIN risk of bias score of the included studies, the small sample size ( $< 50$ ), and the inconsistency between the validity findings of the included studies (Hoffmann *et al.* 2008; Cox *et al.* 2013; Russell *et al.* 2013; Hwang *et al.* 2017b).

Table 2.3 Summary of findings.

Reliability	Summary Result	Overall Rating	Quality of Evidence
6MWT	ICC>0.99; sample size: 17	Sufficient	Very Low (one inadequate study, sample <50-100)
Step Test	ICC≥0.96; sample size: 12	Sufficient	Very Low (one adequate study, sample <50-100)
Grip Strength	ICC>0.99; sample size: 17	Sufficient	Very Low (one inadequate study, sample <50-100)
Berg Balance Scale	ICC≥0.96; sample size: 12	Sufficient	Very Low (one adequate study, sample <50-100)
TUGT	ICC>0.95; total sample size: 29	Sufficient	Very Low (multiple studies of at least inadequate quality, sample <50-100, consistent results)
Functional Reach Test	ICC≥0.96; sample size: 12	Sufficient	Very Low (one adequate study, sample <50-100)
Steps in 360-degree turn	ICC≥0.96; sample size: 12	Sufficient	Very Low (one adequate study, sample <50-100)
Lateral Reach Test	ICC≥0.96; sample size: 12	Sufficient	Very Low (one adequate study, sample <50-100)
Timed Stance Test	ICC≥0.96; sample size: 12	Sufficient	Very Low (one adequate study, sample <50-100)
FIM (motor components)	ICC range 0.94-0.95; sample size: 12	Sufficient	Very Low (one adequate study, sample <50-100)
UDPRS (selected items)	ICC range 0.80-0.84; sample size: 12	Sufficient	Very Low (one adequate study, sample <50-100)
Nine Hole Peg Test	ICC 0.99; sample size: 12	Sufficient	Very Low (one adequate study, sample <50-100)
<b>Criterion Validity</b>			
6MWT	ICC 0.90, mean difference of 4; sample size: 17	Sufficient	Low (one very good study, sample <50-100)
Step Test	Kappa range 0.95-0.97, %EA ≥66.7, %A±1 83.3; sample size: 12	Sufficient	Low (one very good study, sample <50-100)
3 min Step Test	MD SpO2 0.2%, MD rate of perceived exertion 0.5 points, MD heart rate -0.6 beats/min; sample size: 10	Indeterminate	Very Low (one inadequate study, sample <50-100)
Grip Strength	Right hand: ICC <sub>1,1</sub> (95% CI) 0.94 (0.84-0.98) Left hand: ICC <sub>1,1</sub> (95% CI) 0.96 (0.89-0.98); authors report “no differences” observed; total sample size: 29	Sufficient	Very Low (multiple studies of at least inadequate quality, sample <50-100, inconsistent results)

Pinch Strength	Authors report “no differences” observed; sample size: 12	Indeterminate	Very Low (one inadequate study, sample <50-100)
Berg Balance Scale	Kappa 0.94, %EA 16.7, %A±1 75.0; sample size: 12	Sufficient	Low (one very good study, sample <50-100)
TUGT	ICC 0.85, MD 0.24 seconds, LoA 1.25 to 1.24, CAL 5.00, MD -0.01, SD 0.63; total sample size: 29	Sufficient	Very Low (multiple studies of at least inadequate quality, sample <50-100, inconsistent results)
Functional Reach Test	LoA -2.71 to 0.69, CAL 4.74, MD -1.01, SD 0.87, MAD 1.01; No significant difference between results (Z= -0.239, p>0.05), 92% of participants scored within 95% agreement limits; total sample size: 29	Indeterminate	Very Low (multiple studies of at least inadequate quality, sample <50-100, consistent results)
Steps in 360 degrees turn	Kappa range: 0.97-0.98, %EA≥66.7, %A±1 ≥ 91.7; sample size: 12	Sufficient	Low (one very good study, sample <50-100)
Lateral Reach Test	MD -0.79, SD 0.66, LoA 2.09 to 0.51, CAL 4.74, MAD 0.82; sample size: 12	Indeterminate	Very Low (one inadequate study, sample <50-100)
Timed Stance Test	LoA -4.17 to 5.06, CAL 8.00, MD 0.44, SD 2.35, MAD 1.58; sample size: 12	Indeterminate	Very Low (one inadequate study, sample <50-100)
FIM (motor components)	Kappa 0.93, %EA 91.6, %A±1 98.7; sample size: 12	Sufficient	Low (one very good study, sample <50-100)
UDPRS (selected items)	Kappa 0.81, %EA 73.4, %A±1 95.2; sample size: 12	Sufficient	Low (one very good study, sample <50-100)
European Stroke Scale	No significant difference between results (Z=-0.239, p>0.05); sample size: 26	Indeterminate	Very Low (one inadequate study, sample <50-100)
Nine Hole Peg Test	MD range 0.14-0.25 seconds, SD range 0.61-0.90, MAD range 0.45-0.68seconds; sample size: 12	Indeterminate	Very Low (one inadequate study, sample <50-100)

## 2.6.4 Exercise capacity measures

Measures of exercise capacity included in this review were the 6MWT and three minute step test. The 6MWT demonstrated sufficient reliability and criterion validity when administered via telehealth. Evidence for the administration of three minute step test via telehealth is yet to be determined as there was no information available examining its reliability, and the evidence for criterion validity was indeterminate due to non-optimal analysis. Therefore, recommendation for the use of this instrument via telehealth cannot be made. However, the mean differences between the telehealth assessment and the face-to-face assessment

observed by Cox et al. (2013) were very small and suggest that there was no significant difference between the telehealth assessment and face-to-face administration. Therefore, these three minute step test results are encouraging.

### **2.6.5 Functional strength measures**

The grip strength test demonstrated sufficient reliability and criterion validity. Evidence for the pinch strength measure administered via telehealth is yet to be determined due to the lack of information available.

### **2.6.6 Functional balance measures**

Seven measures of functional balance were included in the review. Measures with the most robust results demonstrating sufficient reliability and criterion validity were the Berg Balance Scale, TUGT, Step test and the Steps in 360 degree turn test. The other measures (Functional Reach Test, Lateral Reach Test and Timed Stance Test) all demonstrated sufficient reliability, however, the criterion validity of these measures administered via telehealth when compared to face-to-face administration could not be determined due to non-optimal analysis. The mean difference between the telehealth and face-to-face administration of the functional reach test of -1.01 as observed by Russell et al. [39] lies within the limits of agreement of -2.71 to 0.69. This is also within the clinically acceptable limit of 4.74cm (Smith *et al.* 2004), supporting telehealth administration of the functional reach test (Bland and Altman 1999). Similarly, the mean difference observed between the telehealth and face-to-face administration of the lateral reach test (Russell *et al.* 2013) of -0.79 is within the reported limits of agreement (-2.09 to 0.51) and clinically acceptable limit (4.74cm) (Smith *et al.* 2004), which supports this measure being administered via telehealth. Finally, the mean difference of 0.44 (Russell *et al.* 2013) between the timed stance tests when administered via telehealth compared to face-

to-face administration is also within the limits of agreement (-4.17 to 5.06) and is less than the clinically acceptable limit (8.00 seconds). Therefore, it can be reasonably assumed that the telehealth administration of the timed stance test is valid when compared to face-to-face administration.

### **2.6.7 Functional capacity measures**

Other measures included in the review which measured various aspects of general functional capacity included the European Stroke Scale, Unified Parkinson's Disease Rating Scale, Functional Independence Measure and Nine Hole Peg Test. The most robust results were reported for the Functional Independence Measure and the Unified Parkinson's Disease Rating Scale which both demonstrated sufficient reliability and criterion validity. However, as the Unified Parkinson's Disease Rating Scale is a population-specific measure, the Functional Independence Measure may be more appropriate for various chronic populations. While the Nine Hole Peg Test demonstrated sufficient reliability, the criterion validity was indeterminate due to non-optimal analysis. However, the mean differences of 0.25 seconds (right hand) and 0.14 seconds (left hand) observed between telehealth administration and face-to-face administration of the measure were both within the limits of agreement of -2.02 to 1.52 (right hand) and -1.34 to 1.05 (left hand), which is encouraging. Evidence for the reliability and criterion validity of the European Stroke Scale administered via telehealth is yet to be determined due to the lack of information available and non-optimal analysis.

## **2.7 Discussion**

This systematic review identified five studies which examined the psychometric properties of fifteen performance-based measures of physical function administered via telehealth among people with various chronic conditions. Overall, there is low-very low evidence

demonstrating sufficient reliability and criterion validity for a range of measures across each domain of exercise capacity, strength, balance, and functional capacity when administered via telehealth and compared to face-to-face administration. The overall quality of evidence was low-very low, reflecting the small number of studies, the small sample sizes of the included studies and non-optimal analyses (i.e., failure to correlate scores with the reference standard face-to-face administration method) as per the COSMIN risk of bias tool. The findings of sufficient reliability and criterion validity when administered via telehealth mirror that reported when many measures are administered among chronic populations in a face-to-face environment, including the 6MWT (Singh *et al.* 2014; Uszko-Lencer *et al.* 2017) and the grip strength test (Lamers *et al.* 2014; Bobos *et al.* 2020), as well as the Berg Balance Scale, TUGT and Step Test (Hill *et al.* 1996; Blum and Korner-Bitensky 2008; Jácome *et al.* 2016; Mesquita *et al.* 2016; Christopher *et al.* 2021). As per COSMIN guidance, in order to demonstrate ‘sufficient’ validity the measure administered via telehealth must demonstrate  $>0.70$  correlation with the measurement when administered in a face-to-face setting. While the included measures which appeared to be valid when compared to face-to-face administration, the correlations were not calculated and therefore there was not sufficient information to classify the criterion validity as ‘sufficient’ as per the COSMIN standards. Also, the quality of the included studies were downgraded for this same reason. Therefore, these findings should be interpreted with caution. Although the included studies did not report on all measurement properties for each measure, sufficient evidence was reported for the reliability and criterion validity of some measures across several domains. No evidence regarding the measurement error or responsiveness of the included measures was reported in the included studies.

## **2.8 Strengths and Limitations**

Strengths of this review include the prospective protocol registration, following PRISMA guidance, as well as using two reviewers for screening, shortlisting and data extraction. A particular strength is using the COSMIN approach, which had not been used in previous psychometric evaluations for performance measures via telehealth. There were also some limitations to be acknowledged. As previously stated, two independent reviewers screened a sample of 30% of abstracts and relevant full texts to determine eligibility. As good agreement was achieved on the 30% sample, the remaining screening process was not performed in duplicate. Although the quality of the summarised evidence was rated using the modified GRADE approach by two independent reviewers, neither of these reviewers were formally trained in the use of this method. Due to the heterogeneous nature of the included measures and the populations of the included studies, a meta-analysis could not be performed, and the results could not be quantitatively summarised. As the majority of the results could not be combined, best evidence synthesis was mostly obtained from a single study. Further evidence may have been identified from studies of post-operative populations, such as individuals post total knee arthroplasty (Cabana *et al.* 2010). However, these were excluded as pain and disability levels immediately post-operatively, and how much these change relatively quickly, are quite different from other chronic conditions where physical function may be more stable over time. There was limited information reported regarding the characteristics of the samples in the included studies in relation to aspects such as socioeconomic status, cognitive status and technological literacy. Also, the included studies were all carried out in countries with ‘very high’ Human Development Index scores (World Population Review 2022). These factors could potentially impact the external validity of the findings. Although Cox *et al.* (2013) reported the usability of the three minute step test administered via telehealth and Hwang *et al.* (2017b) reported some information regarding the number and nature of

technical issues encountered during telehealth administration of the 6MWT, TUGT and grip and pinch strength, there was limited information reported in the included studies regarding the interpretability and feasibility of the included measures when administered via telehealth. As noted in the eligibility criteria, this review was concerned with examining the validity of measures administered via telehealth when compared to face-to-face administration of the same measure. Therefore, other types of validity, such as content and construct validity, were not reported in this review. Due to the eligibility criteria and aims of this review, the outcomes of interest were reliability, measurement error and criterion validity. For this reason, we followed COSMIN recommendations for evaluating reliability, measurement error and criterion validity but a priori did not choose to evaluate other types of validity, internal structure, interpretability, and feasibility.

## **2.9 Clinical Implications**

Encouragingly, several performance-based measures of physical function across different domains (e.g., exercise capacity, strength, and balance) may have satisfactory reliability and criterion validity when used in a telehealth environment. Furthermore, the psychometric properties of these measures appear similar to that reported for the same measures when used in a face-face context. This should reassure clinicians that using performance-based measures of physical function via telehealth is possible. However, this evidence is of low-very low quality and there is a significant lack of information regarding the measurement error and responsiveness of these measures. Furthermore, information regarding the interpretability and feasibility of the included measures was very limited (Cox *et al.* 2013; Hwang *et al.* 2017b).

## **2.10 Future Research**

This systematic review highlights the need for further larger, high-quality research, in line with COSMIN guidance, exploring the psychometric properties of performance-based measures of physical function administered via telehealth among people with various chronic conditions. In particular more studies examining the measurement error, responsiveness, interpretability and feasibility of these instruments are required. Although some of the measures included in this review demonstrated sufficient reliability and validity, none of the measures were evaluated with respect to all measurement properties and therefore strong recommendations cannot yet be made. Additionally, the lack of studies exploring the administration of performance-based measures of physical function via telehealth among chronic musculoskeletal populations is acknowledged. Therefore, this review highlights the need for future studies to be conducted in this population.

## **2.11 Conclusion**

A wide range of performance-based measures measuring various domains of physical function administered via telehealth among chronic populations have been identified in this review. All of these measures appear to be reliable when used in a telehealth environment. Validity of these measures is less certain, and there is no information regarding the measurement error or responsiveness of these measures. Further high-quality research is required to examine the psychometric properties of a core set of measures administered via telehealth among people with chronic health conditions, particularly regarding measurement error, responsiveness, feasibility, and interpretability.

## **2.12 Acknowledgements**

We acknowledge the support of Liz Dore, Faculty of Education and Health Sciences librarian at the Glucksman Library in the University of Limerick, for her assistance with the development of the search strategy.

## 2.13 Addendum

The search for this systematic review was completed in June 2022. However, given the topical nature of telerehabilitation following the COVID-19 pandemic, we anticipated that there may be more relevant research available at the time of thesis submission (September 2024). Working within the scope of the PhD resources, a pragmatic approach involving a review of the citations of the studies included in the review to identify relevant studies published since our systemic review was deemed appropriate. Using this approach to update the findings of our review for the thesis, we identified four relevant studies examining the psychometric properties of performance-based measures of physical function administered via telehealth among people with chronic health conditions which have been published (Lawford *et al.* 2022; Pepera *et al.* 2023; Aily *et al.* 2024; Tsen *et al.* 2024).

Two of these studies examined the psychometric properties of outcome measures administered among chronic musculoskeletal populations (Lawford *et al.* 2022; Aily *et al.* 2024). The other studies examined measures administered among people with dementia (Tsen *et al.* 2024) and diabetes (Pepera *et al.* 2023) respectively. The characteristics of the studies and the performance-based measures of physical function examined in the studies are presented in Table 2.4. The measurement properties of the included performance-based measures in the studies are presented in Table 2.5.

Additionally, Aily *et al.* (2024) also reported the occurrence of technical issues when administering these measures via telehealth. Of the 32 telehealth assessments conducted, technical issues occurred in 11 (34.4%). These issues included internet instability, hearing deficiency (3.1%), headphone drop-outs (9.4%), auditory clarity (6.2%), video freezing, and transmission delays (12.5%). No adverse events were reported.

The results of these studies largely align with the findings of our systematic review that a range of performance-based measures of physical function may be administered via telehealth among people with chronic conditions. The additional studies suggest that the 30CST, Stair Climb Test, Calf Raise Test, TUGT and Step Test may have satisfactory reliability and criterion validity when used in a telehealth environment. Similarly to the studies included in the systematic review, most of these studies contain small sample sizes and limited information regarding feasibility, interpretability, and measurement error. Therefore, while the results of these studies are encouraging and they identify additional measures that may be appropriate for use in telehealth environments, it is still not possible to make strong conclusions and recommendations regarding the most appropriate measurement instrument for use in telerehabilitation interventions.

Table 2.4 Study characteristics

Study	Country	Performance Measure	Physical Function Domains	Telehealth Environment	Equipment Required	Participant Population	Mean age $\pm$ SD (range)	Rater Population	Measurement Properties Assessed
(Aily <i>et al.</i> 2024)	Brazil	40-metre fast-paced walk test, 30CST, Stair Climb Test, TUGT	Exercise capacity, functional balance and mobility	Administered via synchronous videoconferencing platform by clinician in a separate room to the participant within the same building	TUGT: Stopwatch, standard chair (approx. 43cm) with armrests, 3-metre walkway marked, 30CST: timer and stopwatch, standard chair (approx. 43cm) with armrests Stair Climb: flight of 12 stairs with 18cm steps and handrails 40-metre fast-paced walk: stopwatch, 10m marked walkway, cones	N=32 adults with knee osteoarthritis, N= 17 females, N= 15 males	56.0 years $\pm$ 8.0 years	N= 2 qualified physical therapists with at least 6 years of experience	Inter-rater reliability, intra-rater reliability, criterion validity
(Lawford <i>et al.</i> 2022)	Australia	30CST, 5-metre fast-paced walk test, Stair Climb Test, TUGT, Timed Single-leg Stance Test, Calf Raises	Exercise capacity, functional balance and mobility, functional strength	Administered using synchronous videoconferencing platform by clinicians in a separate building to the participant	30CST: Timer/stopwatch, straight back chair 40-51cm Stair Climb: timer/stopwatch, flight of stairs with minimum 4 steps TUGT: timer/stopwatch, straight back chair 40-51cm, tape measure, cone/marker marking 3 metres from chair Step Test: timer/stopwatch, step	N= 57 adults with chronic lower limb msk pain, N= 40 females, N= 17 males	63.1 years $\pm$ 9.3 years	N= 4 registered physiotherapists with at least one year of clinical experience	Intra-rater reliability, criterion validity

					approx. 12-23cm in height				
(Pepera <i>et al.</i> 2023)	Greece	6MWT	Exercise capacity	Administered using synchronous videoconferencing platform by a clinician in a remote location to the participant	30-metre walking track with hard level surface	N= 28 adults with Diabetes Mellitus Type 2, N= 21 males, N= 7 females	61 years ± 13 years	N= 1 qualified physiotherapist	Intra-rater reliability, criterion validity
(Tsen <i>et al.</i> 2024)	Brazil	SPPB, TUG, TUG-DT, 30CST	Functional mobility and balance, exercise capacity	Administered using synchronous videoconferencing platform by a clinician in a remote location to the participant	SPPB: chair with armrests, plastic water bottle, measuring tape, adhesive tape for marking, stopwatch 30CST: chair without armrests, stopwatch TUGT: chair with armrests, plastic water bottle, adhesive tape for marking. Stopwatch TUGT-DT: chair with armrests, plastic water bottle, measuring tape, adhesive tape for marking, stopwatch	N= 43 adults with dementia diagnosed according to DSM V diagnostic criteria, N= 35 females, N= 8 males	78.72 years ± 6.27 years	N=2 physiotherapists	Inter-rater reliability, intra-rater reliability

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6MWT= 6 Minute Walk Test, 30CST= 30-second Chair Stand Test, msk= musculoskeletal, SPPB= Short Physical Performance Battery, TUGT= Timed Up and Go Test, TUGT-DT= Timed Up and Go Test Dual Task

Table 2.5 Measurement properties of measures

Performance-based Measure	Reliability				Criterion Validity	
	Result	Design	Time Interval	Overall Rating	Result	Overall Rating
<b>Exercise Capacity</b>						
40-metre Fast-paced Walk Test (Aily <i>et al.</i> 2024)	ICC 0.97	Inter-rater	Same day	+	MD (95% CI) -0.06 (-0.12-0.00) seconds	?
	ICC 0.98	Intra-rater	6 weeks	+		
5-metre Fast-paced Walk Test (Lawford <i>et al.</i> 2022)	ICC 0.71	Intra-rater	2 weeks	+	ICC (95% CI) 0.55 (0.30-0.72)	-
					MD (95% CI) -0.4 (-0.6- -0.1) seconds	
30CST (Aily <i>et al.</i> 2024)	ICC 0.99	Inter-rater	Same day	+	MD (95% CI) -0.22 (-0.60-0.17) times	?
	ICC 1.00	Intra-rater	6 weeks	+		
30CST (Lawford <i>et al.</i> 2022)	ICC 0.77	Intra-rater	2 weeks	+	ICC (95% CI) 0.82 (0.71-0.90)	+
					MD (95% CI) 0.6 (0.0-1.3) times	
30CST (Tsen <i>et al.</i> 2024)	ICC 0.981	Inter-rater	Same day	+		
	ICC 0.997	Intra-rater	2 weeks	+		
Stair Climb Test (Aily <i>et al.</i> 2024)	ICC 0.98	Inter-rater	Same day	+	MD (95% CI) -0.31 (-0.89-0.26) seconds	?
	ICC 0.99	Intra-rater	6 weeks	+		
Stair Climb Test (Lawford <i>et al.</i> 2022)	ICC 0.91	Intra-rater	2 weeks	+	ICC (95% CI) 0.75 (0.52-0.88)	+
					MD (95% CI) -0.0 (-0.1-0.1)	
6MWT (Pepera <i>et al.</i> 2023)	ICC 0.98	Intra-rater	5 days	+	Pearson's r= 0.76	+
					MD 24.4 (± 60.6) metres	
<b>Strength Tests</b>						
Calf Raise Test (Lawford <i>et al.</i> 2022)	Both legs: ICC 0.84	Intra-rater	2 weeks	+	Both legs: ICC (95% CI) 0.82 (0.71-0.89)	+
	Left leg: ICC 0.84			+	MD (95% CI) 0.6 (-0.9-2.1)	
	Right leg: ICC 0.85			+	Left leg: ICC (95% CI) 0.91 (0.85-0.95)	
					MD (95% CI) 0.4 (-0.8-1.6)	+
					Right leg : ICC (95% CI) 0.87 (0.77-0.92)	
					MD (95% CI) 1.5 (-0.1-3.1)	+
<b>Functional balance and mobility tests</b>						
TUGT (Aily <i>et al.</i> 2024)	ICC 0.95	Inter-rater	Same day	+	MD (95% CI) -0.22 (-0.46-0.03) seconds	?
	ICC 0.95	Intra-rater	6 weeks	+		
TUGT (Lawford <i>et al.</i> 2022)	ICC 0.86	Intra-rater	2 weeks	+	ICC (95% CI) 0.81 (0.69-0.88)	+
					MD (95% CI) -0.2 (-0.5-0.2)	

Performance-based Measure	Reliability				Criterion Validity	
	Result	Design	Time Interval	Overall Rating	Result	Overall Rating
TUGT (Tsen <i>et al.</i> 2024)	ICC 0.998	Inter-rater	Same day	+		
	ICC 0.999	Intra-rater	2 weeks	+		
TUGT-DT (Tsen <i>et al.</i> 2024)	ICC 0.999	Inter-rater	Same day	+		
	ICC 1.000	Intra-rater	2 weeks	+		
Step Test (Lawford <i>et al.</i> 2022)	Left leg: ICC 0.79	Intra-rater	2 weeks	+	Left leg: ICC (95% CI) 0.75 (0.57-0.86)	+
	Right leg: ICC 0.81			+	MD (95% CI) 0.9 (0.3-1.5)	
					Right leg : ICC (95% CI) 0.79 (0.63-0.88)	+
					MD (95% CI) 0.9 (0.3-1.4)	
Timed Single-leg Stance Test (Lawford <i>et al.</i> 2022)	Left leg: ICC 0.69	Intra-rater	2 weeks	-	Left leg: ICC (95% CI) 0.82 (0.71-0.89)	+
	Right leg: ICC 0.84			+	MD (95% CI) 0.4 (-1.0-1.9)	
					Right leg : ICC (95% CI) 0.71 (0.55-0.82)	+
					MD (95% CI) -1.2 (-3.0-0.6)	
<b>Functional Capacity Tests</b>						
SPPB (Tsen <i>et al.</i> 2024)	ICC 0.831	Inter-rater	Same day	+		
	ICC 0.862	Intra-rater	2 weeks	+		

6MWT= 6 Minute Walk Test, 30CST= 30-second Chair Stand Test, CI= Confidence Interval, ICC= Intraclass Correlation Coefficient, MD= Mean Difference, SPPB= Short Physical Performance Battery, TUGT= Timed Up and Go Test, TUGT-DT= Timed Up and Go Test Dual Task

**Chapter 3. Exploring attitudes of people with chronic health conditions towards the use of group-based telerehabilitation: A qualitative study**

This chapter has been published in '*Clinical Rehabilitation*; Q1, Impact Factor 2.884.

Barry Walsh, C., Cahalan, R., Hinman, R.S. and O'Sullivan, K. (2024) 'Exploring attitudes of people with chronic health conditions towards the use of group-based telerehabilitation: A qualitative study', *Clinical Rehabilitation*, 38(1), pp.130-142.

### **3.1 Chapter Outline**

The design and development of a disease-agnostic telerehabilitation programme for people with chronic conditions is a central element of this thesis. In the previous chapter, several performance-based measures of physical function that can be used in telerehabilitation programmes for people with chronic conditions were identified. This chapter explores the attitudes and perspectives of service users towards the use of telerehabilitation programmes, and their preferences for future telerehabilitation programmes. This chapter also explores the acceptability of a proposal of a generic telerehabilitation programme for groups of people with different chronic conditions. This chapter provides information regarding the benefits, challenges, barriers, and facilitators associated with telerehabilitation programme engagement, as perceived by people with chronic conditions. It also provides information regarding the preferred design, delivery methods, and characteristics of telerehabilitation programmes by people with chronic conditions. By gathering valuable information regarding the current perspectives and preferences of people with chronic conditions, this chapter informs the development of the subsequent chapters, particularly the design of the TECC intervention.

In Chapters Three and Four the term ‘generic’ is used to describe interventions delivered to groups with mixed chronic conditions. On reflection, and on the advice of our international colleagues who are leaders in this field, we chose to use the term ‘disease-agnostic’ to describe these interventions in later parts of the thesis. We believe that this term best reflects the nature of the TECC programme which involves people with a range of chronic conditions, regardless of the specifics of their individual diseases.

### **3.2 Abstract**

## **Objective**

To explore the attitudes of people with chronic health conditions towards the use of group-based telerehabilitation.

## **Design**

A qualitative research study.

## **Setting**

The setting involved semi-structured focus groups via videoconferencing software.

## **Participants**

A purposive sample of 18 people with chronic health conditions including cardiorespiratory, neurological and musculoskeletal conditions was recruited via national patient advocacy and support groups in Ireland and clinical contacts. The sample included both those who had, and had not, previously engaged in telerehabilitation programmes.

## **Procedures**

An online questionnaire collected demographic information and data regarding previous telerehabilitation participation and telerehabilitation preferences. Focus groups were conducted using videoconferencing software, in accordance with the Consolidated Criteria for Reporting Qualitative Research (COREQ) Checklist, and analysed using thematic analysis following Braun and Clarke's methodology. Findings were triangulated with quantitative questionnaire data.

## **Results**

Four focus groups were conducted including participants with chronic cardiorespiratory (n=8), neurological (n=6) and musculoskeletal (n=4) conditions. Three themes were identified regarding telerehabilitation: (a) benefits and facilitators (including convenience, increased service accessibility, social connection and technological support), (b) challenges and barriers (including technological access and literacy, limited ‘hands-on’ therapy, safety concerns and social limitations), and (c) preferences (regarding mode of delivery, content, duration and generic programmes for mixed-condition groups).

## **Conclusions**

Telerehabilitation is convenient for people with chronic conditions; however, concerns exist regarding the use of technology and the limitations of this healthcare delivery method. The role of telerehabilitation is valued, and future programmes should acknowledge patient preferences including a hybrid model of care, exercise and educational content, social interaction, and synchronous components.

### 3.4 Introduction

Chronic conditions, including cardiorespiratory (CR), neurological and musculoskeletal (MSK) conditions, are a leading cause of morbidity and disability worldwide (Darker *et al.* 2015). The increasing prevalence and burden of chronic disease present a significant socioeconomic burden and challenges health care services (Hernández *et al.* 2019). Group rehabilitation programmes emphasising patient education and exercise are an integral aspect of chronic condition management (Bolton *et al.* 2013; Price *et al.* 2013; Long *et al.* 2019). Nevertheless, healthcare services often lack the capacity to deliver these programmes, while patient engagement can be affected by barriers such as time and travel limitations (Desveaux *et al.* 2016; Oates *et al.* 2019). Telerehabilitation (rehabilitation via telecommunication technologies such as videoconferencing or telephone calls) can increase service accessibility and patient engagement by overcoming barriers to traditional in-person rehabilitation. Furthermore, telerehabilitation is as effective as traditional in-person rehabilitation for many people with chronic conditions (Bourne *et al.* 2017; Cottrell *et al.* 2017a; Jiang *et al.* 2018). The recent COVID-19 pandemic accelerated the adoption of telerehabilitation for patients with many health conditions. Notwithstanding the potential benefits of telerehabilitation, resistance has been demonstrated by both patients and healthcare providers, leading to reduced uptake of these services (Kruse *et al.* 2017). Despite clinical heterogeneity between diverse chronic conditions, their recommended self-management programmes are similar, often consisting of progressive exercise training and education to optimise general health (Hevey *et al.* 2020). While there is plentiful research investigating single-condition rehabilitation programmes (e.g. cardiac rehabilitation) (Rawstorn *et al.* 2016; Selzler *et al.* 2018; Dias *et al.* 2021), recent evidence points to the potential efficacy of generic rehabilitation programmes which include patients with a diverse range of chronic conditions

(Barker *et al.* 2018; Hevey *et al.* 2020; Taylor and Singh 2021). Patient attitudes towards telerehabilitation have been explored in condition-specific cohorts (Hinman *et al.* 2017; Hwang *et al.* 2017a; Tyagi *et al.* 2018; Knudsen *et al.* 2021). However, less is known about how patients perceive generic group telerehabilitation programmes designed for a range of chronic health conditions. Therefore, the aim of this research is to explore the attitudes of people with a range of chronic health conditions towards group-based telerehabilitation and the acceptability of generic telerehabilitation programmes.

### **3.5 Methods**

This study employed a qualitative approach involving online, semi-structured focus groups and was conducted and reported in accordance with the Consolidated Criteria for Reporting Qualitative Research (COREQ) Checklist (Appendix 8.1.6) (Tong *et al.* 2007). Ethical approval for this study was granted by the Faculty of Education and Health Sciences Research Ethics Committee in the University of Limerick (EHSREC 10\_RA01). We recruited a diverse sample of adults with chronic health conditions, including both those who had and had not previously engaged in condition-specific telerehabilitation programmes, using a purposive sampling technique. A diverse sample was sought to ensure a range of chronic health conditions were included, specifically participants with CR, neurological and MSK conditions. All participants had undertaken some form of condition-specific rehabilitation previously, in various settings, including in-person, telerehabilitation, group and individual settings. Participants were recruited via national patient advocacy and support groups in Ireland that serve these patient cohorts, as well as the clinical contacts of the authors. Patient advocacy and support group leaders were contacted by email outlining the research project and were provided with invitation leaflets outlining the study aims and the eligibility criteria (Appendix 8.2.1). These were then shared with potential participants via relevant

social media and telecommunication platforms to seek expressions of interest. Interested participants who contacted the authors were then provided with a patient information leaflet containing further detail regarding the study processes and eligibility details (Appendix 8.3.1). Participants were eligible for inclusion if they were aged 18 years or older, had fluent spoken or written English, and had a diagnosis of any chronic CR, neurological or MSK condition. Therefore, people with acute orthopaedic, mental health or cancer diagnoses (for example) were not eligible. Participants were contacted by email to ensure they had read and understood the information leaflet and to address any outstanding concerns. Interested individuals then provided online consent and were provided with an invitation to the online focus group (Appendix 8.4.1). In advance of the focus groups, participants completed brief online questionnaires to collect demographic data and their thoughts on telerehabilitation programmes. The online questionnaire collected demographic information including participants' age, sex, chronic health condition(s), previous telerehabilitation experience and future telerehabilitation preferences including acceptability of generic telerehabilitation programmes for individuals with various chronic conditions. The questionnaire included multiple choice questions and statements using a five-point Likert scale to indicate participant levels of agreement to collect data regarding preferences for future telerehabilitation programmes and acceptability of a generic telerehabilitation programme (Appendix 8.5.1). Qualitative data were collected through semi-structured focus groups using a videoconferencing platform (Microsoft Teams). Each focus group lasted between 30 minutes and 60 minutes with participants located in their own homes. Focus groups were conducted by the first author (CBW), a female physiotherapist with three years of postgraduate physiotherapy and research experience who was completing PhD research at the University of Limerick exploring the use of telerehabilitation for people with chronic

health conditions. Participants did not have a relationship with the interviewer prior to study commencement. Options to use telephone calls were available if participants did not have access to video conferencing software. This was to ensure participation by individuals with a range of technological access and abilities; however, all participants opted to engage using the videoconferencing platform. Four focus groups were conducted according to the following patient groupings: (a) one focus group included CR patients only (n=6 participants), (b) one included neurological patients only (n=4), (c) one included MSK patients only (n=3), and (d) one was conducted with a mixed patient group (n=5) consisting of patients with various chronic health conditions from across the three domains. The focus groups were purposefully structured to include both condition-specific and mixed-condition focus groups to encourage peer interaction and conversation to stimulate and inspire diverse thoughts and perspectives. The questions were based on an interview guide (Appendix 8.6.1) based on the author's clinical and research experience and previous literature (Cranen *et al.* 2012; Hwang *et al.* 2017a; Shulver *et al.* 2017; Tyagi *et al.* 2018). The interview guide included open-ended questions to explore participants' attitudes towards and previous experiences of participating in telerehabilitation and their preferences for future programmes and attitudes towards a generic telerehabilitation programme for individuals with various chronic health conditions. The questionnaire and interview guide were pilot tested with an individual with a chronic health condition in advance of conducting the focus groups. Recruitment occurred concurrently with data collection. Data collection was ceased when the authors felt confident of having reached data saturation, referring to the point at which new data collected from the focus groups repeated what was expressed in previous data (Saunders *et al.* 2018). Therefore, the sample size was also determined by data saturation (Guest *et al.* 2017). Focus groups were video recorded for accuracy of transcription using the Microsoft Teams platform.

Baseline demographic data and information pertaining to attitudes towards telerehabilitation collected in the questionnaire were analysed descriptively. Qualitative data were automatically transcribed using Microsoft Teams software. Thereafter, the first author (CBW) checked the transcripts and edited minor errors relating to sound quality and accent variation, by comparing the transcripts to the video recordings. Transcripts were returned to focus group participants for comment or correction to ensure accuracy. A bottom-up thematic analysis, using the principles of grounded theory, was conducted on data collected through the focus groups (Braun and Clarke 2006). The transcripts were initially reviewed by CBW to familiarise with the data. Transcripts were then coded to identify patterns in the data. The transcripts were also reviewed by a second author (RC; a physiotherapist with qualitative research experience) and coded to identify patterns in the data. Both authors independently organised the codes into categories and developed a list of themes and subthemes. A codebook of themes and subthemes were discussed and agreed upon collaboratively by all research team members. A sample of 40% of the collected data were then re-coded individually by two independent authors (CBW and RC) using the established codebook to ensure agreement. As a high level of agreement between coders was demonstrated, the remainder of the data was coded by one independent author using the established themes and subthemes. Qualitative findings were triangulated with relevant quantitative questionnaire data to ensure trustworthiness. Data management and analysis were supported using Microsoft Word and Excel software for organisation, storage and analyses by CBW and RC.

### **3.6 Results**

A total of 18 participants with chronic health conditions, including 10 males (55.6%), with a mean (SD) age of 58.7 (12.8) years, were recruited. Due to the method of recruitment, the

number of people who were contacted to participate is unknown. Therefore, it was not possible to calculate a participation rate. Participant characteristics are described in Table 3.1. The primary chronic health conditions reported were CR (n=8 (44.4%)), neurological (n =6 (33.3%)) and MSK (n=4 (22.2%)). A total of 12 participants (66.7%) also had other chronic conditions; 11 participants (61.1%) had previously participated in telerehabilitation programmes. Of these 11 participants, synchronous modes of telerehabilitation (e.g., live telephone or video calls) were more commonly reported than asynchronous modes of telerehabilitation (e.g., pre-recorded videos, images, etc.). Patient preferences for future telerehabilitation programmes are displayed in Figure 3.1. In total, 11 participants (61.1%) stated a preference for a programme which included a mixture of both synchronous and asynchronous content, while the remaining participants (n=7 (38.9%)) stated preference for a synchronous mode of delivery (e.g., live videoconferencing) scheduled for a specific time. No participants stated a preference for future programmes that were entirely asynchronous; 14 participants (77.8%) stated that they would prefer a hybrid model including a combination of telerehabilitation and in-person rehabilitation if they were to engage in telerehabilitation in the future. The remaining participants (n=4 (22.2%)) stated preference for a full telerehabilitation programme delivered remotely via telehealth. The qualitative results are outlined through key themes and subthemes as outlined in Figure 3.2. The three key themes include (a) benefits and facilitators, (b) challenges and barriers and (c) preferences.

**Table 3.1 Participant characteristics (N= 18).**

<b>ID</b>	<b>Age (years)</b>	<b>Gender</b>	<b>Participant Location</b>	<b>Primary Health Condition</b>	<b>Other Chronic Conditions</b>	<b>Previous participation in TR</b>	<b>Mode of TR previously used</b>
P01	53	Male	Rural	Cardiorespiratory	Musculoskeletal	Yes	Synchronous & remote monitoring
P02	78	Male	Rural	Cardiorespiratory	None	Yes	Synchronous & remote monitoring
P03	61	Male	Rural	Cardiorespiratory	Cardiorespiratory, Musculoskeletal, Diabetes	Yes	Synchronous
P04	69	Female	Rural	Cardiorespiratory	Gastrointestinal, Musculoskeletal	No	N/A
P05	68	Male	Rural	Cardiorespiratory	Cardiorespiratory, Musculoskeletal	No	N/A
P06	77	Male	Urban	Cardiorespiratory	None	Yes	Synchronous
P07	40	Female	Rural	Neurological	Cardiorespiratory, Musculoskeletal	Yes	Synchronous & asynchronous
P08	41	Female	Urban	Neurological	Cardiorespiratory, Gastrointestinal	Yes	Synchronous, asynchronous & remote monitoring
P09	53	Female	Urban	Neurological	None	Yes	Synchronous & asynchronous
P10	62	Female	Urban	Neurological	None	Yes	Synchronous
P11	67	Male	Rural	Neurological	Gastrointestinal	No	N/A
P12	42	Female	Urban	Musculoskeletal	Neurological	No	N/A
P13	73	Female	Urban	Cardiorespiratory	Gastrointestinal	No	N/A
P14	53	Male	Urban	Neurological	Neurological	Yes	Synchronous
P15	54	Female	Urban	Musculoskeletal	Cardiorespiratory	Yes	Synchronous
P16	61	Male	Rural	Musculoskeletal	None	No	N/A
P17	37	Male	Urban	Musculoskeletal	None	Yes	Synchronous
P18	67	Male	Urban	Cardiorespiratory	Musculoskeletal, Neurological	No	N/A

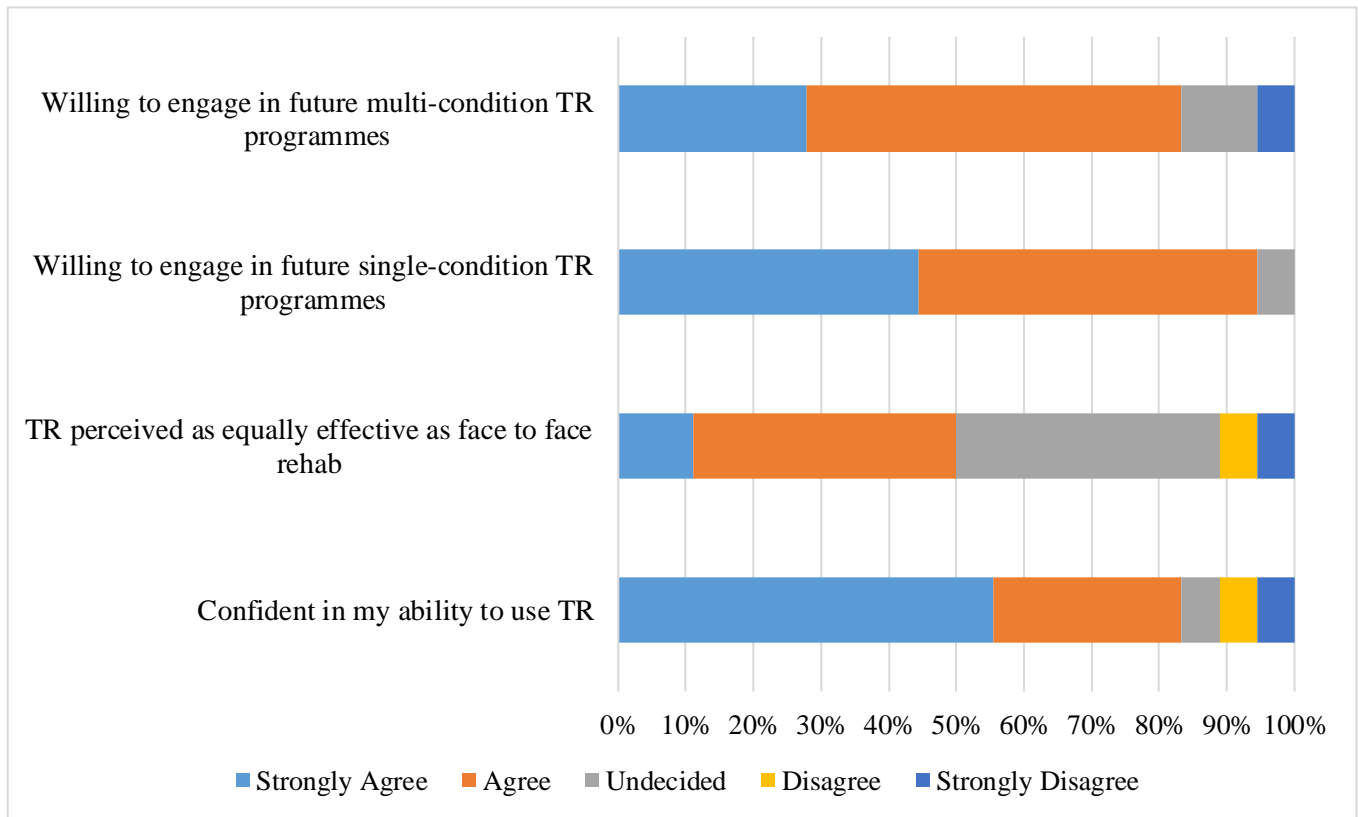


Figure 3.1 Participant attitudes towards engaging in telerehabilitation programmes.

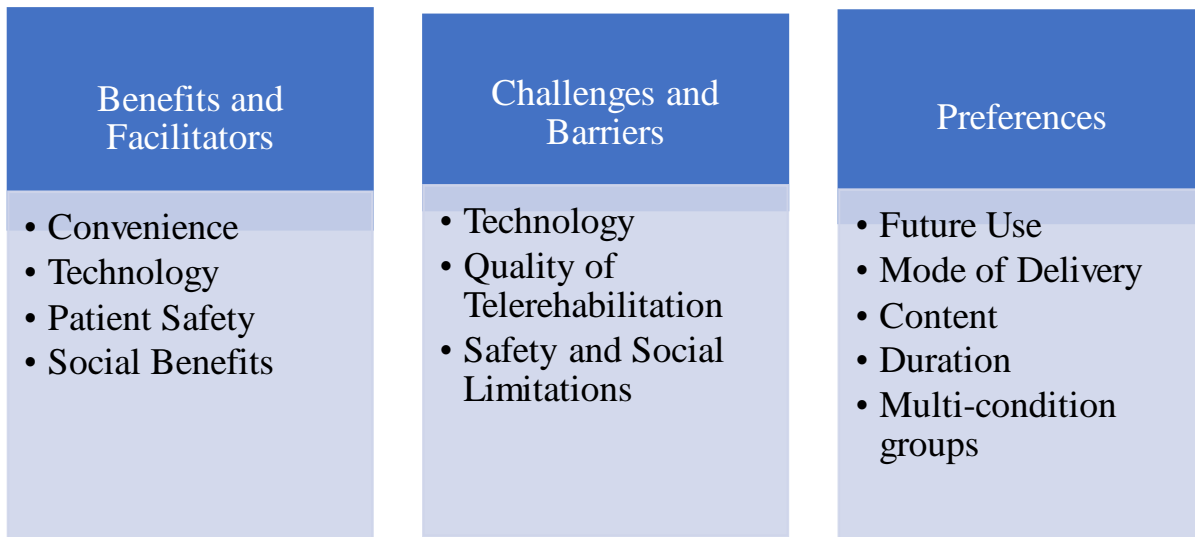


Figure 3.2 Key themes and subthemes

### **3.6.1 Benefits and Facilitators**

#### *3.6.1.1 Convenience*

Convenience was stated as a major benefit of telerehabilitation in each focus group. Participants noted the increased accessibility of rehabilitation services and the benefit of avoiding the need to travel to specific locations to attend in-person rehabilitation sessions. Benefits included the absence of fatigue associated with travel to rehabilitation locations and the cost savings to patients by eliminating fuel costs for patients and rental costs associated with the delivery of traditional rehabilitation for healthcare providers and patient advocacy and support groups.

“Convenience...then like, just not having to go somewhere for me was big thing...And also then I suppose it was mainly about not having to travel.” (Participant (P)16, male (M), MSK)

The convenience of participating from the safety and comfort of one’s own home, particularly when unwell, was also cited.

“It’s great if you’re not feeling well, you don’t have to get up and get out, you can actually attend the classes at home, and in the comfort of your own home, you don’t have to be going out in the rain to go to a hall.” (P03, M, CR)

#### *3.6.1.2 Technology*

Participants believed that technology has the ability to increase accessibility of rehabilitation and is ‘*not region bound*’ (P02, M, CR). This could provide patients with access to rehabilitation services which may not be delivered in their immediate geographic area. Participants value the benefit of being able to access video recordings of rehabilitation sessions at their own convenience via technology to review rehabilitation content and facilitate exercise performance.

“Plus, the fact that a lot of you know we say the physio and all that is all gone up online now so you can go back and check it again. You know if you don’t make the class today you can do it online again.” (P09, F, N)

The positive impact of external technical support from family members and friends to facilitate patient engagement with telerehabilitation was highlighted. The impact of the provision of training and education on the use of technology to facilitate engagement among patients with chronic health conditions with telerehabilitation was discussed. Leaders in patient groups stated:

“We need somebody to go in more than once a week for the first month maybe, and teach them (patients) how to use the device and I think it will work then once the right people get them...That’s what we need.” (P04, F, CR)

#### *3.6.1.3 Patient Safety*

As evident during the recent COVID-19 pandemic, telerehabilitation offered an opportunity for patients to access classes without the risk of spreading infection or additional threats to their health.

“There’s no fear of catching the virus through meeting up with a group, so the zoom is really safe.” (P03, M, CR)

Participants also commented on the strategies that optimised patient safety during telerehabilitation, including strategies to limit the risk of falls and injuries.

“With the online they ask for a contact number...So they’ve got the backup number, the emergency number to contact if I did fall or hurt myself.” (P13, F, CR)

The benefit of increased personal attention received from instructors in telerehabilitation classes and how this can be maximised in smaller group classes was also raised.

#### *3.6.1.4 Social Benefits*

The majority of participants commented on the social benefits and connection that telerehabilitation provided, in particular the potential to establish and maintain new connections and relationships. The benefit of this connection particularly for vulnerable, isolated participants was discussed.

“I have friends in most other parts of the country, that I didn’t know existed. That’s what this is about. It brings the whole country together. I think it’s the connection for people...especially during winter when older people can’t get out, or many of us (can’t).” (P04, F, CR)

### **3.6.2 Challenges and Barriers**

#### *3.6.2.1 Technology*

The challenges associated with the use of technology, and how this created a barrier which could potentially reduce engagement, were emphasised across each focus group. Discomfort with technology and the associated fear and anxiety, particularly among elderly patients, adversely affected uptake, and engagement in these programmes.

“Zoom is very good, but we lost about two-thirds of our participants from the face-to-face meeting through the Zoom because they either didn’t have Wi-Fi or didn’t feel comfortable with Zoom.” (P02, M, CR)

Issues with access to technology, devices, Wi-Fi, poor broadband quality, and financial limitations were also cited as challenges and barriers.

“You might get some freezing and things like that so that’s probably a bit of a con as well and then you have to think again in your older population you know Internet access and how tech savvy the older population might be.” (P17, M, MSK)

### *3.6.2.2 Quality of Telerehabilitation*

Participants noted the potential limitations associated with the quality of telerehabilitation. The inability of clinicians to provide “hands-on” assessments and treatments was particularly highlighted by those with chronic MSK conditions. Some participants also raised issues regarding the quality of the interaction between the clinician and patients and the potential for a lack of personal attention from clinicians when delivering rehabilitation remotely.

“How much you’re getting out of the session in terms of value for money because you know you’re not getting a hands-on assessment or you’re not getting a hands-on treatment.” (P17, M, MSK)

The perceived limitations associated with the quality of telerehabilitation treatment converges with the quantitative data (Figure 1) which shows that only half of participants agreed that telerehabilitation is as equally effective as traditional in-person rehabilitation, while the other half of participants were undecided or did not agree with the statement.

### *3.6.2.3 Safety and Social Limitations*

Challenges and concerns relating to patient safety when engaging in telerehabilitation were identified, specifically the pressure that patients felt to push themselves beyond their own limits and ability levels.

“I find it hard to and then I push and I hurt myself afterwards I am like oh my gosh. Maybe that would be easier in a real class to sit back.” (P08)

Some participants also suggested potential danger regarding patient privacy issues and concerns associated with the improvisation of the patients’ environment and equipment including technology devices.

“Yeah, the other one might be I dunno is there a danger around privacy...obviously, you know, there could be perhaps some some risks there.” (P16: MSK)

The social challenges and limitations associated with telerehabilitation were highlighted in all of the focus groups. It was perceived that patients missed out on the social aspect of engaging in rehabilitation when participating via telehealth. They also highlighted the limited social element when telerehabilitation is compared to traditional in-person rehabilitation classes.

“You miss out on the chat and a cup of tea and also the chance for people living alone to actually get out of their house and meet up with their friends. There is a huge difference because when you’re doing classes people are talking to one another and having a laugh, that doesn’t happen on the zoom.” (P03, M, CR)

### **3.6.3 Preferences**

The vast majority expressed preference for the option to engage in telerehabilitation in the future and noted the value of telerehabilitation delivery beyond the COVID-19 pandemic. This converges with quantitative data (Figure 1) which shows that all but one participant agreed that they would be willing to engage in future telerehabilitation programmes with other people with similar chronic health conditions. The neurological cohort particularly expressed interest in engaging in future telerehabilitation programmes following previous positive experiences with well-established programmes. The majority of participants stated that they would prefer to engage in a hybrid model of care including a combination of telerehabilitation and in-person rehabilitation. This converges with quantitative data showing a preference for a hybrid approach to future telerehabilitation programmes (n=14 (78%)) compared to a full telerehabilitation programme delivered remotely via telehealth (n=4 (22%)). A reluctance to replace traditional in-person rehabilitation with a complete telerehabilitation approach was noted.

“I’d go for a mix of the two. Yeah, I’d go for a blend cause I think they have different values for each of them and you know combination of the two to me it would appear most suitable for the kind of needs I have anyway.” (P16, M, MSK)

Differences regarding the preferred mode of telerehabilitation delivery were noted across each group. Most participants commented on the value of synchronous modes of telehealth that facilitate real-time interaction between the telerehabilitation instructor and patients. They noted the value of increased guidance, monitoring and motivation from the healthcare professional when using synchronous modes of telehealth such as real-time telephone and video calls. This converges with quantitative data showing that all participants stated a preference for some synchronous component to be included in future telerehabilitation programmes. The advantage of being able to ask questions to the healthcare provider during synchronous telerehabilitation classes was also reported.

“Well pre-recorded is not a very good idea because I think it should be live. Uh, so we can keep an eye on the people how they are doing. Uh, and ask personal questions as well. So, if you pre-recorded you have no idea what you’re doing.” (P02, M, CR)

Benefits of asynchronous telerehabilitation included the potential to review the content at patients’ own convenience via recorded content, which can facilitate increased exercise performance among patients who may not be able to attend regular classes. Quantitative data shows a preference by the majority of participants (n=11 (61.1%)) for some asynchronous or recorded material to be included along with synchronous content in future telerehabilitation programme.

“If you miss it or you can’t get there at that time having that to fall back on, you know, and a bit of common sense, to take it careful when you’re doing it. Again, it won’t

suit some people. I find it convenient. If I couldn't, if I missed the class to be able to look back.” (P01, M, CR)

Most participants valued group telerehabilitation classes but noted a preference for smaller group sizes to ensure sufficient personal attention for each patient from the healthcare professional leading the class. The MSK cohort noted that they had limited experience in group telerehabilitation settings, with most of their experience consisting of one-to-one telerehabilitation sessions with a healthcare professional.

The composition of future potential telerehabilitation offerings was discussed across the groups. The value of exercise and education, which are typically included in rehabilitation programmes, was noted; however, the inclusion of a social component in programmes was also recommended.

“Yep, we've done our exercises twice a week and every two months or that we'd have somebody, a dietitian or maybe somebody talking even on things like what you are entitled to social welfare and all like that...and every now and again as well we go away for a day and we have a Christmas meal and it's important to make it a social thing as well.” (P03, M, CR)

The majority valued the delivery of telerehabilitation by a healthcare professional, highlighting the value of synchronous telerehabilitation allowing direct communication with the professional. They also suggested that telerehabilitation programmes should include a variety of exercises to promote patient engagement and expressed preference for the inclusion of some form of objective monitoring during telerehabilitation classes and programmes. The CR cohort in particular noted the importance of objectively monitoring clinical parameters during telerehabilitation programmes.

“The approach (to telerehabilitation delivery) does change a bit and so going forward if it was something that you’re looking at to sort of improve or to be able to standardize...maybe the way they monitor the people taking the class at the moment. They just have a look, which is fine to make sure that everyone looks OK, but when you’re doing the official pulmonary rehab with the people from the hospital then you have a little oxygen thing on your finger, and they’ll ask you every so often what your oxygen was like.” (P01, M, CR)

Participants agreed that from previous experience that the standard duration of 45 minutes to 1 hour class length was appropriate for telerehabilitation. There were varied opinions regarding the overall length of programmes. Some expressed a preference for twice weekly classes for a period of 6–8 weeks, while others felt that rolling classes with an ongoing follow-up beyond a 6–8-week period would promote long-term adherence and benefit.

Perspectives regarding generic group telerehabilitation programmes for a range of chronic conditions varied. Similarities in rehabilitation for different chronic health populations such as educational components were noted, in particular by the MSK cohort.

“I think like that general advice kind of, you know, around lifestyle factors...is not just for musculoskeletal conditions or things like that...certainly lifestyle and stress and diet and exercise and things like that... doesn’t necessarily need to be tied to one specific condition.” (P17, M, MSK)

However, concerns were raised regarding how different groups might need different types and intensities of exercise, especially by the CR cohort.

“Some of the exercise we do, uh, they’re pretty strenuous enough like you know, and is it putting pressure on other people that mightn’t be able to do it. Like you know, I know they say sit down if you get tired and all that like.” (P06, M, CR)

Nevertheless, most were open to future generic group rehabilitation if it could be tailored to meet their needs and guided by a healthcare professional. This converges with quantitative data (Figure 1) showing that the majority of participants (n=15 (83.3%)) agreed that they would be willing to engage in future generic telerehabilitation programmes for people with a range of chronic health conditions.

“I wouldn’t mind if people had different conditions as long as the person given the class was doing it properly for everyone there.” (P01, M, CR)

### **3.7 Discussion**

This study provides an insight into the attitudes and preferences of people with chronic health conditions towards the use of group-based telerehabilitation and the acceptability of a generic group telerehabilitation programme for people with different chronic conditions. The perceived benefits of telerehabilitation including convenience, increased accessibility and safety concur with previous international research including elderly patients (Shulver *et al.* 2017), chronic CR (Hwang *et al.* 2017a; Scherrenberg *et al.* 2021), neurological (Tyagi *et al.* 2018) and MSK (Cranen *et al.* 2012) populations. Likewise, barriers and limitations of telerehabilitation including difficulty with the use of technology, social and safety limitations, limited interaction with rehabilitation providers and the lack of a ‘hands-on’ approach have also been cited previously (Eriksson *et al.* 2011; Cranen *et al.* 2012; Hwang *et al.* 2017a; Tyagi *et al.* 2018). Strategies identified to overcome the barriers, including provision of training, education and external support with the use of technology, are consistent with

previous suggestions of strategies to enhance telerehabilitation engagement (Hwang *et al.* 2017a).

Sociodemographic characteristics, lifestyle and general health-related factors have been found to be important predictors of telerehabilitation adherence (Daniore *et al.* 2022; Jakob *et al.* 2022; Harris *et al.* 2023; Kiadaliri *et al.* 2023). Access to, and the appropriateness of, telerehabilitation may be greatest among specific patient cohorts, including those with higher sociodemographic status, digital literacy, intrinsic motivation and self-efficacy levels and general health status. If this is not accounted for, telerehabilitation may reinforce existing healthcare inequities (Simon and Shachar 2021; Price and Simpson 2022). Creative technological, attitudinal, and financial solutions, such as the provision and optimisation of technology and resources, are required to overcome these disparities and optimise delivery for a more diverse sample.

The recent COVID-19 pandemic forced a rapid adoption of telerehabilitation services for people with chronic health conditions. Despite the recent return to traditional in-person rehabilitation programmes, our study sample recognised the value of future telerehabilitation delivery beyond the pandemic as an adjunct to traditional in-person rehabilitation. A preference for a hybrid model of rehabilitation combining both traditional in-person and telerehabilitation approaches, rather than complete substitution of traditional approaches with telerehabilitation, mirrors previous findings (Cranen *et al.* 2012; Hwang *et al.* 2017a; Shulver *et al.* 2017; Scherrenberg *et al.* 2021). Other preferences for future telerehabilitation programmes included the use of synchronous modes of delivery, with some recorded material also made available, the value of group rehabilitation classes, inclusion of exercise, education and social components to programmes, along with periodic objective monitoring of clinical parameters, echoing previous research findings (Cranen *et al.* 2017; Fernandes *et al.* 2022).

Rehabilitation providing self-management support is a primary intervention for various chronic health conditions. Evidence exploring the effects of generic self-management programmes, such as the Stanford Chronic Disease Self-Management Programme (CDSMP) model that can be used for a heterogeneous sample of patients with chronic conditions, is promising (Williams *et al.* 2013; Health Information Quality Authority 2015; Hevey *et al.* 2020). Generic programmes have been developed under the hypothesis that people with different chronic conditions have comparable challenges and that similar self-management techniques and strategies can be used across a variety of these conditions (Hevey *et al.* 2020). However, our findings highlight the mixed attitudes of people with chronic health conditions towards engagement in generic group telerehabilitation programmes for a range of chronic conditions. While some are willing to consider engaging in generic telerehabilitation programmes, others show a reluctance to this due to perceived distinctions across condition-specific rehabilitation programmes.

The strengths of this study include the purposive sampling technique which ensured a diverse sample participated in the study, providing a wide range of perspectives and experiences. Focus groups included participants with a diverse range of chronic conditions and included both those who had and had not previously participated in telerehabilitation programmes. This enhances the generalizability of our findings. This study was conducted and reported in accordance with COREQ reporting guidelines to ensure transparency (Tong *et al.* 2007). Two authors independently coded a sample of each transcript, using an established codebook of themes and subthemes agreed by the authors from initial review of the data, to enhance rigour of the analysis process. Several limitations are also worth noting. Focus groups were conducted via videoconferencing software, which may have deterred the participation of individuals with limited technological access or abilities. Those who agreed to participate

could potentially have higher levels of technical literacy and therefore may be more positive about, and accepting of, telerehabilitation. Although options to participate in focus groups via telephone call were provided to support the participation of those who did not have access to videoconferencing software, it is a potential limitation of the study. We acknowledge the small sample size of the study, however, as previously discussed, data collection ceased when saturation was reached within the data arising from the entire mixed sample, aligning with the aims of the study. It also aligns with the recommendations of Guest et al. (2017) who suggest that at least three focus groups are enough to identify the most prevalent themes within a data set. The small sample size may limit the generalizability of the findings to a broader population. We acknowledge that thematic analysis of the data collected within each patient subgroup was not performed, nor did we reach data saturation within each of the different patient subgroups; however, the aim of this research was not to compare the themes that arose across the different subgroups. Participants were recruited via national patient advocacy and support groups, as well as the clinical contacts of the authors. Therefore, the participants are more likely to be among a cohort that participates proactively in their own healthcare management which may limit the generalizability of the study findings. Additionally, our study recruited participants from Ireland, a developed country with a very highly developed economy according to the United Nations Human Development Index (HDI) (United Nations Development Programme 2022). Therefore, the findings may not be representative of the attitudes of patients from other countries, particularly developing and underdeveloped countries. Many of the comments surrounding previous experiences of telerehabilitation were made by participants who had previously participated in telerehabilitation. However, we included participants with no previous experience of participating in telerehabilitation to gain insight into their preferences and expectations for

future telerehabilitation programmes to reflect the large number of people with chronic health conditions who are yet to be exposed to telerehabilitation. While the MSK cohort was most concerned with the lack of ‘hands-on’ therapy with telerehabilitation, they also reported the least experience with group-based telerehabilitation. Therefore, we cannot rule out the possibility that a MSK cohort with greater prior experience of telerehabilitation might be less concerned.

The attitudes of people with chronic health conditions towards the use of telerehabilitation and the acceptance of a generic group telerehabilitation for people with a range of chronic health conditions have been explored in this study. Consideration of these perceptions and preferences could help to inform the development and facilitate success of future telerehabilitation programmes.

### **3.8 Clinical Message**

- Offering training and support could help patients overcome challenges associated with telerehabilitation participation.
- Future programmes should use hybrid delivery models, synchronous and recorded content and include exercise, educational and social components.
- It is still uncertain if a generic group telerehabilitation programme for different chronic conditions would be acceptable among patients.

### **3.9 Acknowledgements**

We would like to acknowledge the contribution of those who participated in this study for their contributions and national patient advocacy and support group leaders and clinical contacts of the authors for their support with participant recruitment.

**Chapter 4. Exploring attitudes of physiotherapists towards the delivery of group-based telerehabilitation and their acceptability of mixed-condition group programmes for people with chronic health conditions: A qualitative study**

This chapter is currently under review for publication in ‘*Chronic Illness*’ Journal; Q2, Impact Factor 1.8.

Barry Walsh, C., Cahalan, R., Hinman, R.S. and O’Sullivan, K. (2023) ‘Exploring attitudes of physiotherapists towards the delivery of group-based telerehabilitation and their acceptability of mixed-condition group programmes for people with chronic health conditions: A qualitative study’, *Manuscript submitted for publication*

## **4.1 Chapter Outline**

The previous chapter outlined the perspectives and preferences of service users regarding telerehabilitation programmes. The focus of this chapter shifts to the attitudes and perspectives of service providers towards the delivery of telerehabilitation programmes, their preferences for future telerehabilitation programme delivery, and their acceptability of a proposed generic telerehabilitation programme for groups of people with different chronic conditions. This chapter provides information regarding the benefits and challenges associated with telerehabilitation programme delivery as perceived by physiotherapists involved in the delivery of rehabilitation services to people with chronic conditions. It also provides information regarding the preferences relating to the design and delivery of future telerehabilitation programmes for people with chronic conditions. The information presented in this chapter informs the development of the subsequent chapters, particularly the design of the TECC intervention.

## **4.2 Abstract**

### **Objective**

To explore the attitudes of physiotherapists towards group-based telerehabilitation delivery and the acceptability of a generic telerehabilitation programme for mixed-condition groups.

### **Methods**

This study employed a qualitative design using semi-structured focus groups conducted via videoconferencing and is reported in accordance with the Consolidated Criteria for Reporting Qualitative Research (COREQ) checklist. An online questionnaire collected baseline demographic data and attitudes towards telerehabilitation delivery. Physiotherapists involved

in rehabilitation delivery to cohorts with chronic cardiorespiratory, neurological, and musculoskeletal conditions were recruited via clinical contacts of the authors. Qualitative data were analysed using thematic analysis following Braun and Clarke's methodology and findings were triangulated with quantitative questionnaire data.

## **Results**

Ten physiotherapists were recruited from various public (n=8) and private (n=2) healthcare settings, and two focus groups were conducted. Three themes were identified regarding telerehabilitation: 1) Benefits (including convenience and efficiencies, safety, and new skills), 2) Challenges (including technology, clinical delivery issues and safety issues), and 3) The future of telerehabilitation (including future delivery and generic telerehabilitation programmes for mixed-condition groups).

## **Discussion**

Telerehabilitation was deemed a valuable service delivery method, however challenges also exist. Suggestions have been made which could optimise the delivery and implementation of future telerehabilitation programmes for mixed-condition groups.

## 4.4 Introduction

Chronic health conditions, including cardiac, respiratory, neurological and musculoskeletal diseases, are a leading contributor to mortality and disability levels worldwide (Darker *et al.* 2015). Due to the ageing nature of our population, the prevalence and burden of various chronic conditions will likely rise significantly (Mathers and Loncar 2006; Hernández *et al.* 2019). Therefore, empowering people with chronic conditions to actively participate in managing their own health is a key priority of many healthcare services (Department of Health 2012; Health Information Quality Authority 2015; Smyth 2017).

Evidence supports the implementation of rehabilitation programmes for a range of chronic conditions to promote self-management and improve overall function and quality of life (Pedersen and Saltin 2006; Bolton *et al.* 2013; Price *et al.* 2013; Pasanen *et al.* 2017; Long *et al.* 2019). The recent COVID-19 pandemic accelerated the adoption of telerehabilitation- the remote delivery of rehabilitation using telecommunication technologies- for service delivery, including delivery to vulnerable patients with chronic conditions. Telerehabilitation has the potential to sustainably increase service accessibility for patients by overcoming barriers to face-to-face rehabilitation (Desveaux *et al.* 2016; Oates *et al.* 2019), including transport and time limitations. Furthermore, evidence suggests that these programmes may be as clinically effective as traditional face-to-face programmes for people with chronic conditions (Bourne *et al.* 2017; Cottrell *et al.* 2017a; Jiang *et al.* 2018).

These programmes are typically delivered to condition-specific cohorts, such as cardiac rehabilitation programmes for people with cardiac conditions. Despite diversity in the underlying medical conditions, the design, and components of rehabilitation programmes for mixed chronic conditions are largely similar, typically consisting of progressive exercise training and education (Mulligan *et al.* 2019; Hevey *et al.* 2020). Programmes such as the

Stanford Chronic Disease Self-Management Programme (CDSMP), which deliver generic educational programmes for mixed-condition groups, have been recognised as an efficient method of service delivery (Health Information Quality Authority 2015; Barker *et al.* 2018; Hevey *et al.* 2020). This recognition is based on the premise that people with different chronic conditions typically have similar challenges and concerns, and therefore require similar guidance to effectively manage their conditions.

Previous evidence exploring the attitudes of physiotherapists towards the delivery of telerehabilitation has typically involved physiotherapists who each work in a single clinical area (Cottrell *et al.* 2017b; Damhus *et al.* 2018; Malliaras *et al.* 2021; Bhardwaj *et al.* 2023). Thus, telehealth experiences in these samples tend to be condition focused. It is not clear if physiotherapy attitudes to telehealth differ for programmes and experiences that are more generic in nature. This research aims to explore the attitudes of physiotherapists working with diverse chronic populations towards the delivery of group-based telerehabilitation for people with chronic conditions. We also aim to explore their acceptability of a generic telerehabilitation programme for mixed-condition groups.

## **4.5 Methods**

Ethical approval for this study was granted by the Faculty of Education and Health Sciences Research Ethics Committee in the University of Limerick (EHSREC 10\_RA01). A qualitative design was employed, and the study was conducted and reported in accordance with the Consolidated Criteria for Reporting Qualitative Research (COREQ) Checklist (Appendix 8.1.7) (Tong *et al.* 2007).

### **4.5.1 Participants**

A purposive sampling technique was used to recruit a sample of physiotherapists involved in the delivery of rehabilitation programmes for patients with various chronic health conditions, including physiotherapists who had and had not previously delivered telerehabilitation programmes. A diverse sample was sought to include physiotherapists working in both public and private healthcare settings with chronic cardiorespiratory, neurological, and musculoskeletal cohorts. All participants had some form of previous experience in the delivery of rehabilitation, including face-to-face, telerehabilitation, group and individual care. Participants were recruited via the existing clinical and professional networks of the authors. Physiotherapists were contacted by email and were provided with leaflets outlining the study aims and eligibility criteria (Appendix 8.2.2). Interested participants who contacted the authors were provided with further detail regarding the study processes and eligibility details through participant information sheets (Appendix 8.3.2). Participants were eligible for inclusion if they were a physiotherapist involved in the delivery of physiotherapy rehabilitation for chronic populations, including either face-to-face rehabilitation and telerehabilitation, and had fluent spoken and written English. Participants were contacted by email to ensure they had read and understood the information leaflet and to address any outstanding concerns. Interested individuals then provided online consent (Appendix 8.4.2) and were invited to the online focus group.

### **4.5.2 Data Collection**

Participants completed brief online questionnaires to collect demographic data and their perspectives on telerehabilitation programme delivery in advance of focus group participation. The online questionnaire collected information including participants' age,

gender, clinical work area, previous telerehabilitation experience, and attitudes including the perceived acceptability of delivering generic telerehabilitation programmes for mixed-condition groups. In order to collect data pertaining to attitudes towards, and preferences for, telerehabilitation programme delivery, and the acceptability of generic telerehabilitation programmes, the questionnaire included multiple choice questions and statements using a five-point Likert scale to indicate levels of agreement (Appendix 8.5.2). These attitudes and preferences were further explored during the subsequent focus groups.

Semi-structured focus groups were conducted using a videoconferencing platform (Microsoft Teams) to collect qualitative data. Participants could dial in using a telephone if they did not have access to video conferencing software, however all participants opted to engage using the videoconferencing platform. Two focus groups were conducted with each lasting between 30 and 60 minutes. Participants were located in their own work and/or home settings. Focus groups were conducted by the first author (CBW), a female physiotherapist with three years of postgraduate physiotherapy and research experience who was completing PhD research at the University of Limerick, Ireland exploring the use of telerehabilitation for people with chronic health conditions. The interview guide (Appendix 8.6.2) was developed based on the authors' clinical and research experience, and previous literature (Damhus *et al.* 2018; Malliaras *et al.* 2021). Recruitment ceased when the authors felt confident of having reached data saturation, referring to the point at which new data repeats what was expressed in previous data (Saunders *et al.* 2018). Focus groups were video, and audio recorded using the Microsoft Teams platform for accuracy of transcription.

### **4.5.3 Data Analysis**

Data collected in the online questionnaire were analysed descriptively. Qualitative data were automatically transcribed using Microsoft Teams software. Transcripts were compared to the video recordings and minor errors relating to sound quality and accent variation were edited by the first author (CBW). To ensure accuracy, transcripts were returned to focus group participants for comment or correction. A bottom-up thematic analysis, using the principles of grounded theory, was conducted on qualitative data following Braun and Clarke's methodology (Braun and Clarke 2006). Transcripts were reviewed by two independent authors (CBW and RC [a physiotherapist with qualitative research experience]) to familiarise themselves with the data and were then coded to identify patterns in the data. Codes were organised into categories and a list of themes and subthemes was developed by both authors independently. A codebook of themes and subthemes were discussed and agreed upon collaboratively. Two authors (CBW and RC) re-coded a sample of 40% of the collected data independently using the established codebook to ensure agreement. A high level of agreement between coders was demonstrated. Therefore, the remainder of the data was coded by one independent author (CBW) using the established themes and subthemes. To ensure trustworthiness, qualitative findings were triangulated with relevant quantitative online questionnaire data. Data management and analysis was supported using Microsoft Word and Excel software to organise, store and analyse the data.

### **4.6 Results**

Two focus groups, with five participants in each group, were conducted and analysed. The total sample (n=10, eight females, two males) had a mean age of 41.1 (7.65) years and a range of seven to 30 years of clinical experience. Due to the method of recruitment, the

number of people who were contacted to participate is unknown and it was not possible to calculate a participation rate.

Participant characteristics are described in Table 4.1. Participants worked in a variety of one or more clinical areas including musculoskeletal (n= 8 [80%]), cardiorespiratory (n= 4 [40%]), neurology (n= 4 [40%]) and gerontology (n= 4 [40%]). Eight participants (80%) had previously delivered telerehabilitation programmes to various patient cohorts including cardiorespiratory (n= 4 [40%]), musculoskeletal (n= 4 [40%]), and neurological (n= 2 [20%]) cohorts. Of these eight participants, six reported delivering telerehabilitation using synchronous modes of delivery (e.g., live telephone or video calls), while two did not state the mode of delivery. Participants' attitudes towards the use of telerehabilitation, as ascertained in the questionnaire, is outlined in Figure 4.1. All participants (n=10 [100%]) stated that they would prefer a hybrid model including a combination of telerehabilitation and face-to-face rehabilitation if they were to deliver future telerehabilitation programmes, rather than a stand-alone telerehabilitation programme.

The qualitative results are outlined through key themes and subthemes as outlined in Figure 4.2. The three key themes were: 1) Benefits, 2) Challenges, and 3) The future of telerehabilitation.

Table 4.1 Participant demographics (N= 10)

ID	Age (years)	Gender	Clinical area	Work setting	Work location	Clinical experience (years)	Previously delivered TR	Population involved in TR delivery	Detail of TR mode, frequency, duration
P01	42	Male	CR	Public	Rural	18	Yes	CR	Synchronous VC, twice per week for 8 weeks.
P02	36	Female	MSK, N	Public	Urban	14	Yes	CR, MSK, N	Varied per population, typically once per week for 8 weeks for group classes; once per week for 4-8 weeks for individual session.
P03	32	Female	CR, G, MSK, N	Public	Urban	11	Yes	CR	Synchronous VC, once per week for 5/6-week blocks
P04	30	Female	G, MSK, N	Public	Urban	7	No	N/A	N/A
P05	45	Female	MSK	Public	Rural	22	Yes	MSK	Synchronous VC, once per week for 6 weeks
P06	43	Female	CR	Public	Urban	12	Yes	CR	Synchronous VC, twice per week for 8 weeks
P07	36	Female	G, MSK	Private	Urban	18	Yes	N	Synchronous VC, 60 min class once per week
P08	54	Male	MSK	Private	Rural	30	Yes	MSK	Synchronous VC, individually based, frequency of follow up as required.
P09	50	Female	CR, G, MSK, N	Public	Urban	27	Yes	MSK	Assessment and follow up treatment as required.
P10	43	Female	MSK	Public	Rural	18	No	N/A	N/A

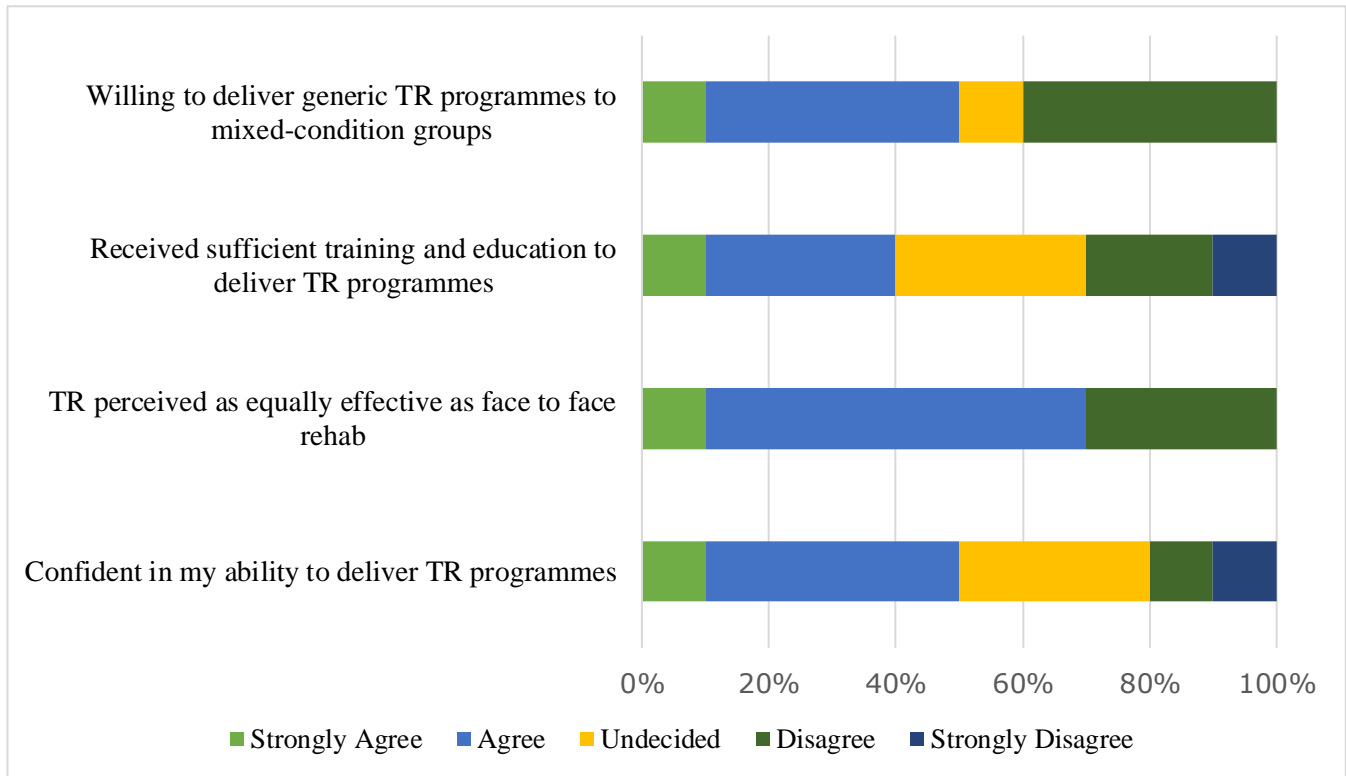


Figure 4.1 Participant attitudes towards delivery of telerehabilitation programmes

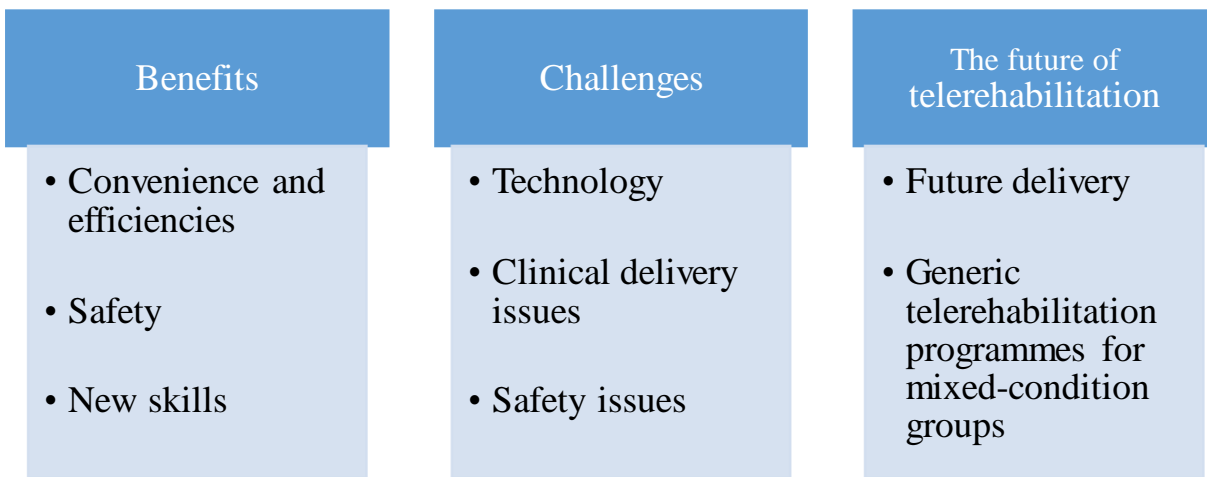


Figure 4.2 Key Themes and Subthemes

#### 4.6.1 Benefits

The benefits of telerehabilitation delivery consistently identified by participants across clinical areas related to convenience and efficiencies, safety and the new skills gained through participation.

##### *Convenience and efficiencies*

Savings in terms of time and costs for patients, family members, carers, and physiotherapists were noted. Telerehabilitation increased service accessibility for patients and limited the burden associated with travel to face-to-face rehabilitation.

“...even pre-covid there was always this list of people that you couldn't get to because transport was an issue. Obviously, they've to attend twice a week for eight weeks, so it's a big undertaking...I can now actually offer them the service.” [P06, F, CR]

Another benefit was the reduced travel burden on patients' family members and carers compared to attendance at face-to-face rehabilitation classes.

“...family aren't available to bring them (patients) in for appointments, so it definitely made a big difference...it was a lot easier for them than having to bring them in and drive them in that would mean taking your time off work.” [P07, F, G, MSK]

Multiple participants highlighted that “it takes half the time to run a virtual telehealth class then it would a face-to-face programme” [P01, M, CR], which benefits service providers, physiotherapists, and patients. Being able to expand service provision to wider patient groups and geographical locations, was seen as advantageous.

“You can widen it to a larger geographical area so let's say I'm working in Limerick... but we also align with services in the in the rest of the CHO3 (Community Health Organisation Area 3)”. [P01, M, CR]

Additionally, participants noted that increased geographical access made possible by telerehabilitation allowed physiotherapists to streamline individual patients into groups of similar ability.

“...the advantages of telehealth for us... (was that) people could be streamlined into groups with people that were very much of their ability which we weren't able to do as much when we were running them (face-to-face). [P02, F, MSK, N]

### *Safety*

Facilitating healthcare delivery for patients with chronic health conditions during the COVID-19 pandemic while preventing the spread of infections among vulnerable cohorts was noted.

“it's still really useful for a certain client cohort that that's still won't come in face-to-face and that's more from fear/anxiety/COVID more than anything else.” [P06, F, CR]

### *New skills*

Participants suggested that patients gained confidence and technical skills by participating in telerehabilitation. Most patients enjoyed telerehabilitation once they got used to it and were willing to engage in telerehabilitation again.

“We had a class finish last week in virtual pulmonary rehab and it was the first kind of program as things opened up and I asked them at the end if I offered you the class down the road now or the virtual class, what would you go for? And all four said we'd stick with virtual and that's surprised me because I thought they won't be willing to engage. But they had engaged and enjoyed it and saw that it worked, and it suited their remit.” [P01, M, CR]

The skills gained by physiotherapists and the value of learning from previous experiences of delivering telerehabilitation was also raised.

“You learn from your mistakes... like you do in normal practice, if something didn't work well, why didn't it work? ...until you're actually doing it, it's great to do theory, but you actually probably need a couple of dummy runs nearly more than anything.”

[P03, F, CR, G, MSK, N]

#### **4.6.2 Challenges**

Challenges included those related to the use of technology, professional, clinical and safety issues.

##### *Technology*

The challenges most often cited included poor bandwidth and internet connectivity issues, particularly in rural areas.

“Some of the complications were obviously the IT stuff...especially, a rural area effectively... it's all good, say within the town, but you go out and the reception wasn't good. So, there were lots and lots of hiccups.” [P08, M, MSK]

Participants also discussed challenges among both patients and physiotherapists who lacked the necessary technical skills.

“A lot of people are often technology shy, and then they're depending on family members to be there at the time to set them up... I've often maybe been able to see somebody on a screen but not able to hear them.” [P04, F, G, MSK, N]

Participant fear and reluctance to engage with technology was believed to limit uptake and engagement.

“I think there's a little fear and initial reluctance on people to engage with technology because they think it's based on their abilities” [P01, M, CR]

### *Clinical delivery issues*

Most participants commented on the challenging nature of conducting assessments via telerehabilitation. Participants with previous experience of delivering telerehabilitation noted the need to adapt their usual face-to-face assessments, which then impacted on exercise prescription.

“What we couldn't do on a virtual call was a field walking test like six-minute or an incremental shuttle walk. We did a sit-to-stand test instead but that's because that was forced upon us pandemic wise, and you can't accurately prescribe exercise just from sit-to-stand test...and you couldn't see if someone desaturated, for example, on a sit-to-stand like they would over a longer walk.” [P01, M, CR]

Physiotherapists working particularly with chronic musculoskeletal cohorts highlighted the difficulty with conducting lower limb assessments remotely via technology and the inability to provide ‘hands-on’ therapy when delivering telerehabilitation.

“I'm similar to (C08) in that I've used it mainly in a musculoskeletal setting and I would agree the upper limb stuff worked quite well, but it was quite hard to assess the lower limb...just based on what you were just seeing.” [P09, F, CR, G, MSK, N]

The challenge associated with delivering asynchronous telerehabilitation content (a ‘store-and-forward’ approach to rehabilitation delivery where information is shared by the healthcare practitioner and then viewed by the patient at a later time, or vice versa) to patients was also discussed. Participants noted the lack of flexibility of asynchronous or pre-recorded

content and the difficulties that this created when trying to modify programme content according to individual patient needs and abilities.

“If something is pre-recorded (asynchronous), you know people might not be able to modify, whereas if you're teaching it live, you can always say, well, look, I'll modify to X if that suits somebody better or Y. Whereas if it's pre-recorded, it may be too prescriptive and that might not always suit everybody.” [P03, F, CR, G, MSK, N]

Concerns were raised that telerehabilitation created barriers to participant-peer interaction, thereby foregoing valuable peer learning. Similarly, there was reluctance noted regarding participant readiness to interact with physiotherapists, whether to raise queries or ask for clarification.

“They (patients) don't engage as much...in a lot of cases there's learnings from themselves as opposed to the clinician...peer learning...and they lose a little bit of that in in virtual. [P01, M, CR]”

“People are a little bit reluctant to ask questions that they would have kind of very informally come up after class asking, so just creating a little bit of a safe space after the class as well to allow for that to happen online was really good for us. [P02, F, MSK, N]

### *Safety issues*

Three safety concerns were noted, relating to privacy, physical safety, and a more limited ability to monitor specific clinical parameters.

“The whole GDPR (General Data Protection Regulation) aspect of these classes...there's always people that come in, and I guess you try and tell them to have like a plain background and maybe not identifying features. But...you'll still have

people sitting in the big armchair with...identifying features around them. [P06, F, CR]

The risk of falls when asking people to be active in their own home was also raised.

“You can't see trip hazards...you can't see rugs and tables even though the pack that was sent out to them at the start would have given them guidance on you know, don't exercise near any of these things, etc. [P06, F, CR]

Condition-specific safety concerns were noted, such as the difficulty of monitoring specific parameters from a remote location including oxygen saturation, heart rate and blood pressure for cardiorespiratory patients, weight bearing levels for musculoskeletal patients and balance for neurological patients.

“(my safety concern) I guess is desaturation, heart rate, making sure someone is exercising within the safe parameters for them. That's from a respiratory and cardiac point of view... for the majority, it wasn't an issue, but then a few things did crop up when we post-assessed a few people face-to-face, you know, and their blood pressure was through the roof.” [P06, F, CR]

“It was quite hard to just really assess, from a weight bearing point of view, to see exactly what they're doing. [P09, F, CR, G, MSK, N]

#### **4.6.3 The future of telerehabilitation**

Participants provided commentary on potential future delivery considerations for telerehabilitation and their thoughts about the viability of generic telerehabilitation programme delivery for mixed-condition groups.

### *Future delivery*

A preference for a hybrid model of telerehabilitation delivery including both telerehabilitation with some face-to-face interaction was expressed, concurring with the quantitative data showing that 100% of participants prefer a hybrid model of rehabilitation. Participants largely agreed that they would prefer to conduct face-to-face assessments, particularly at initial pre-intervention stages.

“I think you'd have to have the blended model but also the telehealth sandwiched in between bookended by a face-to-face at the start and the face-to-face at the end.” [P07, F, G, MSK]

Telerehabilitation programmes were reported to best suit particular patient cohorts (including younger cohorts, those with access to technology, and those with less risk of adverse events such as falls or desaturation during exercise classes) and participants recommended “cherry-picking” [P01, M, CR] the most appropriate patients for future programmes.

“I think you got to pick and choose your patients who would be good for telerehab and some others that would be better off in the face-to-face, either that they couldn't log on or from a health and safety point of view, or you'd rather be able to eyeball that patient because you had a fear of their risk of falls or risk from a respiratory point of view, desaturating in my case.” [P01, M, CR]

Musculoskeletal physiotherapists were not optimistic regarding the future role of telerehabilitation for their patients post-pandemic, for various reasons including patient reluctance, the difficulty carrying out lower limb assessments, and inability to provide ‘hands-on’ therapy, as alluded to previously.

“...there's been very little carryover (post-pandemic).” [P08, M, MSK]

Synchronous telerehabilitation (a remote form of rehabilitation delivery involving live, real-time interaction between the patient and healthcare provider) was favoured. It was viewed as a flexible delivery method that allowed physiotherapists to adapt content according to patient needs. The inclusion of pre-recorded video content during synchronous classes was noted to allow physiotherapists to monitor patients while they perform the required activities.

“We used it (pre-recorded content) when we were running (synchronous) classes on our own so that you could monitor people better...and then you were able to give verbal instruction to people because you're just able to monitor a little bit closer.”

[P02, F, MSK, N]

The support of another clinician during classes to monitor participants and assist with technology, gathering important patient information including home post codes and emergency contact information, and good set-up and planning of classes was recommended by participants. Adding a social component to promote social interaction, and creating a “safe space” [P02, F, MSK, N] to discuss concerns with the healthcare provider was encouraged.

“I know that we have a contact number of somebody else that's not necessarily the home phone because they might be home alone, but somebody else in case we saw that they had fallen over or whatever the case may be.” [P03, F, CR, G, MSK, N]

Participants noted that their prior training was limited and largely focused on the use of technology and management of technical difficulties. A desire for further training and guidance particularly regarding the adaptation of knowledge and skills that are used in the face-to-face setting for optimal use via telerehabilitation was evident. This converges with the quantitative data (Figure 1) where only 40% (n=4) agreed that they received sufficient training.

“I think the technology side of it I think you can kind of pick up and kind of get better at it, but I think it's just like transfer your specific skills you have of MSK physio into an online session training that would be really important.” [P07, M, G, MSK]

The need to promote the value and availability of telerehabilitation services among healthcare staff and patients to promote future uptake and engagement and overcome the negative perception of telerehabilitation being a “lesser version” of face-to-face rehabilitation was highlighted.

“Maybe a little bit more ‘PR’ in relation to telehealth that people are aware it still exists and highlighting that it actually works and when you make those initial calls to people and you offer that they don't just turn it down because they think this is a lesser version of and maybe backing it up with the stats that actually this does work and it might be more convenient for you.” [P01, M, CR]

#### *Generic telerehabilitation programmes for mixed-condition groups*

There were differing attitudes regarding the delivery of a generic telerehabilitation programme for mixed-condition groups. This aligned with the quantitative data where only 50% of participants were willing to deliver simultaneous telerehabilitation programmes to mixed-condition groups (Figure 1). Participants voiced some concerns regarding the feasibility of delivering generic programmes for people with various chronic conditions. A notable recommendation was the importance of streamlining patients into these proposed programmes based on their ability. Participants also suggested that programmes could be structured to include some generic components (e.g., education regarding self-management) while also including some condition-specific rehabilitation content.

“My gut reaction is I wouldn't be 100% for it. The educational side of it yes, no problem...It depends on what kind of assessment you've done face-to-face...you would probably have to stratify people into different groups more so than you would do...there are people you know with varying abilities.” [P06, F, CR]

“I wonder if you if you had both, that generic kind of an exercise point of view and then you split them to into their groups and maybe breakout rooms and use technology in some sort of way to have that more specific part as well. Would that work and it would be interesting to see if that would meet both needs?” [P04, F, G, MSK, N]

However, some participants were open to the idea of considering generic programmes noting the reality that most patients attending programmes have multiple co-morbidities and therefore generic information regarding chronic disease management is appropriate for these patients.

“The reality is that patients attending a lot of classes, once they're over a certain age, are going to have multiple comorbidities anyway, and maybe one predominates but we know what the percentages are, they just don't have one.” [P01, M, CR]

## **4.7 Discussion**

Physiotherapists reported various benefits associated with telerehabilitation delivery for people with chronic conditions including convenience and safety. However, challenges including technological, professional, clinical and safety issues were also discussed. Going forward, hybrid offerings supported by face-to-face assessments, including careful selection of patients and further training for physiotherapists are preferred. Attitudes towards telerehabilitation for mixed-condition groups vary, but certain elements such as education

may be appropriate, particularly in older cohorts who are likely to have multiple chronic conditions.

The benefits and challenges identified in this study echo similar themes from previous literature (Cottrell *et al.* 2017b; Damhus *et al.* 2018; Albahrouh and Buabbas 2021; Malliaras *et al.* 2021; Reynolds *et al.* 2021; Ross *et al.* 2022; Bhardwaj *et al.* 2023). Although the safety benefit highlighted in this study related to preventing spread of COVID-19 infection, this benefit may extend beyond the recent pandemic and facilitate participation among cohorts who avoid attendance at face-to-face classes due to the risk of infection and illness. Although technical issues are commonly reported to have a negative impact on telerehabilitation delivery and participation, previous research has shown that technical issues that occur during telerehabilitation delivery are infrequent and tend to cause minimal disruption to healthcare delivery (Ross *et al.* 2023). Strategies previously suggested to overcome technological challenges include providing troubleshooting guides and resources to physiotherapists, and access to technical and administrative support for physiotherapists delivering telerehabilitation (Ross *et al.* 2022). Our data reiterates the value in having a supporting clinician to assist with technology and patient support. Ross and colleagues further (Ross *et al.* 2022) recommend providing videos, patient handouts, educational summaries and management plans to optimise the process and ensure effective telerehabilitation delivery. The preference for initial face-to-face assessments prior to telerehabilitation follow-up treatment has also been cited previously (Cottrell *et al.* 2017b; Albahrouh and Buabbas 2021). Participants noted that a large cohort of patients demonstrated a preference to return to face-to-face rehabilitation when it resumed following the recent COVID-19 pandemic. However, they also acknowledged the value of the provision of telerehabilitation services beyond the recent COVID-19 pandemic, concurring with previous literature (Damhus *et al.* 2018;

Reynolds *et al.* 2021). Telerehabilitation increases service accessibility allowing physiotherapists to reach a wider patient cohort particularly those who cannot engage with face-to-face services for various reasons such as transportation difficulties (Damhus *et al.* 2018). However, physiotherapists in this study noted the importance of choosing suitable patients for telerehabilitation and acknowledged the need for continued face-to-face service delivery for those less suitable for telerehabilitation participation, which is consistent with previous literature (Bennell *et al.* 2021). Predictive factors of telerehabilitation participation include age, digital and health literacy, capacity and willingness to engage, cognitive ability, communication ability and mobility status (Reynolds *et al.* 2021). Patient attributes positively associated with telerehabilitation engagement include high self-efficacy and motivation levels, younger aged cohorts and those familiar and willing to engage with technology (Ross *et al.* 2022). Patients with expectations for hands-on physiotherapy or who are not willing to engage in telerehabilitation initially tend to be less likely to engage in telerehabilitation services (Malliaras *et al.* 2021; Ross *et al.* 2022). To facilitate uptake, engagement, and success of interventions, physiotherapists should consider these factors when choosing patients for future telerehabilitation programmes.

One important recommendation generated was the need for the broad promotion of telerehabilitation services to bolster uptake and participation. The importance of a “whole team approach” including healthcare staff and providers and organisational and administrative support, to ensure successful uptake of telerehabilitation has been documented previously (Ross *et al.* 2022). Previous literature has shown that although physiotherapists may demonstrate initial reticence regarding telerehabilitation delivery, they typically enjoy and embrace this new method of healthcare delivery once experienced first-hand (Lawford *et al.* 2019). Our findings recommended not only educating patients, but also educating all

staff involved in service delivery, including healthcare providers and administrative staff, regarding the availability and efficacy of telerehabilitation to increase uptake. The value of learning to improve telerehabilitation service delivery from previous experiences and the experience of colleagues has also been noted previously (Albahrouh and Buabbas 2021; Malliaras *et al.* 2021; Ross *et al.* 2022).

Concerns regarding the limited training and guidance offered to physiotherapists and the need for further training has also been discussed previously (Albahrouh and Buabbas 2021; Malliaras *et al.* 2021). The desire for further training surrounding the adaptation of existing clinical skills used in traditional face-to-face environments should be addressed to optimise future telerehabilitation delivery (Signal *et al.* 2020). Core capability frameworks which outline the essential skills required by physiotherapists delivering telerehabilitation interventions should guide physiotherapists and inform future delivery (Davies *et al.* 2021; Davies *et al.* 2022).

Despite recent evidence supporting the use of generic rehabilitation programmes for mixed-condition groups (Health Information Quality Authority 2015; Barker *et al.* 2018; Hevey *et al.* 2020), physiotherapists in the current study had some concerns regarding the feasibility and practicality of such programmes. Physiotherapists highlighted considerations and certain programme elements that may be more amenable to group delivery including educational components. Despite concerns raised by physiotherapists, the reality that generic programmes may be more efficient for the elderly cohort with chronic conditions who typically present with various co-morbidities and additional health complaints was also noted. Some physiotherapists working with musculoskeletal patient cohorts noted concerns regarding the limitations of telerehabilitation, particularly the lack of physical contact with patients. This may reflect the work these physiotherapists typically perform requiring more

of a hands-on approach than physiotherapists in other clinical areas (Malliaras *et al.* 2021). Physiotherapists in musculoskeletal clinical areas were also less enthusiastic regarding the future value of telerehabilitation for their patient cohorts and noted patient preference for a return to face-to-face services following the recent COVID-19 pandemic. Physiotherapists involved in delivering telerehabilitation for cardiorespiratory and neurological cohorts were more enthusiastic regarding the value of telerehabilitation programme delivery. These physiotherapists noted that they received increased training and guidance from policy makers and physiotherapists with previous experience of delivering established telerehabilitation programmes which supported them and therefore may reflect their positive bias towards telerehabilitation.

#### **4.8 Strengths and Limitations**

We recruited a diverse sample of physiotherapists working across various settings and clinical areas including private and public healthcare settings with various musculoskeletal, neurological, and cardiorespiratory cohorts. We also included physiotherapists who had and had not previously delivered telerehabilitation. This diverse sample of participants ensures a wide range of perspectives representative of a wide range of practice areas, thus enhancing the generalisability of our findings. The study was conducted and reported in accordance with COREQ reporting guidelines to ensure transparency (Tong *et al.* 2007). However, our sample size was relatively small making it difficult to assume that saturation was achieved, and this may be noted as a limitation of the study. All participants in the study were located in Ireland which may limit the generalisability of the findings. There is also potential participant bias and attitudes may be informed by the participants' previous experiences, or lack of experiences, with telerehabilitation delivery. Data collection was conducted soon after the recent COVID-19 pandemic and therefore physiotherapists were engaging with

telerehabilitation at a greater rate than usual which may have affected their responses and attitudes towards telerehabilitation delivery.

## **4.9 Conclusion**

Telerehabilitation is considered a valuable and convenient method of healthcare service delivery. However, challenges exist, and physiotherapists have expressed concerns that telerehabilitation is best suited to certain patient cohorts. Telerehabilitation has the potential to increase service accessibility to a wider cohort of patients who may not participate in traditional face-to-face rehabilitation. Recommendations have been made to support and optimise future telerehabilitation implementation and delivery including the desire for further training, guidance and support for clinicians, and the need to promote the availability and efficacy of telerehabilitation services among healthcare staff and patients. The acceptability of generic telerehabilitation programmes for mixed-condition groups remains unclear with some physiotherapists demonstrating apprehension, while others considered this to be a valuable service delivery method. The strategies recommended to optimise implementation noted by participants have the potential to optimise uptake and success of future telerehabilitation programmes for people with chronic health conditions.

## **4.10 Acknowledgements**

The authors would like to acknowledge the contribution of those who participated in this study for their contributions, and to clinical contacts of the authors for their support with participant recruitment.

## **Chapter 5. TECC- Design and development of a complex intervention for people with chronic health conditions**

This chapter presents the design and development of the TECC intervention. This intervention was designed in accordance with the MRC framework and underpinned by the findings of Chapters Two, Three and Four. In addition, the intervention was refined according to further stakeholder input from another physiotherapy focus group.

## 5.1 Chapter Outline

The current chapter describes the design and development of a disease-agnostic telerehabilitation programme for people with chronic health conditions, also known as the TECC programme. The design and development of this intervention was guided by the MRC framework (Skivington *et al.* 2021) and underpinned by the findings of the systematic review conducted in Chapter Two and the qualitative evaluation of stakeholder perspectives and preferences in Chapters Three and Four. The findings from Chapter Two identified several performance-based measures of physical function which may be reliable and valid when administered via telehealth (Barry Walsh *et al.* 2022). However, following the review, a paucity of high-quality evidence examining the psychometric properties of measures, along with limited information regarding the feasibility and interpretability of performance-based measures of physical function administered via telehealth among people with chronic conditions, was highlighted. Therefore, decisions regarding an appropriate outcome measure to use in the planned feasibility trial were further informed by the perspectives and experiences of clinical stakeholders as well as the expertise of the research team, balanced with a pragmatic approach to patient safety, assessment and monitoring. Investigation into the perspectives of key stakeholders (Chapters Three and Four) identified the benefits of telerehabilitation programmes, the challenges encountered when engaging with and delivering these programmes, and the preferences for future telerehabilitation programmes for people with chronic conditions (Barry Walsh *et al.* 2024b). These elements have contributed to the design, characteristics, and delivery methods for a new disease-agnostic telerehabilitation programme for people with chronic conditions described in detail in this chapter. Without the information gathered in Chapters Two, Three and Four, and the subsequent development of the disease-agnostic physiotherapy-led telerehabilitation

described in this chapter, the overall aim of this doctoral research could not be addressed. This chapter provides the necessary platform to examine the feasibility and acceptability of a disease-agnostic telerehabilitation programme for a mixed-condition group of people with chronic conditions (Chapter Six). The protocol for the feasibility trial, which was registered in Open Science Framework, is presented in Appendix 8.1.8 (Barry Walsh *et al.* 2024c).

## **5.2 Abstract**

### **5.2.1 Objective**

To describe the process of designing and developing a disease-agnostic telerehabilitation programme for mixed-condition group of people with different chronic conditions titled the TECC programme. To outline the content and delivery methods for the TECC programme prior to evaluation of the intervention in a feasibility trial (Chapter Six).

### **5.2.2 Methods**

TECC was developed in accordance with the MRC framework for the development and evaluation of complex interventions. Review of the existing research evidence (Chapter Two) and engagement with key stakeholders (Chapters Three and Four) have informed the development of the TECC intervention. Furthermore, a focus group of physiotherapists involved in telerehabilitation service delivery (n=6), and existing practice guidelines were consulted to further develop and refine the intervention.

### **5.2.3 Results**

The TECC programme comprised a 6-week disease-agnostic telerehabilitation programme including exercise, education and social components. Synchronous group exercise sessions were delivered each week by a physiotherapist via videoconferencing. These sessions were

followed by the opportunity for participants to engage in a guided social discussion with peers via the videoconferencing software. Participants were also provided with access to synchronous educational webinars exploring various aspects of self-management delivered weekly by relevant healthcare professionals via videoconferencing. Participants were given access to recordings of the exercise and education sessions during the intervention period to facilitate further engagement. The TECC intervention is described in accordance with the Template for Intervention Description and Replication (TIDieR) checklist.

#### **5.2.4 Conclusion**

The TECC programme was developed in accordance with the MRC framework and described using the TIDieR checklist. This robust and transparent approach used in the development of the TECC programme informed the feasibility trial (Chapter Six) and evaluation of the intervention. The protocol for the subsequent feasibility trial (Chapter Six), reported in accordance with the Standard Protocol Items: Recommendations for Interventional Trials (SPIRIT) Checklist, can be found in Appendix 8.1.9.

### 5.3 Introduction

Complex healthcare interventions are multifaceted initiatives involving several interacting components, targeting diverse populations, and operating within dynamic healthcare systems. A series of phases are recommended for consideration in complex intervention research including development or identification of an intervention, feasibility assessment, evaluation and implementation (Skivington *et al.* 2021). Intervention development is a dynamic, iterative, creative process that is open to change and forward looking to future evaluation and implementation (O'Cathain *et al.* 2019). A robust approach to the development phase is required to ensure success and to maximise the efficacy and efficiency of the intervention in future evaluation and implementation phases (Turner *et al.* 2019). Development of these interventions requires a systematic approach that integrates various actions including planning, stakeholder engagement, identifying the evidence base, understanding the context and designing and refining the intervention (O'Cathain *et al.* 2019).

As previously discussed, this doctoral thesis is guided by the MRC framework for the development and evaluation of complex interventions (Skivington *et al.* 2021), with a focus on the development and feasibility stages of the framework. Thus far, the thesis has outlined the existing evidence base exploring the psychometric properties of performance-based measures when used in telehealth (Chapter Two). Reviewing the existing evidence-base is a key component of the robust approach to intervention development which can inform the design and content of the intervention and identify key uncertainties (Turner *et al.* 2019). In addition, stakeholder engagement plays a critical role in the development of complex healthcare interventions (O'Cathain *et al.* 2019; Turner *et al.* 2019). Involving key stakeholders, including both service users and service providers, can help to ensure that the intervention is relevant, acceptable, and sustainable. The development of complex healthcare

interventions requires a multidisciplinary and collaborative approach that draws on the expertise of researchers, clinicians, and other stakeholders. Chapters Three and Four explored stakeholder perspectives of telerehabilitation, identified their preferences for content and delivery methods for future telerehabilitation programmes and their acceptability of disease-agnostic telerehabilitation programmes for mixed-condition groups.

In addition to a robust and systematic approach to the intervention development phase, clear and accurate intervention description is crucial to build on the initial feasibility findings, facilitate replication and maximise the success of potential future evaluation and implementation (Hoffmann *et al.* 2014). The planned TECC intervention is described using the Template for Intervention Description and Replication (TIDieR) checklist (Hoffmann *et al.* 2014) to ensure good reporting and intervention description and thus increase the potential impact of the research. This chapter aims to outline the design and development of the TECC intervention, using the MRC Framework, and will describe the planned intervention for the feasibility trial which will be discussed in Chapter Six.

## **5.4 Methods**

### **5.4.1 Planning the development process**

Planning the development process commenced with identifying the issues with existing rehabilitation programmes for people with chronic conditions. As discussed in Chapter One, prevention and management of chronic conditions is a key priority of government and health care services (Chronic Conditions Working Group 2017; Health Service Executive 2020; Department of Health Ireland 2023). However, limited uptake and engagement with traditional in-person rehabilitation programmes promoting self-management of chronic conditions has been highlighted (Jones *et al.* 2017; Hinde *et al.* 2019). Telerehabilitation has

the potential to increase service accessibility for this cohort by overcoming the barriers to traditional rehabilitation programmes. Furthermore, disease-agnostic telerehabilitation programmes delivered to groups with mixed chronic conditions have the potential to act as a sustainable and pragmatic approach to healthcare service delivery. Despite the evidence supporting the efficacy of telerehabilitation, resistance to the adoption of telerehabilitation from both service providers and services users is typically demonstrated. This has been attributed to a number of different factors including patient preference for in-person services, perceived superiority of in-person rehabilitation, personal characteristics and technological access or literacy limitations (Fang *et al.* 2022). Although these factors have been previously reported as contributors to poor uptake and adherence with telerehabilitation services, previous research has shown that physiotherapists and patients who engage with telerehabilitation services have positive experiences reporting ease of use, perceived effectiveness, safety, and high satisfaction with telerehabilitation services, and also report that they would be likely to engage with telerehabilitation again in the future (Lawford *et al.* 2019; Bennell *et al.* 2021; Fang *et al.* 2022; Lee *et al.* 2024). Furthermore, although technological access and literacy are reported to have a negative impact on telerehabilitation engagement and participation, previous research has shown that technical issues that occur during telerehabilitation delivery are infrequent and tend to cause minimal disruption to healthcare delivery (Ross *et al.* 2023).

#### **5.4.2 Underpinning Theory**

Another core element for consideration during intervention development as per the MRC guidance is the underpinning programme theory (Skivington *et al.* 2021). Programme theory explains how, and under what conditions, an intervention is expected to have an impact. The TECC programme is based on Self-Efficacy theory, a subset of Bandura's Social Cognitive

theory (Bandura 1977; Bandura 1986). Self-efficacy refers to a person's belief in their ability to carry out the actions required to achieve particular performance outcomes. This aligns with the overall goal of the TECC programme to enable participants to enhance their confidence and ability to self-manage their health and well-being, improving their health outcomes including physical function and quality of life, and reduce healthcare utilisation. According to Bandura, self-efficacy theory-based self-management programs are essential for improving the efficacy and efficiency of care for patients with chronic conditions (Bandura 1997). The Self-Efficacy theory has been incorporated in previous disease-agnostic self-management interventions, such as the Chronic Disease Self-Management Programme by Hevey et al. (2020).

#### **5.4.3 Research Evidence Review**

Drawing on the findings from the systematic review outlined in Chapter Two, a prominent finding was the paucity of high-quality research examining the psychometric properties of performance-based measures of physical function administered via telehealth among people with chronic health conditions. From this review of the existing evidence, several measures were identified that may have sufficient reliability and validity when compared to in-person administration of the same measures, which is promising. However, the review also identified the need for further research to explore the measurement error, responsiveness, interpretability, and feasibility of these measures when they are administered via telehealth. From the findings of the review, it was not possible to provide clear recommendations on the most appropriate measurement instrument for use in the planned feasibility trial. Therefore, decisions regarding the most appropriate outcome measure to use in the feasibility trial to measure objective physical function via telehealth were further informed by updated research and the perspectives and experience of clinical participants as well as the expertise of the

research team, balanced with a pragmatic approach to patient safety, assessment and monitoring. The 30-second chair stand test was identified as the most appropriate and pragmatic tool to measure objective physical function for the planned feasibility trial following the review of existing evidence and engagement with key stakeholders.

#### **5.4.4 Stakeholder Involvement**

In accordance with the MRC framework's recommendations for the development and evaluation of complex interventions, individuals targeted by the intervention- including both service providers and service users- should be involved in the intervention's development (O'Cathain *et al.* 2019; Skivington *et al.* 2021). Integrating stakeholder involvement encourages meaningful intervention development and alignment with user demands, which improves the development intervention's feasibility, acceptability, evaluation and implementation. According to MRC guidance, stakeholders can be involved in the development process in different ways including a once-off consultation to understand context, or a co-production process where stakeholders generate ideas and make decisions along with developers throughout the development process (Skivington *et al.* 2021).

Stakeholder involvement in the development of the TECC intervention has been previously outlined in Chapters Three and Four. Chapter Three outlined qualitative research exploring the attitudes and perspectives of people with chronic conditions on the optimal content and design of telerehabilitation programmes for people with chronic conditions. This chapter also explored the acceptability of participation in disease-agnostic programmes delivered to groups of people with different chronic conditions. Chapter Four detailed the perceptions and attitudes of physiotherapists involved in the delivery of rehabilitation to chronic populations and their recommendations for the optimal delivery of future telerehabilitation programmes.

The perceptions of the physiotherapists regarding the delivery of disease-agnostic programmes to mixed-condition groups were also outlined in Chapter Four. The perceptions of these stakeholders and their preferences for the optimal content and design for future telerehabilitation programmes informed the development of the TECC intervention. Further stakeholder involvement to refine the developed intervention is described later in this Chapter (See 5.4.6).

#### **5.4.5 Key Uncertainties**

Following the initial development of the TECC intervention some key uncertainties remained particularly regarding the feasibility and practicality of the intervention and the planned feasibility trial. Remaining uncertainties regarding the most appropriate recruitment process, intervention content and measures to optimise safety needed to be considered before commencing the planned feasibility trial. A decision was made to form a panel of clinical experts with previous experience in service delivery to address these uncertainties. This intervention refinement process is outlined below. Furthermore, we were signposted by existing guidelines for the delivery of rehabilitation and telerehabilitation programmes, particularly with regard to safety, screening and assessment procedures (Dechman *et al.* 2020; NCP Respiratory 2023).

The exercise component of the intervention was developed by the research physiotherapists and guided by existing rehabilitation programmes and physiotherapist guidance (Association of Chartered Physiotherapists in Cardiac Rehabilitation 2015; de Souto Barreto 2017; NHS Coventry and Warwickshire 2021; Barry Walsh *et al.* 2024a). Previous telerehabilitation guidance was consulted to guide the intensity of the exercise component (Dechman *et al.* 2020; NCP Respiratory 2023). The education component was guided by recommendations

from the HSE Living Well with a Chronic Condition Framework (Chronic Conditions Working Group 2017) and the Stanford Chronic Disease Self-Management Programme (Hudon *et al.* 2016).

#### **5.4.6 Intervention Refinement**

To facilitate transition from the intervention development stage of the MRC framework to the feasibility stage, the intervention needed to be further refined (Skivington *et al.* 2021). This was conducted by engaging with potential stakeholders through a focus group session to inform the intervention refinements. We conducted a focus group with a panel of clinical experts (n= 6) including clinical specialist physiotherapists and physiotherapy managers involved in rehabilitation service delivery across various clinical areas, including musculoskeletal, cardiorespiratory and neurological patient services, in Ireland in October 2023. This panel was recruited from the clinical contacts of the research team. During the focus group session, the panel was informed of the planned intervention which had been developed in accordance with stakeholder preferences outlined in Chapters 3 and 4 and the proposal for the planned feasibility trial. The group were asked to detail their views and provide feedback and recommendations to enhance the feasibility and acceptability of the proposal based on their clinical experience.

Following the focus group, proposed changes to the planned intervention and feasibility trial from focus group members were as follows:

- Orientation session for participants to ensure correct set-up prior to intervention.
- Participants to be screened in-person by treating physiotherapists prior to referral to TECC intervention.

- Recommendations regarding planned recruitment process to explore potential to recruit from Community Chronic Disease Hubs.
- Information to be collected from participants to optimise safety during the programme including Eircode and emergency contact information and telehealth set up sheets to be provided to participants.
- Self-reported quality of life to be evaluated as a secondary outcome of interest. The Euro-QoL-5D-5L is an appropriate measure for various clinical conditions (Zhou *et al.* 2021) and was decided upon as an appropriate measure for use among the mixed-condition group in the planned feasibility study.
- Intensity of exercise performance to be self-monitored by participants and guided using the BORG Rate of Perceived Exertion (RPE) Scale.

## 5.5 Results

Following the development process, the planned intervention was described using the TIDieR checklist to ensure good reporting and intervention description (Table 5.1). The TECC intervention schedule is outlined in Table 5.2. Eligibility criteria developed for the TECC programme is outlined in Table 5.3.

*Table 5.1 TECC intervention described using TIDieR checklist (Hoffmann et al. 2014)*

Item No	Item
<b>Brief Name</b>	
<b>1</b>	<b>Provide the name or a phrase that describes the intervention.</b>

	TECC (Telerehabilitation and Exercise for Chronic Conditions): A disease-agnostic physiotherapy-led telerehabilitation programme for people with chronic conditions
<b>Why</b>	
2	<p><b>Describe any rationale, theory, or goal of the elements essential to the intervention.</b></p> <p>Rehabilitation programmes promoting exercise and self-management are an essential component of chronic condition management. Telerehabilitation has the potential to increase service accessibility by overcoming barriers to traditional in-person rehabilitation, while also offering comparable effectiveness and feasible and cost-effective service delivery method. The potential efficiency of disease-agnostic rehabilitation programmes delivered to mixed-condition groups (i.e., groups of people with various chronic conditions) has been recently recognised given the similarities noticed across the rehabilitation programmes delivered to condition-specific rehabilitation cohorts. Therefore, disease-agnostic telerehabilitation programmes delivered to mixed-condition groups may act as a sustainable and pragmatic approach to rehabilitation service delivery. (See Chapter 1 for details of the theory underpinning the intervention development).</p>
<b>What</b>	
3	<p><b>Materials: Describe any physical or informational materials used in the intervention, including those provided to participants or</b></p>

	<p><b>used in intervention delivery or in training of intervention providers. Provide information on where the materials can be accessed (such as online appendix, URL).</b></p> <p>Participants were required to use their own technological device and internet connection to engage with the intervention. The ‘Microsoft Teams’ videoconferencing platform was used to deliver synchronous components of the intervention including exercise and social components and educational webinars. Asynchronous components, including recorded exercise and education sessions and information sheets, were delivered via email (See Appendices 8.3.2 &amp; 8.3.3).</p>				
4	<p><b>Procedures: Describe each of the procedures, activities, and/or processes used in the intervention, including any enabling or support activities.</b></p> <p>The TECC intervention involved a 6-week disease-agnostic physiotherapy-led telerehabilitation programme for a mixed-condition group of people with different chronic conditions. The eligibility criteria to determine participant eligibility for the TECC programme was as follows:</p> <table border="1"> <thead> <tr> <th><b>Inclusion Criteria</b></th> <th><b>Exclusion Criteria</b></th> </tr> </thead> <tbody> <tr> <td> <ul style="list-style-type: none"> <li>Community-dwelling adults (aged <math>\geq 18</math> years old) with a confirmed diagnosis of any chronic cardiorespiratory,</li> </ul> </td> <td> <ul style="list-style-type: none"> <li>Adults who were medically unstable as deemed by the referring physiotherapist or who</li> </ul> </td> </tr> </tbody> </table>	<b>Inclusion Criteria</b>	<b>Exclusion Criteria</b>	<ul style="list-style-type: none"> <li>Community-dwelling adults (aged <math>\geq 18</math> years old) with a confirmed diagnosis of any chronic cardiorespiratory,</li> </ul>	<ul style="list-style-type: none"> <li>Adults who were medically unstable as deemed by the referring physiotherapist or who</li> </ul>
<b>Inclusion Criteria</b>	<b>Exclusion Criteria</b>				
<ul style="list-style-type: none"> <li>Community-dwelling adults (aged <math>\geq 18</math> years old) with a confirmed diagnosis of any chronic cardiorespiratory,</li> </ul>	<ul style="list-style-type: none"> <li>Adults who were medically unstable as deemed by the referring physiotherapist or who</li> </ul>				

	<p>neurological, or musculoskeletal condition. We used the ICD-10-CM definition of a chronic condition being one lasting greater than 12 months and resulting in the need for ongoing medical intervention and limiting self-care, independent living, and social interaction (World Health Organization 1993).</p> <ul style="list-style-type: none"> <li>• Medically stable and appropriate to participate in the exercise-based intervention independently and safely as deemed by self-declaration. Subsequent screening using the PAR-Q (Chisholm <i>et al.</i> 1978) identified any additional concerns which would require a discussion with one's GP prior to signing the disclaimer and participating in the intervention.</li> <li>• Access to an appropriate technological device with</li> </ul>	<p>had uncontrolled medical conditions limiting participation in exercise interventions including uncontrolled hypertension or recent acute cardiovascular events, uncontrolled atrial fibrillation, suspected underlying malignancy, etc.</p> <ul style="list-style-type: none"> <li>• Significant orthopaedic, psychological, neurological, or cognitive conditions or mobility difficulties that prevented participation in seated or standing exercise interventions as deemed by the referring physiotherapist.</li> </ul>
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	<p>an internet connection and email address to facilitate participation in the telerehabilitation intervention.</p> <ul style="list-style-type: none"><li>• Willing to provide informed consent to participate in the study.</li><li>• Good level of spoken and written English.</li></ul> <hr/> <p>The intervention consisted of weekly synchronous group exercise sessions delivered via videoconferencing by a physiotherapist. Each exercise session was structured to include a warm-up, main exercise session including resistance, aerobic, balance and flexibility training, and a cool down. There were two exercise class levels with allocation to each level being based on the participants' baseline functional mobility level assessed using the Activities-specific Balance Confidence (ABC) Scale. A threshold score of 67% on the ABC Scale was used to identify increased risk of falls (Lajoie and Gallagher 2004). Participants who scored below the threshold will be allocated to the seated exercise class, while those who scored above the threshold were allocated to the standing exercise class. Participants used the BORG Rate of Perceived Exertion Scale to guide and monitor the intensity of the exercise sessions. Recordings of exercise sessions were made available to participants via email. Participants were advised to perform additional unsupervised exercise sessions at their</p>
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own convenience to supplement the synchronous exercise sessions and facilitate adherence to physical activity guideline recommendations. At the end of each weekly synchronous exercise session participants had the opportunity to engage in a synchronous online social discussion with other participants. The social discussion was driven by patient preference and could refer to supports or issues related to chronic conditions, or non-clinical issues related to current news or events. Participants were provided access to one synchronous educational webinar per week delivered via videoconferencing by relevant healthcare professionals. These webinars explored various aspects of self-management including exercise and physical activity, goal setting, mental health, nutrition, and fatigue. Recordings of these educational webinars were also made available to participants to engage with at their own convenience.

A safety procedure was developed in advance to outline the process to be taken in the event of a medical emergency during the TECC programme. If something went wrong during the classes, the class would stop immediately, and appropriate medical advice would be sought. If something went wrong during a focus group session, the interview session would immediately stop until the researcher and participant(s) were ready to restart the session, or the session would be stopped completely. Prior to taking part in the programme, we collected information including participants' contact numbers, Eircode and a contact number of next of kin or a person to contact who

	<p>would be nearby and could check on participants in case of an emergency. Participants were advised prior to the programme to have somebody nearby when taking part in the exercise classes. In the event of lost or disrupted connection during the video call the physiotherapist delivering the programme would attempt to contact the participant via the telephone number provided. If contact was not established the physiotherapist would contact the number of the emergency contact person. If participants felt unwell during a video call, they were advised to inform the physiotherapist leading the session and all other participants would be asked to leave the video call. In the event of a sudden medical emergency, the participant would be advised to call 911 if they could follow directions. If unable to follow directions, the physiotherapist leading the session would call 911 and give the Eircode and contact information that had been previously provided. The physiotherapist would remain on the call until emergency services arrived. After finishing the call, the physiotherapist would contact the number of the emergency contact.</p>
<p><b>Who provided</b></p>	
<p><b>5</b></p>	<p><b>For each category of intervention provider (such as psychologist, nursing assistant), describe their expertise, background, and any specific training given.</b></p> <p>The exercise component of the intervention was delivered by a chartered physiotherapist and PhD researcher (CBW). The</p>

educational webinars were delivered by relevant healthcare professionals which was dependant on the webinar topic. These healthcare professionals involved in the provision of the educational webinars are listed below:

<b>Webinar Topic</b>	<b>Provider</b>
Exercise & Physical Activity	General Practitioner & Associate Clinical Professor of General Practice
Goal Setting	Clinical Specialist Physiotherapist
Nutrition and Diet	Associate Professor in Nutrition and Dietetics
Managing Your Mental Health	Senior Lecturer in Psychology
Managing Fatigue and Sleep	Chartered Physiotherapist and PhD researcher
Living with a Chronic Condition	Dietician with personal experience of chronic condition

**How**

**6 Describe the modes of delivery (such as face to face or by some other mechanism, such as internet or telephone) of the**

	<p><b>intervention and whether it was provided individually or in a group.</b></p> <p>The TECC intervention was a telerehabilitation programme involving remote delivery using telecommunication technologies. Based on the stakeholder input, the value of a combination of both synchronous and asynchronous content was noted, along with a preference for group settings. Therefore, the weekly group exercise sessions and social components were delivered via synchronous videoconferencing (using the ‘Microsoft Teams’ platform). The weekly webinars were also delivered in a group setting via synchronous videoconferencing. Recordings of each of the exercise and educational sessions were sent to participants via email.</p>
<p><b>Where</b></p>	
<p><b>7</b></p>	<p><b>Describe the type(s) of location(s) where the intervention occurred, including any necessary infrastructure or relevant features.</b></p> <p>Participants engaged with the intervention using their own technological device and internet connection while situated in their own homes. The intervention was delivered by healthcare professionals situated in a remote location. Participants were provided with an information and telehealth set up checklist prior to participating in the intervention to ensure their environment was</p>

	prepared to facilitate safe participation in the intervention (See Appendix 8.3.3).
<b>When and How Much</b>	
<b>8</b>	<p><b>Describe the number of times the intervention was delivered and over what period of time including the number of sessions, their schedule, and their duration, intensity, or dose.</b></p> <p>The TECC intervention was delivered over a 6-week period. One 45–60-minute synchronous exercise session was delivered each week. The intensity of these sessions was guided and monitored using the BORG RPE Scale. Participants were encouraged to exercise at level 14 on the BORG RPE Scale. These exercise sessions were followed by a 10–15-minute social discussion. One 45-60-minute synchronous educational webinar was delivered each week. Throughout the 6-week period participants had access to recording of the exercise and educational sessions to engage with at their own convenience. Participants were asked to record any engagement with the recorded sessions (included time spent performing unsupervised exercise and the intensity of these sessions using the BORG RPE Scale) using a self-report logbook.</p>
<b>Tailoring</b>	
<b>9</b>	<p><b>If the intervention was planned to be personalised, titrated or adapted, then describe what, why, when, and how.</b></p>

	<p>The exercise component included two different class levels which was based on the participants' baseline functional mobility level which was assessed using the Activities-specific Balance Confidence (ABC) Scale. A threshold score of 67% was used to allocate participants into an appropriate class level. Participants scoring below the threshold were allocated to the seat-based exercise class group, while those who scored above the threshold were allocated to the standing-based exercise class. The intensity of the exercise class was individualised with participants encouraged to use the BORG RPE Scale to guide the intensity of exercise they performed.</p>
<p><b>How well</b></p>	
<p><b>11</b></p>	<p><b>Planned: If intervention adherence or fidelity was assessed, describe how and by whom, and if any strategies were used to maintain or improve fidelity, describe them.</b></p> <p>Data relating to recruitment and retention rates and adherence were collected. Adherence to various components of the programme was recorded, including attendance at the orientation session and adherence to the synchronous group exercise classes, social components and educational webinars which was monitored and recorded by the researchers. Engagement with recorded sessions was measured via self-reported logbooks in which participants were encouraged to record time spent performing unsupervised exercise each week, BORG RPE ratings for unsupervised exercise sessions,</p>

	and engagement with recordings of education webinars. Retention rates were recorded as the percentage of enrolled participants who completed the post-intervention assessments and focus groups.
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Table 5.2 TECC intervention schedule

<b>Week 0</b>	Orientation sessions and pre-intervention assessments		
	<b>Standing Exercise</b>	<b>Seated Exercise</b>	<b>Education</b>
<b>Week 1</b>	Warm-up: Marching on the spot Neck movements (flexion, extension, lateral flexion, rotation) Shoulder circles Chest stretch Trunk tilts Heel taps Main exercise session: Sit to stand x 2 sets Bicep curls x 2 sets Knee lifts x 2 sets	Warm-up: Seated marching Neck movements (flexion, extension, lateral flexion, rotation) Shoulder circles Chest stretch Trunk tilts Heel taps Main exercise session: Heel taps x 2 sets Bicep curls x 2 sets Knee lifts x 2 sets	Theme: Exercise and Physical Activity Speaker: General Practitioner

	<p>Lateral raise x 2 sets</p> <p>Hip abduction x 2 sets</p> <p>Heel raises x 2 sets</p> <p>Upright row x 2 sets</p> <p>Knee extensions x 2 sets</p> <p>Cool down:</p> <p>Calf stretch</p> <p>Hamstring stretch</p> <p>Chest stretch</p> <p>Trunk tilts</p> <p>Arm stretch</p>	<p>Lateral raise x 2 sets</p> <p>Tricep kickbacks x 2 sets</p> <p>Heel raises x 2 sets</p> <p>Upright row x 2 sets</p> <p>Knee extensions x 2 sets</p> <p>Cool down:</p> <p>Calf stretch</p> <p>Hamstring stretch</p> <p>Chest stretch</p> <p>Trunk tilts</p> <p>Arm stretch</p>	
<b>Week 2</b>	<p>Warm-up</p> <p>Main exercise session:</p> <p>Sit to stand x 2 sets</p> <p>Bicep curls x 2 sets</p> <p>Side taps x 2 sets</p> <p>Frontal raise x 2 sets</p> <p>Hip extension x 2 sets</p> <p>Heel raises x 2 sets</p>	<p>Warm-up</p> <p>Main exercise session:</p> <p>Heel taps x 2 sets</p> <p>Bicep curls x 2 sets</p> <p>Side taps x 2 sets</p> <p>Frontal raise x 2 sets</p> <p>Tricep kickbacks x 2 sets</p>	<p>Theme: Goal setting</p> <p>Speaker: Clinical Specialist Physiotherapist</p>

	Shoulder press x 2 sets Knee extensions x 2 sets Tandem stance x 2 sets Cool down	Heel raises x 2 sets Shoulder press x 2 sets Knee extensions x 2 sets Cool down	
<b>Week 3</b>	Warm-up Main exercise session: Half squat x 2 sets Tricep kickbacks x 2 sets Side taps x 2 sets Lateral raise x 2 sets Hip abduction x 2 sets Heel raises x 2 sets Shoulder blade squeezes x 2 sets Knee extensions x 2 sets Marching with head turns x 2 sets Cool down	Warm-up Main exercise session: Heel taps x 2 sets Bicep curls x 2 sets Side taps x 2 sets Lateral raise x 2 sets Tricep kickbacks x 2 sets Heel raises x 2 sets Shoulder blade squeezes x 2 sets Knee extensions x 2 sets Cervical rotations x 2 sets Cool down	Theme: Nutrition and Diet  Speaker: Associate Professor in Nutrition and Dietetics

<b>Week 4</b>	<p>Warm-up</p> <p>Main exercise session:</p> <p>Half squat x 3 sets</p> <p>Bicep curls x 3 sets</p> <p>Side taps x 3 sets</p> <p>Frontal raise x 3 sets</p> <p>Standing knee flexion x 3 sets</p> <p>Shoulder press x 3 sets</p> <p>Hip extensions x 3 sets</p> <p>Single leg stance x 3 sets</p> <p>Cool down</p>	<p>Warm-up</p> <p>Main exercise session:</p> <p>Heel taps x 3 sets</p> <p>Bicep curls x 3 sets</p> <p>Side taps x 3 sets</p> <p>Frontal raise x 3 sets</p> <p>Seated marching x 3 sets</p> <p>Heel raises x 3 sets</p> <p>Shoulder blade squeezes x 3 sets</p> <p>Knee extensions x 3 sets</p> <p>Cool down</p>	<p>Theme: Mental health</p> <p>Speaker: Senior Lecturer in Psychology</p>
<b>Week 5</b>	<p>Warm-up</p> <p>Main exercise session:</p> <p>Squat x 3 sets</p> <p>Bicep curls x 3 sets</p> <p>Knee lifts x 3 sets</p> <p>Shoulder press x 3 sets</p> <p>Standing knee flexion x 3 sets</p>	<p>Warm-up</p> <p>Main exercise session:</p> <p>Heel taps x 3 sets</p> <p>Bicep curls x 3 sets</p> <p>Seated marching x 3 sets</p> <p>Shoulder press x 3 sets</p> <p>Heel raises x 3 sets</p> <p>Lateral raises x 3 sets</p>	<p>Theme: Sleep</p> <p>Speaker: Chartered Physiotherapist and PhD Researcher</p>

	Heel raises x 3 sets Upright row x 3 sets Tandem stance x 3 sets Cool down	Upright row x 3 sets Knee extensions x 3 sets Cool down	
<b>Week 6</b>	Warm-up Main exercise session: Squat x 3 sets Shoulder press x 3 sets Knee lifts x 3 sets Lateral raise x 3 sets Hip abductions x 3 sets Heel raises x 3 sets Upright row x 3 sets Single leg stance x 3 sets Cool down	Warm-up Main exercise session: Heel taps x 3 sets Shoulder press x 3 sets Seated marching x 3 sets Lateral raise x 3 sets Tricep kickbacks x 3 sets Heel raises x 3 sets Upright row x 3 sets Knee extensions x 3 sets Cool down	Theme: Living with Chronic Conditions Speaker: Chartered Dietician with experience of a chronic diagnosis

## 5.6 Conclusion

In accordance with the MRC framework for the development and evaluation of complex interventions (Skivington *et al.* 2021), this chapter describes the design and development of

a disease-agnostic telerehabilitation programme guided by physiotherapists for a group of patients with mixed chronic conditions. To guarantee a high standard of reporting and intervention description, the TIDieR framework was employed (Hoffmann *et al.* 2014), and the protocol for the planned feasibility trial (Appendix 8.1.8) was reported following the SPIRIT checklist (Appendix 8.1.9) (Chan *et al.* 2013) and registered on Open Science Framework (Barry Walsh *et al.* 2024c). A feasibility trial, detailed in Chapter Six, will assess the viability of the TECC intervention presented in this chapter.

**Chapter 6. A physiotherapy-led disease-agnostic  
telerehabilitation programme for people with chronic  
health conditions: a mixed-methods feasibility trial**

This chapter is currently under review for publication in ‘Disability and Rehabilitation’; Q1, Impact Factor 2.1.

Barry Walsh, C., Cahalan, R., Hinman, R.S. and O’Sullivan, K. (2023) ‘Exploring attitudes of physiotherapists towards the delivery of group-based telerehabilitation and their acceptability of mixed-condition group programmes for people with chronic health conditions: A qualitative study’, *Manuscript submitted for publication*

## **6.1 Chapter Outline**

This doctoral thesis aimed to identify delivery strategies and content to develop and deliver a disease-agnostic group telerehabilitation programme for people with mixed chronic conditions. As stated previously, this research focuses on the development and feasibility stages of the MRC framework for the development and evaluation of complex interventions (Skivington *et al.* 2021). Previous chapters of this thesis have outlined the development stages of the TECC intervention. This current chapter advances to focus on the feasibility stage of the framework and outlines the evaluation of the feasibility and acceptability of the TECC intervention, a disease-agnostic physiotherapy-led group exercise-based telerehabilitation programme for people with chronic conditions. This chapter also includes preliminary evaluation of the clinical effectiveness of the TECC intervention by evaluating the impact of the intervention on physical function and quality of life.

## **6.2 Abstract**

### **Background**

Exercise-based rehabilitation is an integral aspect of chronic condition management. However, the traditional in-person delivery of rehabilitation to condition-specific groups limits service accessibility. This study examined the feasibility of a disease-agnostic physiotherapy-led telerehabilitation programme for people with various chronic conditions.

### **Methods**

A mixed-methods feasibility trial was conducted examining the feasibility of the Telerehabilitation and Exercise for Chronic Conditions (TECC) programme for a mixed-condition group. The 6-week programme comprised weekly physiotherapy-led synchronous

group exercise sessions, weekly synchronous education sessions, and a social component, all delivered via videoconferencing. Recordings were also made available. Primary outcomes included recruitment, retention, adherence, satisfaction, adverse events, and participant experiences via focus groups.

## **Results**

Sixteen participants were enrolled. Fourteen commencing the intervention. Eleven participants (68.8%) were retained at follow-up. The mean number of participants who attended the synchronous exercise, education, and social sessions were 7 (50.0%), 5.2 (37.1%) and 1.3 (9.3%) respectively. No serious adverse events were reported. High satisfaction levels (93.8%) were expressed. The TECC programme was an acceptable and beneficial experience for participants.

## **Conclusions**

The TECC programme can be a feasible, pragmatic rehabilitation delivery method. However, attendance was poor, and engagement in the social component was limited. Refinements are necessary before progressing to expansive evaluation.

## **Trial Registration**

ClinicalTrials.gov (NCT06388499)

## 6.4 Introduction

Chronic conditions impose a significant burden on individuals, society, and healthcare systems worldwide (Jennings 2014; Darker *et al.* 2015; Hajat and Stein 2018). These conditions typically require long-term management leading to increased health service utilisation, healthcare costs, death and disability rates, and reduced quality of life and function levels (Sav *et al.* 2017; Hacker 2024). Chronic conditions will continue to pose a persistent challenge to our healthcare services in the future given their increasing prevalence and our ageing population (Mathers and Loncar 2006; Hernández *et al.* 2019; Mitchell and Walker 2020).

Engagement with exercise-based self-management rehabilitation programmes empowers patients to independently manage their health and wellbeing, reducing health service utilisation and expenses (de Iongh *et al.* 2015; Hoffmann *et al.* 2016; Mulligan *et al.* 2019; Richardson *et al.* 2019). Previous research has shown that these programmes are effective for a range of chronic populations, increasing participants' physical function and quality of life (Bolton *et al.* 2013; Price *et al.* 2013; Long *et al.* 2019). While evidence supports the efficacy of these programmes, they are traditionally delivered in clinical settings and can be costly, time-consuming, and inaccessible for many individuals (Desveaux *et al.* 2016; Cox *et al.* 2017; Oates *et al.* 2019; Resurrección *et al.* 2019). This often results in poor uptake and engagement levels (Jones *et al.* 2017; Hinde *et al.* 2019).

The delivery of rehabilitation remotely using telecommunication technologies such as videoconferencing, emails, telephone calls and recorded videos, also known as telerehabilitation, offers a promising alternative healthcare service delivery method. This convenient, cost-effective service delivery method could potentially increase accessibility to, and engagement with, rehabilitation (Selzler *et al.* 2018; Subedi *et al.* 2020; Hwang *et al.*

2023; Hinman *et al.* 2024). In addition to this, telerehabilitation is non-inferior to traditional in-person rehabilitation for improving clinical outcomes in various chronic populations, and participants report high levels of satisfaction and positive experiences following engagement with these programmes (Cottrell *et al.* 2017a; Appleby *et al.* 2019; Hinman *et al.* 2024; Lawford *et al.* 2024).

Previous research exploring telerehabilitation has focused on condition-specific programmes such as pulmonary telerehabilitation delivered specifically to people with chronic respiratory diseases. However, the structure and content of rehabilitation programs for various chronic populations are strikingly similar, typically consisting of progressive resistance and cardiovascular exercise training as well as educational material focused on health management, despite the variances in underlying diseases (Desveaux *et al.* 2014; Mulligan *et al.* 2019). Disease-agnostic programmes, delivered to groups of people with different chronic conditions, could be a more pragmatic service delivery method allowing for economies of scale and increased clinician flexibility by optimising resource utilisation, improving efficiency, and providing more flexible care to a diverse population (Health Information Quality Authority 2015; Barker *et al.* 2018; Boehmer *et al.* 2018; Kehoe *et al.* 2020). Disease-agnostic programme delivery could reduce the challenges of staff shortfalls leading to gaps in service delivery by encouraging clinicians to be flexible and expand their knowledge to a broader range of populations, thus reducing the reliance on specialised expertise for specific conditions (Wilkinson *et al.* 2022). Recent evidence supports the development of disease-agnostic programmes catering for a wide range of chronic conditions (Health Information Quality Authority 2015; Barker *et al.* 2018; Hevey *et al.* 2020). However, this previous research has focused on traditional in-person delivery of these programmes. Therefore, we aim to examine the feasibility of a disease-agnostic physiotherapy-led

exercise-based telerehabilitation programme for people with a range of chronic conditions, known as the Telerehabilitation and Exercise for Chronic Conditions (TECC) programme. The primary aim of this study is to examine the feasibility of the intervention by examining recruitment and retention, adherence, adverse events, and satisfaction with the intervention. A secondary aim is to examine the effect of the intervention on physical function and quality of life.

## **6.5 Materials and Methods**

### **6.5.1 Design**

A mixed-methods single-arm feasibility trial was conducted to examine the feasibility of the TECC programme for people with chronic conditions. This study was conducted and reported in accordance with the Consolidated Standards of Reporting Trials (CONSORT) 2010 statement extension for pilot and feasibility trials (Appendix 8.1.10) (Eldridge *et al.* 2016). Ethical approval was granted by the Health Service Executive (HSE) Southeastern Area Research Ethics Committee in Ireland. The trial protocol was previously registered on ClinicalTrials.gov (NCT06388499) and Open Science Framework (Appendix 8.1.8) (Barry Walsh *et al.* 2024c). The protocol was reported in accordance with the Standard Protocol Items: Recommendations for Interventional Trials (SPIRIT) checklist (Appendix 8.1.9) (Chan *et al.* 2013).

### **6.5.2 Development of the TECC programme**

The design of the TECC programme and feasibility trial was informed by discussions with key stakeholders including physiotherapists and physiotherapy managers involved in rehabilitation service provision and people with various chronic conditions (Barry Walsh *et*

*al.* 2024a; Barry Walsh *et al.* 2024b). Four focus groups were conducted with people with chronic conditions (n=18) exploring their perspectives and preferences for telerehabilitation programmes (Barry Walsh *et al.* 2024b). Two focus groups exploring the attitudes and preferences of physiotherapists involved in rehabilitation delivery for chronic populations (n=10) were also conducted (Barry Walsh *et al.* 2024a). One further focus group was conducted with clinical specialist physiotherapists and physiotherapy managers (n=6) to inform the recruitment and screening processes for the feasibility trial and to further refine the TECC intervention. The eligibility criteria (Table 6.1) and recruitment pathway were informed by the input from physiotherapists and current national and local policies and procedures in Ireland (NCP Respiratory 2023). As per current national HSE policies and procedures in Ireland for virtual rehabilitation programme delivery (NCP Respiratory 2023), it was recommended that participants be required to sign a disclaimer to agree voluntary participation in the exercise intervention at their own risk before participating in the TECC intervention. The exercise component of the intervention was developed by the research physiotherapists and guided by existing rehabilitation programmes and physiotherapist guidance (Association of Chartered Physiotherapists in Cardiac Rehabilitation 2015; de Souto Barreto 2017; NHS Coventry and Warwickshire 2021; Barry Walsh *et al.* 2024a). Stakeholders also valued the inclusion of self-management educational content in telerehabilitation programmes which informed the TECC intervention design (Barry Walsh *et al.* 2024a; Barry Walsh *et al.* 2024b). A social component was also included in the TECC programme based on stakeholder input.

### **6.5.3 Participants and Setting**

Adults with various chronic conditions, including chronic cardiorespiratory, neurological and musculoskeletal conditions, were informed of the study by treating physiotherapists from

community sites in Ireland and the networks of the research team from April to May 2024. An outline of the study was provided and those who expressed interest in participating were screened for eligibility based on the pre-defined criteria (Table 6.1) by the research team.

**Table 6.1** Eligibility criteria

<b>Inclusion Criteria</b>	<b>Exclusion Criteria</b>
<ul style="list-style-type: none"> <li>• Community-dwelling adults (aged <math>\geq 18</math> years old) with a confirmed diagnosis of any chronic cardiorespiratory, neurological, or musculoskeletal condition. We used the ICD-10-CM definition of a chronic condition being one lasting greater than 12 months and resulting in the need for ongoing medical intervention and limiting self-care, independent living, and social interaction (World Health Organization 1993).</li> <li>• Medically stable and appropriate to participate in the exercise-based intervention independently and safely as deemed by self-declaration. Subsequent screening using the PAR-Q (Chisholm <i>et al.</i> 1978) identified any additional concerns which would require a discussion with one's GP prior to signing the disclaimer and participating in the intervention.</li> </ul>	<ul style="list-style-type: none"> <li>• Adults who were medically unstable as deemed by the referring physiotherapist or who had uncontrolled medical conditions limiting participation in exercise interventions including uncontrolled hypertension or recent acute cardiovascular events, uncontrolled atrial fibrillation, suspected underlying malignancy, etc.</li> <li>• Significant orthopaedic, psychological, neurological, or cognitive conditions or mobility difficulties that prevented participation in seated or standing exercise interventions as deemed by the referring physiotherapist.</li> </ul>

- Access to an appropriate technological device with an internet connection and email address to facilitate participation in the telerehabilitation intervention.
  - Willing to provide informed consent to participate in the study.
  - Good level of spoken and written English.
- 

Recruitment took place over a 4-week period during which all participants who expressed interest were provided with an information sheet (Appendix 8.3.3), electronic consent forms (Appendix 8.4.3), and a series of electronic baseline evaluation measures to assess their suitability. Baseline measures were sent via email and included a baseline demographic questionnaire, Physical Activity Readiness Questionnaire (PAR-Q) form (Chisholm *et al.* 1978), Activities-Specific Balance Confidence (ABC) Scale (Powell and Myers 1995) (Appendix 8.5.3) and Euro-QoL-5D-5L (EQ-5D-5L) (Herdman *et al.* 2011) which were completed using Microsoft Forms. Eligible participants were then sent orientation documents (Appendix 8.1.11) via email which contained information including a telehealth set-up checklist and the BORG Rate of Perceived Exertion (RPE) Scale self-monitoring test to guide appropriate exercise intensity (Borg 1998). Participants were also invited to a synchronous online one-to-one orientation session with the primary author (CBW), which was conducted via videoconferencing using Microsoft Teams software. The purpose of the orientation session was to support and guide participant set-up for the telerehabilitation sessions, complete baseline data collection and to conduct the 30-second chair stand test (30-CST) to measure baseline physical function levels for each participant. Table 6.5 outlines the study

schedule and includes the pre- and post-intervention outcome measures administered along with the timepoints at which the measures were administered.

#### **6.5.4 Intervention**

The TECC programme comprised of a 6-week disease-agnostic exercise-based telerehabilitation programme for people with chronic conditions delivered by a chartered physiotherapist. The programme has been described using the TIDieR (Template for Intervention Description and Replication) checklist to ensure good reporting and intervention description (Hoffmann *et al.* 2014) (Table 5.1). The programme consisted of weekly synchronous exercise sessions followed by a social component, and synchronous educational webinars to promote self-management of health and well-being. Recordings of the exercise and education sessions were made available to participants each week via email. Participants were advised to perform additional exercise sessions at their own convenience to supplement the synchronous exercise sessions and facilitate adherence to physical activity guideline recommendations. Participants were advised to record any engagement with the recorded exercise and education sessions via electronic self-report logbook (Appendix 8.1.12).

##### *Exercise component*

Synchronous group exercise sessions led by a physiotherapist, were delivered weekly via videoconferencing using Microsoft Teams software. The exercise sessions included a 10-minute warm-up, 30-40-minute main exercise session which included resistance, aerobic, balance and flexibility training, and a 5-minute cool down. We initially planned to deliver the exercise sessions to two exercise group levels based on baseline functional mobility levels. It was planned that one group would perform seated-based exercises while the other group would perform standing-based exercises. Allocation to either exercise group was based on the ABC scale score with participants scoring below the threshold of 67% allocated to the seat-based exercise group (Lajoie and Gallagher 2004). Exercises were instructed and demonstrated by a physiotherapist with instructions for suitable regressions and progressions

for each exercise also provided. Participants were informed of the use of the BORG RPE Scale (Borg 1998) before the programme to guide appropriate exercise intensity during exercise performance. Participants were encouraged to exercise at an intensity of 11-14 on the BORG RPE scale during the exercise sessions.

*Educational component*

Participants were invited to attend one 45-minute synchronous educational webinar each week to promote self-management of health and well-being. These webinars were delivered via videoconferencing using Microsoft Teams software by relevant healthcare professionals. The webinar topics, guided by recommendations from the HSE Living Well with a Chronic Condition Framework (Chronic Conditions Working Group 2017) and the Stanford Chronic Disease Self-Management Programme (Hudon *et al.* 2016), are listed in Table 6.2.

**Table 6.2** Educational Component Schedule

<b>Week</b>	<b>Webinar Topic</b>	<b>Professional background of session facilitator</b>
1	Exercise & Physical Activity	General Practitioner
2	Goal Setting	Physiotherapy
3	Nutrition and Diet	Nutrition & Dietetics
4	Managing Your Mental Health	Psychology
5	Managing Fatigue and Sleep	Physiotherapy
6	Living with a Chronic Condition	Dietetics

*Social component*

At the end of each weekly synchronous group exercise session, participants had the opportunity to engage in a 10–15-minute synchronous online social interaction with other participants in the group via videoconferencing. The social component could be guided by

the research team with theme-driven discussions based on the educational topics explored in the webinars, or unregulated and left to participants to discuss subjects of their choice.

### **6.5.5 Data Collection**

#### *Primary outcomes*

The primary outcomes of interest used to examine the feasibility of the programme were recruitment and retention rates, adherence to the programme (i.e. attendance), satisfaction, adverse events and qualitative data relating to participant experiences of the programme (Table 6.3). The retention rate was based on the completion of the post-intervention CSQ-8 satisfaction measure, EQ-5D-5L, and participation in the focus group in the post-intervention phase. The adherence rate was measured based on the average number of participants who attended the synchronous group exercise sessions. Adverse events were assessed using an electronic questionnaire and were defined as any problems or injuries experienced during the study that were deemed by the participant to be more likely resulting from participation in the programme, rather than resulting from disease progression. Serious adverse events were defined as any medical occurrence resulting in death, threat to life, hospital admission or significant disability.

Qualitative data relating to participant experiences was collected using semi-structured focus groups which were conducted via videoconferencing using Microsoft Teams during the post-intervention period. Two focus groups were conducted by the primary author (CBW) with five and six participants in each group (female n=7, male n=4). Both groups lasted approximately 40 minutes. The questions were informed by an interview guide which was based on the research and clinical experience of the authors (Appendix 8.6.3). The interview guide included open-ended questions to explore the participants' experiences participating in

the TECC programme. Focus groups were recorded and automatically transcribed using Microsoft Teams software.

*Secondary outcomes*

The secondary outcomes of interest related to the clinical impact of the programme, including changes in self-reported quality of life and objective physical function, following the TECC programme (Table 6.3).

**Table 6.3** Measurement method for each outcome of interest

<b>Outcome of interest</b>	<b>Method of measurement</b>
Recruitment rate	Number of participants recruited over a 4-week recruitment period
Retention rate	Percentage of enrolled participants who complete the post-intervention assessments and focus groups
Adherence with intervention	Attendance at synchronous group exercise sessions
Satisfaction with overall intervention	CSQ-8 (4-point Likert scale employed across questions with 4 indicating high satisfaction and 1 indicating low satisfaction, total scores range from 8-32)
Satisfaction with components of intervention	NRS (score of 10= ‘extremely satisfied’, score of 1= ‘extremely not satisfied’)
Adverse events	Electronic questionnaire completed by participants via Microsoft Forms in the post-intervention period to report the occurrence of adverse events during the intervention phase.
Acceptability and experiences	Qualitative data via semi-structured focus groups

Physical function	30CST administered by the researcher (CBW) via videoconferencing using Microsoft Teams. The 30-CST is a reliable, safe and feasible measure of function and lower limb strength when administered via telehealth (Lawford <i>et al.</i> 2022; Bowman <i>et al.</i> 2023). The 30-CST was administered in accordance with guidance from a manual for the administration of performance-based tests via telehealth (Lawford <i>et al.</i> 2022).
Self-reported quality of life	EQ-5D-5L completed electronically via Microsoft Teams. The EQ-5D-5L questionnaire measures self-reported health-related quality of life across 5 dimensions using a 5-point Likert Scale. The measure also includes a visual analogue rating scale to measure the participants' self-reported health level quantitatively. The EQ-5D-5L is a reliable and valid measure that is appropriate for use across a broad range of populations and settings (Feng <i>et al.</i> 2021).

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*CSQ= Client Satisfaction Questionnaire, NRS= Numerical Rating Scale, CST= Chair Stand Test*

### **6.5.6 Statistical Analysis**

Descriptive statistics were used to describe the characteristics of the participants at baseline using proportions, percentages, ranges, means and standard deviations. Visual plots and the Shapiro-Wilk test of normality were used to assess numerical data for skewness. According to the MRC framework for developing and evaluating complex interventions, the feasibility phase of the framework should be designed to assess predefined progression criteria relating to the evaluation design or the intervention (Skivington *et al.* 2021). Primary feasibility and adherence outcomes were reported using proportions and were also evaluated using a traffic light system as reported in the feasibility trial protocol which outlined predefined progression

criteria (Avery *et al.* 2017; Barry Walsh *et al.* 2024c). The traffic light system includes red (stop until solutions found), amber (amend and proceed) and green (proceed) thresholds which indicate progression criteria to evaluate progression to a main trial (Avery *et al.* 2017). A preliminary analysis of clinical outcomes involved evaluating mean differences (with associated 95% confidence intervals) between pre-and post-intervention scores. Paired t-tests were conducted to calculate the significance of the results. Data analysis was conducted using SPSS software (v29.0.2.0) and supported by Microsoft Word and Excel for organisation and storage.

Qualitative data analysis was conducted using open inductive coding through line-by-line reading of the transcripts of the focus groups using the principles of grounded theory. Focus group data was video recorded and transcribed using Microsoft Teams software. The first author (CBW) checked the transcripts and edited minor errors relating to sound quality and accent variation, by comparing the transcripts to the video recordings. Transcripts were sent to participants to ensure accuracy and participants were invited to send any comments or edits to the research team within one week of receiving the transcripts. The transcripts were initially reviewed by CBW to familiarise with the data. Transcripts were then coded by CBW to identify themes. Microsoft Word and Excel software was used to facilitate data analysis, organisation and storage.

## **6.6 Results**

### **6.6.1 Primary Outcomes**

#### *Recruitment and Retention*

A total of 16 participants were recruited within the 4-week recruitment window, and initially enrolled to take part in the study (Table 6.4). All participants were allocated to the standing-

based exercise group based on their ABC scale scores. Therefore, the seated-based exercise class group did not proceed. Eleven (68.8%) of the 16 participants had more than one chronic condition diagnosis, while the remaining five (31.3%) reported a diagnosis of one chronic condition. Thirteen participants reported a cardiorespiratory condition, 4 participants reported a neurological condition, and seven participants reported a musculoskeletal condition.

Two individuals withdrew from the study before commencing the programme due to medical reasons (including an exacerbation of a neurological condition). Three individuals withdrew from the study during the intervention phase for personal and medical reasons (including family bereavement, and exacerbation of their respiratory and musculoskeletal conditions). Three participants were unable to complete the post-intervention 30CST outcome measure due to medical reasons (including two acute musculoskeletal complaints that occurred independent of the intervention, and one hospital admission due to an acute respiratory infection). A total of 11 participants (n=7 female, n= 4 male), of the 16 who enrolled, (68.8%) completed the 6-week intervention, post-intervention CSQ-8 and EQ-5D-5L measures and focus groups (See Table 6.5).

**Table 6.4** Participant characteristics

<b>Sex</b>	
Female	11 (68.8%)
Male	5 (31.3%)
<b>Age (Years; Mean (SD))</b>	62.8 (10.8)
<b>Residential Area</b>	

Rural	9 (56.3%)
Urban	7 (43.8%)

### Chronic Medical Conditions

Single chronic condition diagnosis	5 (31.3%)
Multimorbidity (presence of two or more chronic conditions)	11 (68.8%)

### History of Previous Telerehabilitation Participation

Yes	11 (68.8%)
No	5 (31.3%)

*Table 6.5 Study schedule diagram*

	Study Period			
	Enrolment	Allocation	Post-allocation	
Timepoint	0	0	6 weeks	8 weeks
<b>Enrolment:</b>				
Informed consent	X (n=16)			
Eligibility screen	X (n=16)			
Allocation		X (n=14)		
<b>Intervention:</b>				
TECC intervention		◆ (n=14)	◆ (n=11)	
<b>Assessments:</b>				
Activities-Specific Balance Confidence (ABC) Scale	X (n=16)			

Physical Activity Readiness Questionnaire (PAR-Q)	X (n=16)			
Baseline Questionnaire	X (n=16)			
30-second chair stand test (30-CST)	X (n=16)			X (n=8)
EURO-QoL-5D questionnaire	X (n=16)			X (n=11)
Client Satisfaction Questionnaire-8 (CSQ-8)				X (n=11)
Focus Groups				X (n=11)

*n* = number of participants

#### *Adherence*

All participants who commenced the programme attended the orientation session before commencing the intervention. Attendance rates are detailed in Appendix 8.1.13. The mean attendance rates at each of the synchronous exercise, education, and social sessions were 7 (50%), 5.2 (37.1%), and 1.3 (9.3%) participants respectively. The recordings made available to watch asynchronously were viewed by several of the 14 participants who commenced the intervention (exercise recordings *n*=10 participants (71.4%); education recordings *n*=7 participants (50%)). The mean (SD) number of asynchronous exercise sessions completed by participants each week was 2.2 (1.8). The mean (SD) rate of perceived exertion reported by participants for exercise sessions completed throughout the intervention was 13.7 (1.6) equating to a ‘somewhat hard’ level of perceived exertion.

Of the 14 participants who commenced the programme, the mean number of synchronous exercise sessions attended per participant was 3 sessions out of a total of 6 synchronous

exercise sessions (50%). Two participants (14.3%) did not attend any synchronous exercise session and subsequently withdrew from the programme. Three participants (21.4%) attended 1-3 synchronous exercise sessions, while the remaining eight participants (57.1%) attended 4 or more synchronous exercise sessions. The mean number of synchronous education sessions attended per participant was 2.2 sessions out of a total of 6 synchronous exercise sessions (36.7%). Five of the 14 participants (35.7%) did not attend any synchronous education sessions, with two of these subsequently withdrawing from the programme. Six participants (42.9%) attended 1-3 synchronous education sessions, and three participants (21.4%) attended four or more synchronous education sessions. The mean number of synchronous sessions attended per participant, including both exercise and education sessions, was 5.2 sessions out of a total of 12 synchronous sessions (43.3%). The mean number of optional social component sessions attended per participant was 0.6 sessions out of a total of six (10.0%). Seven of the 14 participants (50.0%) did not attend any of the social component, while the remaining participants (n=7) (50.0%) attended 1-3 social sessions out of a total of six sessions.

### *Satisfaction*

The CSQ-8 was completed by 11 participants following programme completion. The responses to the CSQ-8 are shown in Appendix 8.1.14. Total scores ranged from 24 to 32. The mean score was 30 (SD= 2.4), equating to a rate of 93.8% satisfaction with the overall TECC programme (See Supplementary File 9).

Appendix 8.1.14 outlines participant satisfaction with each of the programme components. Participants reported high satisfaction levels with the orientation sessions, exercise and education components, each scoring more than 8/10 on the NRS. However, a low level of satisfaction (3.6/10 NRS) with the social component was reported.

### *Adverse Events*

There were no serious adverse events reported by participants in the post-intervention questionnaire. One participant reported some minor knee joint discomfort while performing the exercises included in the programme. As stated previously, three participants withdrew from the study during the intervention phase due to personal and medical reasons that were independent of the TECC programme. Three participants who completed the programme were unable to complete the post-intervention 30CST measure due to medical reasons which were also independent of the programme.

### *Criteria to Evaluate Progression to a Main Trial*

The results from the trial have been compared with the traffic light system thresholds set in the trial protocol (Barry Walsh *et al.* 2024c) to assess the viability of progression to a main trial (Table 6.6). The recruitment (n=16) and retention rates (68.8%) were in the amber (amend) zone, while the adherence rates (50.0%) were in the red (stop) zone. The adverse events and satisfaction rate (93.8%) were in the green (proceed) zone.

**Table 6.6** Traffic light system indicating progression criteria to evaluate progression to a main trial.

<b>Criteria</b>	<b>Outcome</b>	<b>Red (stop)</b>	<b>Amber (amend and proceed)</b>	<b>Green (proceed)</b>
<b>Recruitment rate</b>	16	2 per week (8 in 4 weeks)	4 per week (16 in 4 weeks)	6+ per week (24+ in 4 weeks)
<b>Retention rate</b>	68.8%	<60%	60-70%	≥70%
<b>Adherence rate</b>	50.0%	<60%	60-70%	≥70%
<b>Adverse events</b>	No serious adverse events	>2 serious adverse events	1-2 serious adverse events	No serious adverse events
<b>Satisfaction rate</b>	93.8%	<50% satisfied	50-75% satisfied	≥75% satisfied

### *Qualitative focus group feedback*

The main themes identified from the qualitative focus group data include: 1. Shared aims; 2. Telerehabilitation perceptions; 3. Programme evaluation; and 4. Recommendations for change.

#### *Shared aims*

Participants were asked about their experience of participating in a disease-agnostic programme which included a group of participants with various chronic health conditions. Since most had participated in condition-specific rehabilitation programmes such as pulmonary rehabilitation previously, this disease-agnostic programme for a mixed-condition group was a novel experience. All participants, however, expressed no initial concerns about participating in a programme with a mixed-condition group, and noted that they did not encounter any related issues while participating in the programme. Both the exercise and education components of the intervention, according to the participants, applied to them and met their needs.

PT-08: “I will say initially it (mixed-condition group) was sort of novel because anything I've done similar to this before has all been geared towards COPD that I have. But I didn't have any problem with it, it made no odds (difference) once the exercises that you (facilitator) had put together were suitable for each of the different conditions that people had.”

PT-13: “To me personally, it didn't matter really. I didn't know what was wrong with people, what conditions they had, it didn't really matter”

Participants expressed that, although variations in their underlying medical conditions existed, all participants were striving towards the same goal of enhancing their overall health

and well-being. Participants expressed appreciation for the variety of content covered in the educational component, noting that many of the topics covered would “apply to everyone across the board” (PT-10).

PT-03: “Yeah, I just found we were all on the same aim trying to keep ourselves well. So, it was nice. And I don't think it really mattered what (condition) you had; we were all on the same goal.”

PT-10: “so many, many things overlap and we're all getting older, there are so many things that apply to you as you age that apply to everyone across the board. I thought they (education sessions) were brilliant”

### *Telerehabilitation perceptions*

Most participants expressed that they would be satisfied to participate in a similar programme again in the future, indicating that they had a positive experience with the remote online telerehabilitation programme. Some expressed their initial concerns about using technology, and a few participants encountered challenges with technology throughout the intervention. All participants did, however, affirm that this would not stop them from taking part in telerehabilitation in the future. It was recognized that participation was facilitated by the support provided by the service provider and family members. After participating in the intervention, the participants stated they felt more comfortable using technology.

PT-11: “my concern was the technology and being able to access it online and I wouldn't be au fait with a lot of the technology, and I did say to (facilitator) that there was once or twice I wasn't able to get on and but within seconds I emailed (facilitator) and she had it sorted for me. So, for me that was really helpful and now I'd like to think that I'm a bit more au fait with the technology.”

PT-01: “We can pass on the word now to say that the online works and don't be afraid of it, embrace it.”

The majority of the group emphasized how practical and convenient the telerehabilitation programme was, especially with regard to the accessibility of the asynchronous recorded content. The programme's flexibility and the ability to access the content at any time and location were appreciated by participants. There was also discussion on the advantages of the synchronous content. Participants stated that they were motivated to engage with the intervention due to the structured nature of the synchronous sessions.

PT-08: “... having the online from the comfort of your home, if it's raining you don't have to worry about getting out somewhere or sitting in traffic for half an hour.”

PT-01: “The big thing for me is the recordings...when you're doing the exercises, if you're a bit under pressure, you can pause it, you can go back to it whenever you feel like it...you can do your few little jobs, then you come back and you can continue exercising, which is much more beneficial, I think, than being in a class where you have to get everything done within the hour. So, the recordings are great, that's what I found really good.”

### *Programme evaluation*

Participants listed several benefits of participating in the program, and generally expressed satisfaction with the experience. Self-reported physical benefits including improved breathing, and increased strength and energy levels. Some participants reported the exercise component was challenging but manageable, while participants valued the options to modify exercises with regression and progression options to suit their individual needs. It was also observed that the BORG rate of perceived effort scale was helpful in guiding the intensity of the exercise component to cater for individual needs.

PT-02: “I find if I'm sitting in the chair, and when I stand up, I find it easier to stand up. I'd be grunting before, but I do less grunting now and stand-up kind of better and easier.”

PT-03: “I really enjoyed it, I felt stronger and felt more energetic while I was doing it.”

Participants reported that the education component provided them with a deep understanding of the value lifestyle modifications and self-management strategies. Participants also cited some practical ‘hints and tips’ which they gained from the educational sessions which they have since incorporated into their lives to self-manage their health and wellbeing.

PT-11: “The one thing I think the Doctor who talked the first week and it just seems to be sticking in my head is he talked about exercise snacking. And that's been, if I'm standing doing the dishes or cooking, going up on my heels and back down, they (exercises) don't have to be in the chunks that the little ones can also help. So, for me, that was a great suggestion.”

PT-08: Well, that's one of the things I found about all the (education) talks there was something practical in all of them.

### *Recommendations for change*

Poor engagement with the social component of the programme was noted. This was attributed to factors including time limitations, social anxiety and fear related to the discussion of their medical conditions. Participants offered suggestions to improve this component of the programme in the future including a group introduction session prior to commencing the programme or exercise session, and increased support from the programme facilitator to encourage social interaction among the participants. Some participants noted that they prefer

to socialise in-person, and they rather use the telerehabilitation programme for the exercise and education components rather than for social purposes.

PT-08: “I have to say, I probably felt a little bit anxious about the talks (social component) that I didn't actually join in any of them, but it coincidentally I just had stuff on at the same time. So, it was simple for me to say, look great, thanks, good luck, see you again.”

PT-03: “Yeah, to me if I'm picking the time for exercise... I'm always making extra lists for myself and jobs that I need to do, but I didn't really have time for the chats, I did well to do the exercise.”

To promote individual, unsupervised exercise performance between the group synchronous sessions, some participants also suggested the availability of a visual print-out of the exercise sessions. There were no further recommendations for enhancements to the education or exercise components of the intervention.

### **6.6.2 Secondary Outcomes**

The pre- and post-intervention secondary outcome results are presented in Table 6.7 and Figure 6.1. Eight participants completed the post-intervention 30CST physical function assessment. There was evidence of improvements ( $p < 0.001$ ) in physical function from pre-intervention to post-intervention, as measured by the 30CST, MD= 3.1 (95% CI 4.4, 1.8). Eleven participants completed the post-intervention EQ-5D-5L measure assessing changes in quality of life. There was no evidence of improvement observed in self-reported quality of life from pre- to post-intervention, as measured by the EQ-5D-5L Index Values, MD= 0.0 (95% CI 0.3, -0.3) ( $p$ -value= 0.664), and Visual Analogue scale (VAS) scores, MD= 3.636

(95% CI 9.5, -2.2) (p-value= 0.195). Figure 6.1 presents the pre- and post-intervention scores for each EQ-5D-5L dimension used to assess self-reported quality of life.

**Table 6.7** Secondary outcomes pre- and post-intervention

Measure	Pre-intervention	Post-intervention	Mean difference (95% CI)	P-value	Effect size (Cohen's d)
30CST (n=8)	12.4 (SD= 3.2)	15.5 (SD= 3.7)	3.1 (4.4, 1.8)	<0.001	2.0
Euro-QoL-5D-5L Index Values (n=11)	0.5 (SD=0.4)	0.5 (SD=0.4)	0.0 (0.3, -0.3)	0.664	0.0
Euro-QoL-5D-5L VAS (n=11)	62.7 (SD= 16.6)	66.4 (SD= 17.3)	3.6 (9.5, -2.2)	0.195	0.4

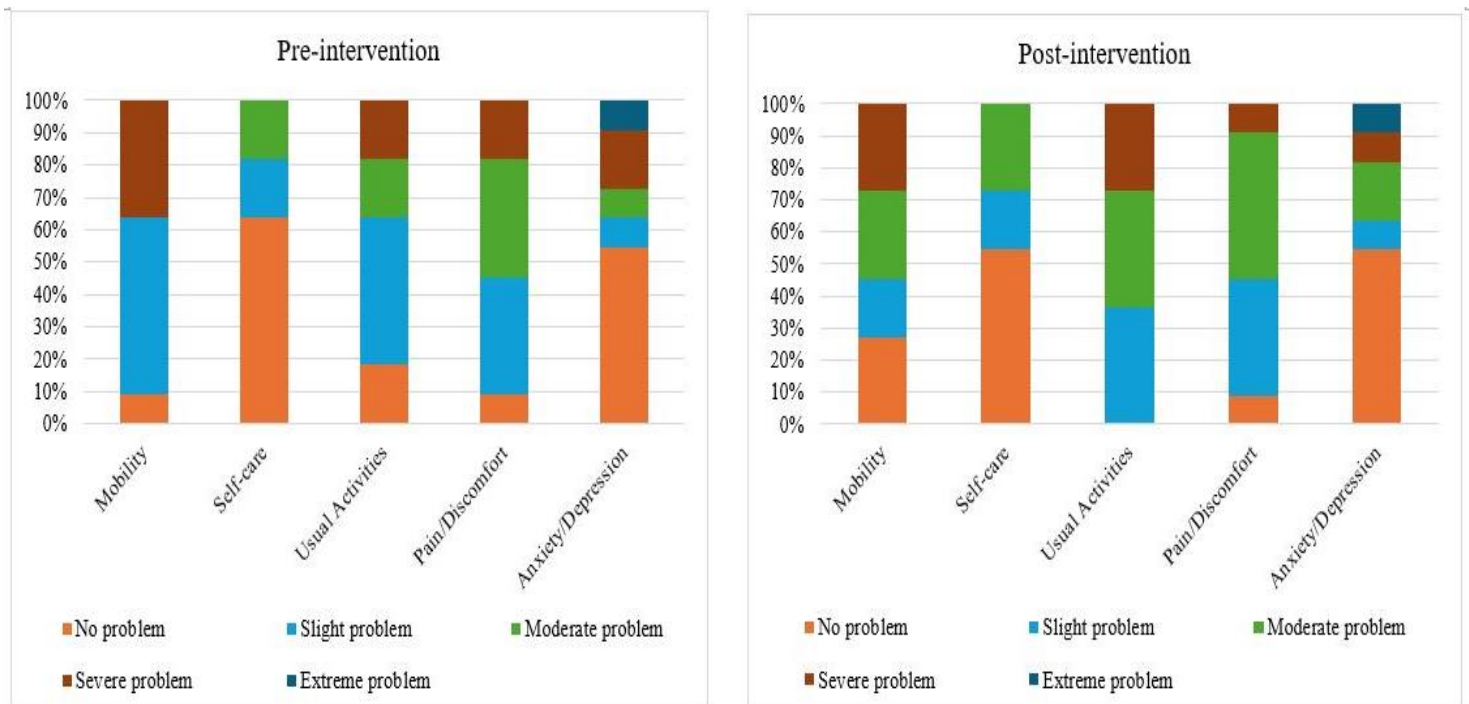


Figure 6.1 EURO-QoL-5D-5L outcomes pre- and post-intervention

## 6.7 Discussion

This study examined the feasibility of the TECC programme, a disease-agnostic physiotherapy-led exercise-based telerehabilitation programme for people with chronic conditions. This study also included a preliminary evaluation of the clinical effectiveness of the programme.

Our findings indicate that the TECC programme is feasible and acceptable among participants, however, our results also suggest that some significant amendments to the programme are necessary before progressing to a main trial. The recruitment rate did not meet the pre-set thresholds and desired sample size outlined in the trial protocol (Barry Walsh *et al.* 2024c). However, given the scope of the PhD timelines and resources, this trial adopted a pragmatic proof of concept approach. Therefore, participants were recruited promptly within a narrow recruitment period and pathway over 4 weeks by physiotherapists in a limited number of clinical settings. The recruitment pathway should be broadened for future trials and an extended recruitment period could enhance recruitment rates. The retention of participants who commenced the intervention phase and progressed to complete the post-intervention assessments was satisfactory, thus showing promise for a future, more expansive intervention and trial.

The adherence rate, as measured by synchronous exercise session attendance, did not meet the a priori traffic light system thresholds that we set in the study protocol (Barry Walsh *et al.* 2024c). It is important to note that this adherence rate was based on the mean attendance at the synchronous group exercise sessions only. Perhaps attendance with the synchronous group exercise sessions was poor due to the availability and convenience of the asynchronous recorded sessions. Most participants reported some engagement with the asynchronous recorded content including both the recorded exercise and education sessions. This reinforces the value of including both synchronous and asynchronous content which has been

previously cited by people with chronic conditions (Barry Walsh *et al.* 2024b). However, due to inconsistent engagement with the self-reported logbook and incomplete recording, it is difficult to accurately report adherence to the asynchronous recorded content. Some participants engaged in other exercise rehabilitation classes during the intervention period which may also have contributed to the poor attendance rate at the synchronous group exercise sessions. Therefore, the adherence rate reported for comparison with the traffic light system threshold should be interpreted with caution. Future research should evaluate adherence to the asynchronous programme content to include a more accurate representation of participant adherence to the overall programme. Consideration should also be given to intervention amendments that could engage participants more effectively and improve participant attendance. A largely positive, enjoyable, and beneficial experience was reported by those who participated in the telerehabilitation programme. The programme was also safe, with no serious adverse events reported, convenient and flexible.

Furthermore, a preliminary evaluation of the clinical effectiveness of the TECC programme demonstrated evidence of improvements in objective physical function following participation. However, evidence of improvements in self-reported quality of life were not observed. Although further evaluation would be needed to establish the clinical efficacy of the programme, results from the initial evaluation are promising.

Participant satisfaction with the TECC programme was remarkably high. The orientation video call, exercise, and education components were reported by participants to be particularly useful and enjoyable. However, despite previous research promoting the inclusion and importance of opportunities to facilitate social interaction during telerehabilitation programmes (Barry Walsh *et al.* 2024b), the social component of the TECC programme was reported to be substantially less useful for participants. This was reflected

by the poor uptake and engagement with the social component during the programme with 50.0% of participants not attending any social session and the remaining participants attending less than half of the social sessions. The qualitative data suggests that this was attributed to various factors such as time limitations and participant fear and anxiety regarding the nature of the social interaction. This mirrors previous findings of Cahalan *et al.* (Cahalan *et al.* 2022) who also reported poor attendance at the optional social component of a telehealth intervention because of similar reasons. Previous qualitative findings of Barry Walsh *et al.* (2024b) highlighted participants' desire for the inclusion of a social component within telerehabilitation programmes. However, this research was completed shortly after the COVID-19 pandemic, a time when there was limited opportunity for in-person social interaction due to cocooning and social distancing requirements. Perhaps now that in-person social events and activities have recommenced as usual, people can engage in social activities elsewhere and no longer desire these opportunities to be included in telerehabilitation programmes. Proposed improvements to the social element of the TECC programme such as the inclusion a group introduction session prior to commencement of exercise sessions, or increased support from the programme facilitator to encourage social interaction, should be explored with potential participants in advance of any such amendments.

Overall, the encouraging findings from this study endorse previous literature supporting the convenience, feasibility, acceptability and clinical effectiveness of telerehabilitation interventions for a wide range of chronic populations (Cox *et al.* 2022; Hawley-Hague *et al.* 2023; Hinman *et al.* 2024; Lawford *et al.* 2024). Additionally, the present study adds a novel finding to the existing research suggesting that these positive results are also obtained with the delivery of a disease-agnostic telerehabilitation programme to a mixed-condition group. Furthermore, our research shows that this method of healthcare service delivery to a

heterogeneous group is acceptable among people with chronic conditions. Previous evidence suggests that disease-agnostic programmes for people with various chronic conditions have the potential to maximise resource utilisation allowing for greater economies of scale when compared to traditional rehabilitation service delivery methods focusing on condition-specific populations (Desveaux *et al.* 2016). Given the increasing prevalence of chronic conditions and particularly the increasing incidence of multimorbidity (the co-occurrence of two or more chronic conditions) (Navickas *et al.* 2016), our results are promising and may encourage this novel and pragmatic approach to healthcare service delivery which may help to manage the increasing challenges and demands being placed on our healthcare services.

There are some limitations to this research that should be acknowledged. The sample size included in this study was relatively small and did not reach the target sample size set in the trial protocol (Barry Walsh *et al.* 2024c). However, the sample included participants diagnosed with a wide variety of chronic conditions spanning chronic cardiorespiratory, neurological and musculoskeletal conditions. Based on the ABC scale scores all participants were allocated to the standing-based exercise group, therefore the planned seated-based exercise class was not required. Furthermore, some of the included participants were unable to complete the post-intervention physical function assessments due to medical reasons, therefore the number who completed the assessments of physical function was smaller. Some participants engaged in other exercise rehabilitation classes during the intervention period. Data relating to engagement with the asynchronous content was collected through self-report by participants. However, participant logbook records were inconsistent and largely incomplete, undermining the accuracy of adherence rates reported. The primary author was involved in programme delivery and data collection including focus group facilitation.

Therefore, this data may have been subject to an increased risk of bias due to the lack of blinding.

The results of this preliminary evaluation are encouraging and suggest that the TECC programme is safe and satisfactory and progression to further evaluation may be warranted. However, amendments and improvements must first be made to improve recruitment, retention and adherence rates before progression to a main trial. Our findings are promising and indicate that this novel method of rehabilitation service delivery for people with chronic conditions could potentially be a pragmatic, viable and effective approach to healthcare service delivery.

## **6.9 Conclusion**

To our knowledge, this is the first original research study exploring the feasibility of a disease-agnostic physiotherapy-led exercise-based telerehabilitation programme for people with chronic conditions. While further evaluation is needed, our initial evaluation suggests that the TECC programme is a safe and acceptable intervention. However, participant attendance and adherence to the programme was poor. Therefore, consideration needs to be given to solutions and intervention amendments that focus on improving the recruitment and retention of participants and their adherence to synchronous content. The social component was of limited interest and was poorly attended by participants. Improvements to this component of the intervention also need to be considered. The results serve as a foundation for the future development of telerehabilitation interventions. Further amendments and progressive refinement of the programme need to be considered before embarking on a full-scale evaluation (Skivington *et al.* 2021).

## **6.10 Acknowledgments**

The authors would like to thank those who participated in this study for their contributions, gatekeepers at recruitment sites for their contribution and support with participant recruitment, and the healthcare professionals involved in the delivery of the educational component of the intervention.

**Chapter 7. Discussion, Limitations, Practical Implications,  
Future Directions and Conclusion**

## 7.1 Chapter Outline

The aim of this doctoral thesis was to identify delivery strategies and content to support the development of a disease-agnostic group telerehabilitation programme for people with mixed chronic conditions. This current chapter aims to synthesise the research and discuss the findings of the thesis in relation to the existing literature. This chapter also includes the strengths and limitations of the research, practical implications for practice and future research, and draws conclusions based on the research included in this doctoral thesis.

## 7.2 Introduction

The aim of this doctoral thesis was to identify delivery strategies and content to inform a disease-agnostic physiotherapy-led group telerehabilitation programme for people with mixed chronic conditions (TECC), with a view to informing future healthcare and rehabilitation delivery strategies. To achieve this aim, a number of specific objectives were outlined (**Chapter One**) and a systematic programme of research, guided by the MRC framework, was developed and undertaken (Skivington *et al.* 2021).

This research encompassed five inter-related phases, including:

- A comprehensive review of the existing evidence (**Chapter Two**);
- A qualitative evaluation of the perspectives and experiences of people with chronic conditions towards telerehabilitation (**Chapter Three**);
- A qualitative evaluation of the perspectives and experiences of physiotherapists involved in rehabilitation delivery towards telerehabilitation delivery (**Chapter Four**);

- The design and development of a novel disease-agnostic physiotherapy-led telerehabilitation programme for a group with mixed chronic conditions (**Chapter Five**);
- And finally, the evaluation of the feasibility and acceptability of the disease-agnostic group telerehabilitation programme also known as the TECC programme (**Chapter Six**).

To our knowledge, this is the first evaluation of the feasibility of a disease-agnostic physiotherapy-led telerehabilitation programme for mixed-condition groups. This chapter summarises the key findings from the research and explores the potential impact of the findings upon healthcare service delivery and future directions of research.

## **7.3 Summary of Findings**

### **7.3.1 Systematic review of psychometric properties of performance-based measures of physical function administered via telehealth among people with chronic conditions (Chapter Two)**

This chapter reviewed the existing literature regarding the psychometric properties of performance-based measures of physical function when administered via telehealth among people with various chronic conditions (Barry Walsh *et al.* 2022). One of the challenges limiting the uptake of telerehabilitation is the perceived difficulty of administering performance-based outcome measures and the uncertainty regarding the reliability and accuracy of the measures when administered via telehealth (Mani *et al.* 2017; Bennell *et al.* 2021; Malliaras *et al.* 2021). Previous reviews have explored the accuracy of physiotherapy assessments conducted via telehealth among condition-specific groups such as people with chronic musculoskeletal conditions (Mani *et al.* 2017; Grona *et al.* 2018). The accuracy of

various clinical assessment procedures administered via telehealth among various clinical populations had also been previously reviewed (Zischke *et al.* 2021). However, the psychometric properties of performance-based outcome measures administered via telehealth among people with various chronic conditions had not been examined previously. Therefore, there was no consensus regarding the appropriate measures to administer to mixed-condition groups via telehealth making it difficult to identify measures that would be appropriate to use for the planned disease-agnostic telerehabilitation intervention. Our review allowed us to identify several performance-based measures of physical function across the domains of exercise capacity, strength, balance and general functional capacity that may have sufficient reliability and criterion validity when administered via telehealth. These findings support those of previous research, which also suggested that clinical assessments and outcome measures may be reliable and valid when administered via telehealth (Mani *et al.* 2017; Grona *et al.* 2018; Holland *et al.* 2020; Houchen-Wolloff *et al.* 2020; Zischke *et al.* 2021). The findings of our review were encouraging and suggested that several measures may be appropriate to use to measure physical function among people with various chronic conditions via telehealth. However, the evidence was of low-very low quality, reflecting the small number of studies conducted and the small sample size included in the existing literature. None of the included studies reported data on measurement error or responsiveness. Therefore, although the results were encouraging, it is not possible to make strong conclusions regarding the accuracy of the measures when administered via telehealth. Conclusive recommendations regarding the optimal performance-based measure of physical function for administration among people with different chronic conditions via telehealth could not be made based on the findings of the review. The need for future research exploring measurement error, responsiveness, interpretability, and feasibility of performance-based

measures of physical function when administered via telehealth among people with chronic conditions was highlighted following the review. A review of relevant studies published since publication has revealed the availability of additional potentially viable outcome measures, but robust conclusions remain elusive, and the area requires further research.

### **7.3.2 Qualitative evaluation of perspectives and experiences of people with chronic conditions towards telerehabilitation (Chapter Three)**

This qualitative evaluation provided insight into the attitudes of a diverse group of people with various chronic conditions towards telerehabilitation and explored their acceptability of a proposed disease-agnostic telerehabilitation intervention. Previous literature had explored the perspectives and experiences of people with specific chronic conditions (Cranen *et al.* 2012; Hwang *et al.* 2017a; Shulver *et al.* 2017; Tyagi *et al.* 2018). The benefits, challenges, barriers and facilitators expressed by participants in our study reflected those previously cited. However, our research added valuable insight from a diverse patient group, particularly regarding their preferences for future telerehabilitation programmes. The preferences and insights expressed helped to guide the development of a disease-agnostic telerehabilitation intervention for a mixed-condition group. To our knowledge, this was the first study to explore the acceptability of a disease-agnostic telerehabilitation intervention among people with various chronic conditions.

The findings initially gathered in this chapter highlighted the value of telerehabilitation perceived by patients but also the perceived limitations of this method of healthcare service delivery. While people with various chronic conditions value telerehabilitation, they expressed the opinion that it is best used as an adjunct to traditional in-person rehabilitation, not as a complete replacement. Challenges and barriers experienced by people with chronic

conditions that limit patient uptake and engagement with telerehabilitation included challenges associated with the use of technology, perceptions of reduced quality of care, and concerns regarding safety and social limitations. Recommendations that were provided to facilitate patient participation included the provision of technological support and appropriate equipment for participation. The benefits of telerehabilitation identified by the people with various chronic conditions included the convenience, safety benefits and facilitation of social interaction with peers.

The preferences of people with various chronic conditions for future telerehabilitation programmes were explored in this qualitative evaluation and informed subsequent development of the TECC intervention. People with chronic conditions expressed preference for a hybrid model of rehabilitation including both synchronous and asynchronous telerehabilitation delivery methods. Small group sizes for exercise classes were preferred. The inclusion of exercise, education and social components in telerehabilitation programmes was valued by people with chronic conditions. The preferred duration for telerehabilitation programmes was 6-8 weeks, including classes of 45 minutes to one hour in duration. People with chronic conditions also valued the delivery of telerehabilitation programmes by healthcare professionals.

Another key contribution of this chapter was the exploration of the acceptability of disease-agnostic telerehabilitation programmes among people with various chronic conditions. Following this qualitative evaluation, the degree to which people with different chronic conditions would engage in a disease-agnostic telerehabilitation programme with a mixed-condition group of people with different chronic conditions remained unclear and varied between groups with different conditions. Most of the people with chronic conditions were open to the suggestion of participating in future disease-agnostic telerehabilitation

interventions for mixed-condition groups if it could be tailored to meet their needs and guided by a healthcare professional.

### **7.3.3 Qualitative evaluation of perspectives and experiences of physiotherapists involved in rehabilitation delivery towards delivery of telerehabilitation (Chapter Four)**

Chapter Four presented a qualitative evaluation of the perspectives and preferences of physiotherapists involved in the delivery of rehabilitation to diverse patient groups with various chronic conditions. Previous research exploring the perspectives of physiotherapists tended to be condition-focused and therefore it was not clear if the benefits and challenges associated with this healthcare delivery method as perceived by physiotherapists were similar or differed across various clinical areas (Cottrell *et al.* 2017b; Damhus *et al.* 2018; Malliaras *et al.* 2021). Similarly to the perspectives of the people with chronic conditions discussed in the previous chapter, telerehabilitation was considered a valuable and convenient method of healthcare service delivery for people with chronic health conditions by physiotherapists. The benefits of telerehabilitation delivery discussed by physiotherapists which were similar to those which were also noted by people with chronic conditions included efficiencies such as time and cost efficiencies, increased service accessibility, and safety benefits for patients. Another benefit noted by the physiotherapists which had not been discussed by people with chronic conditions in the previous chapter was the development of new skills for both clinicians and people with chronic conditions. Physiotherapists also provided insight into the challenges associated with delivering telerehabilitation which included difficulties associated with the use of technology for both clinicians and patients, clinical delivery issues such as challenges associated with conducting assessments via telehealth and the inability to provide hands-on therapy, and safety issues such as privacy issues and difficulty monitoring patients remotely. The clinical delivery issues were particularly highlighted by those involved in the

delivery of services to chronic musculoskeletal populations but were echoed by the other physiotherapists working across diverse clinical areas. The challenges noted by the physiotherapists were largely similar to those previously noted by people with chronic conditions.

Recommendations were provided by physiotherapists in this chapter to optimise future telerehabilitation implementation and delivery and particularly to inform the development of the TECC programme. Similarly to people with chronic conditions, physiotherapists also expressed a preference for a hybrid model of rehabilitation. However, in addition to the preferences for future programmes, the physiotherapists provided further recommendations to optimise future telerehabilitation delivery. Physiotherapists recommended that an initial in-person assessment should be conducted with patients before engaging in a telerehabilitation programme. A desire for further training, guidance, and support for physiotherapists to facilitate the delivery of telerehabilitation services was also expressed. Physiotherapists discussed the perceived inferiority of telerehabilitation services and highlighted the need for promotion of the availability and efficacy of telerehabilitation services among healthcare staff and patients to enable greater uptake and engagement with future programmes.

The perceived benefits, challenges and recommendations for future programmes identified by our research largely concurred with previous research exploring the attitudes of physiotherapists involved in the telerehabilitation delivery for specific clinical populations (Cottrell *et al.* 2017b; Damhus *et al.* 2018; Albahrouh and Buabbas 2021; Malliaras *et al.* 2021; Reynolds *et al.* 2021; Ross *et al.* 2022). However, our findings added a unique contribution to existing research by exploring the acceptability of the delivery of disease-agnostic telerehabilitation programmes for mixed-conditions groups among physiotherapists.

The acceptability of disease-agnostic telerehabilitation programmes among physiotherapists varied, similarly to the acceptability among people with chronic conditions. Some demonstrated apprehension and resistance to the proposal, while others considered the value of this delivery method. Some physiotherapists voiced concerns regarding the feasibility of delivering disease-agnostic programmes for mixed-condition groups. However, some valued the pragmatic nature of the proposed disease-agnostic programmes, particularly for patients with co-morbidities participating in rehabilitation interventions.

#### **7.3.4 Design and Development of TECC intervention (Chapter Five)**

This chapter outlined the design and development of the TECC intervention, a disease-agnostic physiotherapy-led group telerehabilitation programme for people with chronic conditions was guided by the MRC framework for developing and evaluating complex interventions (Skivington *et al.* 2021). The development of this novel disease-agnostic telerehabilitation intervention was informed by the findings of the previous chapters, including the systematic review and qualitative research.

Key components of the TECC intervention development including planning the development process, understanding context, reviewing the existing evidence base, stakeholder involvement and key uncertainties were presented in this chapter (O'Cathain *et al.* 2019). To facilitate the transition from the intervention development stage of the MRC framework to the feasibility stage, the intervention needed to be refined further in advance of the feasibility trial. This was conducted by engaging with a panel of clinical experts involved in rehabilitation service delivery which informed subsequent refinements to the proposed intervention and planned feasibility trial and particular recommendations were provided regarding the recruitment process and eligibility criteria for the feasibility trial.

### **7.3.5 Feasibility testing of TECC intervention (Chapter Six)**

This chapter presented a mixed-methods single-arm feasibility trial conducted to examine the feasibility and acceptability of the disease-agnostic physiotherapy-led telerehabilitation developed in Chapter Five titled the TECC programme. The potential of disease-agnostic self-management rehabilitation programmes delivered in person in clinical settings was previously explored in the literature (Barker *et al.* 2018; Hevey *et al.* 2020). However, despite the benefits of rehabilitation service delivery via telehealth, previous telerehabilitation research focused on the delivery of condition-specific telerehabilitation services. Therefore, this was the first study, to our knowledge, that explored the feasibility of a novel disease-agnostic telerehabilitation intervention for a mixed-condition group with various chronic conditions.

The TECC programme comprised of a 6-week disease-agnostic physiotherapy-led telerehabilitation programme consisting of weekly synchronous exercise and education sessions delivered by healthcare professionals via videoconferencing. Recordings of the exercise and education sessions were provided to patients also. Participants were provided an opportunity to participate in an optional social interaction component with other group members.

Sixteen participants enrolled in the trial with 14 commencing the intervention phase. Eleven participants (68.8%) were retained at follow-up. The results of the feasibility trial were encouraging and suggest that the TECC programme may be a feasible, viable and acceptable method of healthcare service delivery. However, the programme was poorly attended, and the optional social component of the programme was of limited interest among participants. Participant attendance at the synchronous sessions was limited, however, participation in the optional social sessions was particularly poor. There were no serious adverse events reported.

High satisfaction levels (93.8%) with the overall TECC programme were expressed by those who completed the programme. Qualitative data collected through semi-structured focus groups in the post-intervention assessment phase showed that the disease-agnostic telerehabilitation programme for the mixed-condition group was an acceptable, enjoyable, and beneficial experience for participants. The results of the trial were promising and serve as a foundation for the future development of telerehabilitation interventions. However, consideration needs be given to intervention amendments and solutions to improve recruitment, retention and adherence rates before progression to a main trial.

## **7.7 Strengths and Limitations**

This doctoral thesis follows a systematic and robust approach to intervention development informed by the MRC framework for developing and evaluating complex interventions (Skivington *et al.* 2021). Recognised reporting tools and standards were used throughout the project to ensure robust and high-quality research. Chapter Two presented a systematic review conducted in accordance with PRISMA guidelines (Appendix 8.1.2) (Page *et al.* 2021) and COSMIN methodology. To enhance transparency, the systematic review protocol was registered with Prospero (Registration number: CRD42021262547) (Appendix 8.1.1). Chapters Three and Four presented original qualitative research conducted and reported following COREQ guidance to ensure explicit and comprehensive reporting of the qualitative research (Appendices 8.1.6 & 8.1.7) (Tong *et al.* 2007). The TIDieR Checklist was included in Chapter Five to describe the TECC intervention developed to enhance the completeness of reporting and replicability of the intervention (Table 5.1) (Hoffmann *et al.* 2014). The feasibility trial protocol was registered on Open Science Framework (Appendix 8.1.8) and ClinicalTrials.gov and was reported following the SPIRIT Checklist (Appendix 8.1.9) (Chan *et al.* 2013). The feasibility study presented in Chapter Six was reported following the

CONSORT statement extension to pilot and feasibility trials to improve the transparency and quality of reporting (Appendix 8.1.10) (Schulz *et al.* 2010; Eldridge *et al.* 2016).

The mixed-methods approach ensured stakeholders had meaningful opportunities to engage in, and shape the intervention at multiple stages throughout its development. A strength of this research was the diverse stakeholder group, including people with chronic conditions and physiotherapists involved in rehabilitation service delivery, involved in the intervention development process. We engaged with both service users and service providers who had and had not, previously engaged with telerehabilitation services, which provided a wide range of perspectives and insights. A diverse group of people with various chronic conditions spanning chronic cardiorespiratory, neurological and musculoskeletal conditions were involved throughout the research project. We also worked with a broad clinical stakeholder group during the intervention development, including physiotherapists involved in rehabilitation delivery, clinical specialist physiotherapists and physiotherapy managers, to ensure that the intervention was not merely aspirational but reflected the pragmatic and operational realities of clinical practice.

The specific limitations of each study have been previously mentioned in the respective chapters (Chapters Two-Six). As discussed previously, due to the heterogeneous nature of the included studies in the systematic review a meta-analysis could not be performed. Furthermore, the lack of research exploring the psychometric properties of performance-based measures of physical function administered via telehealth, particularly high-quality research, and the limited nature of the information reported regarding the feasibility, interpretability, and measurement error of measurement instruments limited the findings of our review. The small sample sizes included in our qualitative research (Chapters Three and

Four) and feasibility trial (Chapter Six) have been previously highlighted as a limitation of the research.

All of the research in this doctoral thesis, including the studies within the systematic review, the qualitative research, and the feasibility trial were conducted in ‘very high’ developed countries according to HDI scores (World Population Review 2024). This may limit the applicability and generalisability of the research. Our findings may not be representative of developing and underdeveloped countries in which populations face socio-economic barriers, and limited access to healthcare, rehabilitation services, and advanced technology. Furthermore, various cultural factors may also limit the uptake and engagement with telerehabilitation services. Therefore, while the findings of the research may provide valuable insights into the potential for a sustainable and pragmatic approach to healthcare service delivery, the need for further research and adaption of the intervention to address unique challenges faced by various populations is evident.

The feasibility trial allowed for a small-scale exploration of the feasibility of the TECC intervention, which was an appropriate approach to achieve the aim of the thesis. However, given the single-arm approach, the lack of randomisation and comparison group could be viewed as a limitation of the research. Additionally, while the feasibility trial allowed us to achieve the aim of the thesis, it did not allow us to evaluate the effectiveness of the TECC intervention. All the participants that were recruited for the feasibility trial were allocated to the standing-based exercise group based on their ABC scale score, despite the original plan to include two exercise groups, a standing-based exercise group and a seated-based group. This may have been due to the narrow recruitment pathway used to achieve the aims of the research within the available time and resources. Consequently, the planned seated-based exercise group was not required. This could be viewed as a limitation of the research as the

sample included those with higher levels of physical function and excluded participants who, based on their ABC scale scores, were at higher risk of falling.

## **7.8 Potential Impact and Implications**

### **7.8.1 Potential Implications for Practice**

The results of this research into the development and feasibility of a disease-agnostic telerehabilitation programme for people with various chronic conditions could potentially carry significant implications for practice in the fields of physiotherapy, rehabilitation, and wider healthcare systems. The potential of this new and innovative healthcare service delivery method to support improved patient outcomes, increased service accessibility, and more efficient and pragmatic service delivery are worthy of further exploration.

Given the aging population and increasing prevalence of chronic disease in Ireland, the management of these conditions has become a key priority of the government and national healthcare service (Health Service Executive 2020). The need for an improved standard of care and a shift in focus from hospital-centred care to person-centred, holistic, and proactive care has recently been highlighted in the National Framework for Integrated Prevention and Management of Chronic Disease (Health Service Executive 2020) to create a more sustainable healthcare service. This Framework aims to inform future development of policy, strategy, models of care, and services to prevent and manage chronic conditions and improve health outcomes. Some of the more specific objectives of the Framework include facilitation of care in the community and moving away from a disease-specific focus. The aims and objectives of this Framework align with the aims of this doctoral thesis to develop a disease-agnostic telerehabilitation programme for the management of various chronic conditions.

Rehabilitation is an integral aspect of chronic condition management, promoting independent self-management of patients' health and wellbeing, improving patients' physical function and quality of life, and reducing healthcare service usage and risk of hospital admission (Richardson *et al.* 2019). However, despite the benefits of these interventions, the traditional in-person delivery of rehabilitation limits service accessibility and patient uptake and engagement. Traditional programmes require patients to attend clinical sites, creating barriers to participation such as geographical, transportation, and time limitations (Chindhy *et al.* 2020; Bakhshayeh *et al.* 2021). The remote delivery of rehabilitation through telehealth, as used in the delivery of the TECC programme, eliminates these barriers to participation allowing people with chronic conditions to access rehabilitation conveniently from the comfort of their homes (Richardson *et al.* 2019; Chindhy *et al.* 2020; Bakhshayeh *et al.* 2021). This accessibility can enhance rehabilitation uptake and engagement, particularly among populations living in rural areas who may not have access to clinical sites for in-person rehabilitation services. This increased accessibility, uptake, and engagement allows people with chronic conditions to reap the benefits of rehabilitation participation.

Furthermore, rehabilitation services have traditionally been delivered to condition-specific patient groups, despite the similarities between rehabilitation programmes delivered to various chronic populations (Mulligan *et al.* 2019). However, this method of healthcare service delivery also limits service accessibility, and our healthcare services often cannot meet the demand for these programmes. The development and potential feasibility of the disease-agnostic telerehabilitation programme in this research is promising. Disease-agnostic programmes could be a more pragmatic and sustainable model of rehabilitation service delivery for chronic populations allowing for economies of scale and clinician flexibility. The potential implications of this research on practice could include optimisation of resource

utilisation, improved efficiency, and delivery of more flexible care to diverse populations (Health Information Quality Authority 2015; Barker *et al.* 2018; Boehmer *et al.* 2018; Kehoe *et al.* 2020). The development of disease-agnostic programmes could encourage clinicians to expand their knowledge to a diverse range of conditions, thus reducing the reliance on specialised expertise and the challenges of staff shortfalls which limit service accessibility.

The development and feasibility testing of the TECC programme provides valuable evidence for future policy development. With the increased demand and challenges faced by our healthcare systems due to the increasing prevalence of chronic conditions, efficient and innovative models of healthcare service delivery promoting the management of chronic conditions is a key priority for government, healthcare systems and policymakers (Health Service Executive 2020). This research may support the integration of disease-agnostic telerehabilitation services in practice and subsequently encourage organisations to invest in the infrastructure and training required to ensure optimal service delivery. The contribution of this research to develop a novel and innovative approach to rehabilitation delivery to chronic populations can ultimately drive the widespread adoption of innovative rehabilitation models. It is still uncertain where disease-agnostic telerehabilitation programmes would best lie in respect to disease-specific rehabilitation pathways for the management of chronic conditions. Perhaps these programmes would be best used to complement and enhance disease-specific rehabilitation as a follow-up or maintenance programme for individuals transitioning from disease-specific programmes to ensure continuity of care. However, further consideration and research should be carried out to understand the optimum place for disease-agnostic telerehabilitation along the care pathway for the management of chronic conditions.

The implications of this research for practice are manifold, highlighting the potential of disease-agnostic telerehabilitation to enhance service accessibility, patient engagement, and the integration of new and innovative approaches to meet the needs of diverse patient groups.

### **7.8.2 Potential Implications for Research**

This doctoral thesis contributes to the growing body of research surrounding rehabilitation and the management of chronic conditions in the context of telerehabilitation and disease-agnostic services. The development and feasibility testing of a disease-agnostic physiotherapy-led telerehabilitation programme has important implications for future research addressing the need to develop new and innovative interventions to manage various chronic conditions. The impact of this thesis on research goes beyond the immediate findings, acting as a foundation for future research initiatives and encouraging further exploration into disease-agnostic telerehabilitation services.

Previous research has focused on condition-specific telerehabilitation models however, this thesis outlines the potential feasibility of a disease-agnostic telerehabilitation model encouraging further exploration of this method of service delivery. This flexible, adaptable healthcare service delivery model of service delivery can cater to diverse populations, potentially leading to the development of disease-agnostic service and rehabilitation guidelines. Future research could examine the integration of these guidelines into existing healthcare frameworks and policy, ultimately improving the efficiency and optimising resource utilisation.

This doctoral thesis was guided by the MRC framework for the development and evaluation of complex interventions (Skivington *et al.* 2021) and primarily focused on the development and feasibility stages of this framework. In advance of progressing to the later stages of this

framework (evaluation and implementation stages), further research needs to be conducted to improve and refine the intervention. As previously discussed in Chapter Six, intervention amendments need to be made in particular to improve participant recruitment, retention, and adherence before more expansive evaluation. Given the value of social interaction highlighted by the key stakeholders (Barry Walsh *et al.* 2024a; Barry Walsh *et al.* 2024b), improvements to the social component of the programme are also required to improve participant engagement. Future research should endeavour to explore solutions and strategies to address the issues with recruitment, retention, adherence and to increase engagement with the social component of the intervention before embarking on a full-scale evaluation.

Although an initial evaluation of the clinical efficacy of the intervention was conducted in the feasibility trial (Chapter Six), a full-scale randomised control trial should be conducted in the future to establish the effectiveness of the intervention. Furthermore, future research should explore the cost-effectiveness of the disease-agnostic telerehabilitation intervention compared to traditional in-person condition-specific rehabilitation services. As healthcare services experience increased challenges and expenditure associated with chronic conditions and an increased demand for rehabilitation services, the need for cost-effective, sustainable models of healthcare service delivery is evident. By evaluating the outcomes of this novel intervention, future research could encourage a comprehensive analysis that evaluates the potential cost-effectiveness of this rehabilitation delivery method. This could position disease-agnostic telerehabilitation as a pragmatic, sustainable, and cost-effective solution warranting broader implementation.

This doctoral thesis included stakeholder input which guided the development of the TECC intervention. For the purpose of this thesis, key stakeholders included people with chronic conditions and physiotherapists involved in rehabilitation delivery to chronic populations.

However, following the involvement of various healthcare professionals in the delivery of the TECC intervention education component, we acknowledge the need for future research to gather information regarding the experiences of the wider clinician group involved in intervention delivery to further develop the programme.

## **7.9 Conclusion**

The aim of this doctoral thesis was to identify delivery strategies and content to develop a disease-agnostic group telerehabilitation programme for people with mixed chronic conditions. Our research, which examined the feasibility and acceptability of a novel disease-agnostic telerehabilitation programme for people with various chronic conditions, produced encouraging results. The TECC programme has potential to be a pragmatic, sustainable method of healthcare service delivery increasing service accessibility, improving health outcomes, and presenting opportunities for economies of scale. Further research and development is required in order to maximise the potential of the TECC programme before more expansive evaluation and implementation. The initial development of the TECC programme presented in this thesis will guide future intervention development. Future research should consider the most effective approaches to enhance participant recruitment, retention and adherence to the intervention, as well as the social component of the TECC programme to encourage participant engagement. Future research should also explore the clinical efficacy of the intervention as well as the comparison between this service delivery method and traditional in-person rehabilitation or telerehabilitation programmes delivered to condition-specific populations.

This doctoral thesis provides a unique contribution to the existing literature on telerehabilitation interventions for people with chronic conditions. The findings of this thesis

serve as a foundation to inform future development and evaluation of disease-agnostic telerehabilitation services for diverse chronic populations.

## **Chapter 8. Appendices**

## Appendix 8.1 Supplementary Files

### Appendix 8.1.1 Chapter Two; Systematic Review Protocol as Registered on Prospero

**Title:** Psychometric Properties of Performance-based Measures of Physical Function Administered via Telehealth Among People with Chronic Conditions: A systematic review

**Citation:** Barry Walsh, C., Cahalan, R. Hinman, R.S., O' Sullivan, K. 'Psychometric properties of performance-based measures of physical function administered via telehealth among people with chronic conditions: A systematic review', PROSPERO 2021 CRD42021262547, available from:

[https://www.crd.york.ac.uk/prospero/display\\_record.php?ID=CRD42021262547](https://www.crd.york.ac.uk/prospero/display_record.php?ID=CRD42021262547)

**Review question:** What are the psychometric properties of performance-based measures of physical function administered via telehealth among people with chronic conditions?

**Searches:** An electronic search across databases including PubMed, EMBASE, CINAHL and PsycINFO via EBSCOhost will be completed from inception to identify relevant articles.

Keywords included in the search strategy will relate to the following domains:

- (i) Population: chronic conditions
- (ii) Construct: physical function
- (iii) Context: telehealth platforms, defined by the World Health Organisation (WHO) as “the delivery of health care services, where patients and providers are separated by distance. Telehealth uses information and communication technologies (ICT) for the exchange of information for the diagnosis and treatment of diseases and injuries.”
- (iv) Instrument: performance test/measure or objective test/measure

These searches will be combined with the relevant Consensus-based Standards for the selection of health status Measurement Instruments (COSMIN) search filter for measurement properties (Terwee et al. 2009). The search terms will be combined using relevant Boolean operators.

The search results will be limited to studies published in English. Reference lists of included studies, trial/study registries and grey literature will also be hand searched to identify additional eligible articles.

**Types of study to be included:** Studies will be included if original data is reported on the reliability, responsiveness, or validity of performance-based measures of physical function administered via telehealth.

Inclusion:

- Population: Adults ( $\geq 18$  years) diagnosed with any chronic health condition.
- Construct: The evaluated measure is a measure of objective physical function.
- Measurement instrument: An established performance-based measure commonly used in clinical practice which is evaluated by a tester as the activity is being performed by the individual.
- Setting: Remote location (e.g., home setting) via any telehealth platform.
- Measurement properties: Reports one or more of the psychometric measurement properties as per the COSMIN taxonomy (Mokkink et al. 2010) including reliability, responsiveness, and validity (<https://www.cosmin.nl/tools/cosmin-taxonomy-measurement-properties/>).

Exclusion:

- Patient self-reported measures of physical function or laboratory values indirectly used to assess physical function or self-administered measures that do not involve administration and evaluation by an independent tester.
- Exclusively acute patient populations or <80% participants diagnosed with chronic conditions.

**Condition or domain being studied:** The psychometric properties of performance-based measures of physical function administered via telehealth among people with chronic conditions.

**Participants/population:** The study population consists of adults aged  $\geq 18$  years with any chronic condition. Studies including a mixed sample of acute and chronic populations will be included only if at least 80% of the population have a chronic diagnosis.

**Intervention(s), exposure(s):** Performance-based measures of physical function, as defined by the WHO (2001) International Classification of Functioning, Disability and Health (ICF) framework as activities which relate to the ability to move around and perform daily activities, administered via telehealth platforms.

**Comparator(s)/control:** For studies examining the validity of the measurement instrument administered via telehealth, the comparator will be a face-to-face administration of the same measurement instrument.

**Context:** This review will evaluate the psychometric properties of performance-based measures of physical function administered via telehealth among people with chronic conditions. Despite the recent accelerated adoption of telehealth and the importance of objective evaluation of physical function, the psychometric properties of measures administered via telehealth among people with chronic conditions has not previously

reviewed systematically. Results of this review may inform the selection of appropriate measures for both clinical practice and future research among people with chronic conditions.

**Main outcome(s):** The psychometric measurement properties of the identified measures including reliability, responsiveness, and validity, as outlined by the COSMIN taxonomy of measurement properties of outcome measurement instruments.

**Additional outcome(s):** Not applicable

**Data extraction (selection and coding):** Results retrieved from each database will be imported to the EndNote library and duplicates will be removed. Two independent reviewers will determine the eligibility of resulting studies for inclusion in the review based on title and abstract screening and full text review. If good agreement (at least 80%) is achieved between two independent reviewers on a sample of 30% of eligible studies, the remainder will be selected by one reviewer. Two independent reviewers will select a sample of eligible studies and if good agreement (<80% agreement) is achieved the remainder will be selected by one reviewer. Any disagreements that arise will be resolved through discussion with a third independent reviewer.

Following COSMIN guidance, relevant data relating to the characteristics of measures assessed, psychometric measurement properties and population characteristics will be extracted by one reviewer. A second independent reviewer will verify data extraction by reviewing 30% of the first author's data extraction to ensure accuracy. If good agreement (at least 80%) is achieved the remainder will be extracted by one reviewer. Any disagreements that arise will be resolved through discussion by the reviewers until consensus is reached.

**Risk of bias (quality) assessment:** The methodological quality of included studies will be assessed using the COSMIN Risk of Bias tool to assess the quality of studies on reliability and measurement error (Mokkink et al. 2020). This tool was developed to assess the quality of studies evaluating all types of measurement instruments including performance-based measures. This tool is an extended version of the original COSMIN Risk of Bias Checklist used to assess studies evaluating patient-reported outcome measures. Each study will be assessed by two independent reviewers.

**Strategy for data synthesis:** Following relevant COSMIN guidance, data will be collated and presented in a table format outlining the measure(s) assessed, the psychometric measurement properties, the results of psychometric testing and the methodological quality rating based on the COSMIN tool (Mokkink et al. 2020). Results will be classified as sufficient (+), insufficient (-) or indeterminate (?) following the COSMIN classification guidelines. Narrative synthesis, in accordance with COSMIN recommendations, will provide further information describing the measurement characteristics, population characteristics and the implications of the review findings. Meta-analysis will be performed where at least three studies of a sufficiently homogeneous nature are identified.

**Analysis of subgroups or subsets:** Meta-analysis of population or measurement subgroups will be performed where at least three studies of a sufficiently homogeneous nature are identified.

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## Appendix 8.1.2 Chapter Two; PRISMA 2020 Checklist



### PRISMA 2020 Checklist

Section and Topic	Item #	Checklist item	Location where item is reported
<b>TITLE</b>			
Title	1	Identify the report as a systematic review.	Title
<b>ABSTRACT</b>			
Abstract	2	See the PRISMA 2020 for Abstracts checklist.	Abstract
<b>INTRODUCTION</b>			
Rationale	3	Describe the rationale for the review in the context of existing knowledge.	Introduction
Objectives	4	Provide an explicit statement of the objective(s) or question(s) the review addresses.	Introduction
<b>METHODS</b>			
Eligibility criteria	5	Specify the inclusion and exclusion criteria for the review and how studies were grouped for the syntheses.	Methods
Information sources	6	Specify all databases, registers, websites, organisations, reference lists and other sources searched or consulted to identify studies. Specify the date when each source was last searched or consulted.	Methods & Fig 2.1
Search strategy	7	Present the full search strategies for all databases, registers and websites, including any filters and limits used.	App 8.1.3
Selection process	8	Specify the methods used to decide whether a study met the inclusion criteria of the review, including how many reviewers screened each record and each report retrieved, whether they worked independently, and if applicable, details of automation tools used in the process.	Methods
Data collection process	9	Specify the methods used to collect data from reports, including how many reviewers collected data from each report, whether they worked independently, any processes for obtaining or confirming data from study investigators, and if applicable, details of automation tools used in the process.	Methods
Data items	10a	List and define all outcomes for which data were sought. Specify whether all results that were compatible with each outcome domain in each study were sought (e.g. for all measures, time points, analyses), and if not, the methods used to decide which results to collect.	Methods
	10b	List and define all other variables for which data were sought (e.g. participant and intervention characteristics, funding sources). Describe any assumptions made about any missing or unclear information.	Methods & Table 2.1
Study risk of bias assessment	11	Specify the methods used to assess risk of bias in the included studies, including details of the tool(s) used, how many reviewers assessed each study and whether they worked independently, and if applicable, details of automation tools used in the process.	Methods
Effect measures	12	Specify for each outcome the effect measure(s) (e.g. risk ratio, mean difference) used in the synthesis or presentation of results.	Methods
Synthesis methods	13a	Describe the processes used to decide which studies were eligible for each synthesis (e.g. tabulating the study intervention characteristics and comparing against the planned groups for each synthesis (item #5)).	Methods
	13b	Describe any methods required to prepare the data for presentation or synthesis, such as handling of missing summary statistics, or data conversions.	Methods
	13c	Describe any methods used to tabulate or visually display results of individual studies and syntheses.	Methods
	13d	Describe any methods used to synthesize results and provide a rationale for the choice(s). If meta-analysis was performed, describe the model(s), method(s) to identify the presence and extent of statistical heterogeneity, and software package(s) used.	Methods
	13e	Describe any methods used to explore possible causes of heterogeneity among study results (e.g. subgroup analysis, meta-regression).	Methods
	13f	Describe any sensitivity analyses conducted to assess robustness of the synthesized results.	N/A
Reporting bias assessment	14	Describe any methods used to assess risk of bias due to missing results in a synthesis (arising from reporting biases).	N/A



## PRISMA 2020 Checklist

Section and Topic	Item #	Checklist item	Location where item is reported
Certainty assessment	15	Describe any methods used to assess certainty (or confidence) in the body of evidence for an outcome.	Methods
<b>RESULTS</b>			
Study selection	16a	Describe the results of the search and selection process, from the number of records identified in the search to the number of studies included in the review, ideally using a flow diagram.	Fig 2.1
	16b	Cite studies that might appear to meet the inclusion criteria, but which were excluded, and explain why they were excluded.	Discussion
Study characteristics	17	Cite each included study and present its characteristics.	Table 2.1
Risk of bias in studies	18	Present assessments of risk of bias for each included study.	Table 2.2
Results of individual studies	19	For all outcomes, present, for each study: (a) summary statistics for each group (where appropriate) and (b) an effect estimate and its precision (e.g. confidence/credible interval), ideally using structured tables or plots.	N/A
Results of syntheses	20a	For each synthesis, briefly summarise the characteristics and risk of bias among contributing studies.	Table 2.3
	20b	Present results of all statistical syntheses conducted. If meta-analysis was done, present for each the summary estimate and its precision (e.g. confidence/credible interval) and measures of statistical heterogeneity. If comparing groups, describe the direction of the effect.	Table 2.3
	20c	Present results of all investigations of possible causes of heterogeneity among study results.	N/A
	20d	Present results of all sensitivity analyses conducted to assess the robustness of the synthesized results.	N/A
Reporting biases	21	Present assessments of risk of bias due to missing results (arising from reporting biases) for each synthesis assessed.	Table 2.3
Certainty of evidence	22	Present assessments of certainty (or confidence) in the body of evidence for each outcome assessed.	Table 2.3
<b>DISCUSSION</b>			
Discussion	23a	Provide a general interpretation of the results in the context of other evidence.	Discussion
	23b	Discuss any limitations of the evidence included in the review.	Discussion
	23c	Discuss any limitations of the review processes used.	Discussion
	23d	Discuss implications of the results for practice, policy, and future research.	Discussion
<b>OTHER INFORMATION</b>			
Registration and protocol	24a	Provide registration information for the review, including register name and registration number, or state that the review was not registered.	Methods
	24b	Indicate where the review protocol can be accessed, or state that a protocol was not prepared.	Methods
	24c	Describe and explain any amendments to information provided at registration or in the protocol.	Methods
Support	25	Describe sources of financial or non-financial support for the review, and the role of the funders or sponsors in the review.	Declarations
Competing interests	26	Declare any competing interests of review authors.	Declarations
Availability of data, code and other materials	27	Report which of the following are publicly available and where they can be found: template data collection forms; data extracted from included studies; data used for all analyses; analytic code; any other materials used in the review.	Appendix 8.1

### Appendix 8.1.3 Chapter Two; Search Strategy

#### Filter 1: Target Population

(MH "Chronic Disease+") OR (TI ( "chronic condition\*" or "chronic disease\*" or "chronic health" or "chronic illness\*" or disability or "long?term condition\*" or "long?term disease\*" or "long?term illness\*" or musculoskeletal or pain or arthritis or osteoarthritis or hip or knee or back or shoulder or elbow or wrist or ankle or foot or neck or neuro\* or stroke or cva or "cerebrovascular accident" or "multiple sclerosis" or ms or Parkinson\* or cardiac or cardiovascular or cardiorespiratory or "heart failure" or "heart disease" or chf or ccf or respiratory or pulmonary or copd or "chronic obstructive pulmonary disease" or asthma or cf or "cystic fibrosis" or "interstitial lung disease" or "pulmonary fibrosis" ) OR AB ( "chronic condition\*" or "chronic disease\*" or "chronic health" or "chronic illness\*" or disability or "long?term condition\*" or "long?term disease\*" or "long?term illness\*" or musculoskeletal or pain or arthritis or osteoarthritis or hip or knee or back or shoulder or elbow or wrist or ankle or foot or neck or neuro\* or stroke or cva or "cerebrovascular accident" or "multiple sclerosis" or ms or Parkinson\* or cardiac or cardiovascular or cardiorespiratory or "heart failure" or "heart disease" or chf or ccf or respiratory or pulmonary or copd or "chronic obstructive pulmonary disease" or asthma or cf or "cystic fibrosis" or "interstitial lung disease" or "pulmonary fibrosis" )

#### Filter 2: Construct

TX "physical function\*" or "functional task\*" or "functional capacity" or "physical capacity" or "exercise capacity" or "physical activit\*" or "motor activit\*" or "physical performance\*" or "functional performance\*" or "functional limitation\*" or "physical limitation\*" or

"functional analysis" or "functional status" or "clinical outcome assessment\*" or "clinical measurement\*" or "physical examination test"

#### Filter 3: Measurement Instrument

TI ( assessment\* or evaluation\* or outcome\* or measure\* or test\* or instrument\* or exam or examination\* or tool\* or analysis or observation\* ) OR AB ( assessment\* or evaluation\* or outcome\* or measure\* or test\* or instrument\* or exam or examination\* or tool\* or analysis or observation\* )

#### Filter 4: Context

TI ( telehealth or tele-health or telerehabilitation or tele-rehabilitation or telerehab or telemedicine or tele-medicine or e-health or ehealth or mhealth or m-health or technolog\* or digital or internet or online or virtual or remote ) OR AB ( telehealth or tele-health or telerehabilitation or tele-rehabilitation or telerehab or telemedicine or tele-medicine or e-health or ehealth or mhealth or m-health or technolog\* or digital or internet or online or virtual or remote )

#### Filter 5: COSMIN Measurement Properties Filter

(MH "Psychometrics") or ( TI psychometr\* or AB psychometr\* ) or ( TI clinimetr\* or AB clinimetr\* ) or ( TI clinimetr\* OR AB clinimetr\* ) or (MH "Outcome Assessment") or ( TI outcome assessment or AB outcome assessment ) or ( TI outcome measure\* or AB outcome measure\* ) or (MH "Health Status Indicators") or (MH "Reproducibility of Results") or (MH "Discriminant Analysis") or ( ( TI reproducib\* or AB reproducib\* ) or ( TI reliab\* or AB reliab\* ) or ( TI unreliab\* or AB unreliab\* ) ) or ( ( TI valid\* or AB valid\* ) or ( TI coefficient or AB coefficient ) or ( TI homogeneity or AB homogeneity ) ) or ( TI homogeneous or AB homogeneous ) or ( TI "coefficient of variation" or AB "coefficient of variation" ) or ( TI

“internal consistency” or AB “internal consistency” ) or (MH “Internal Consistency+”) or (MH “Reliability+”) or (MH “Measurement Error+”) or (MH “Content Validity+”) or “hypothesis testing” or “structural validity” or “cross-cultural validity” or (MH “Criterion-Related Validity+”) or “responsiveness” or “interpretability” or ( TI reliab\* or AB reliab\* ) and ( (TI test or AB test) OR (TI retest or AB retest) ) or ( TI stability or AB stability ) or ( TI interrater or AB interrater ) or ( TI inter-rater or AB inter-rater ) or ( TI intrarater or AB intrarater ) or ( TI intra-rater or AB intrarater ) or ( TI intertester or AB intertester) or (TI inter-tester or AB inter-tester) or ( TI intratester or AB intratester) or ( TI intra-tester or AB intra-tester) or ( TI interobserver or AB interobserver) or (TI inter-observer or AB inter-observer ) or ( TI intraobserver or AB intraobserver) or ( TI intra-observer or AB intra-observer) or ( TI intertechnician or AB intertechnician) or (TI inter-technician or AB inter-technician) or ( TI intratechnician or AB intratechnician ) or ( TI intra-technician or AB intra-technician ) or ( TI interexaminer or AB interexaminer ) or (TI inter-examiner or AB inter-examiner) or (TI intraexaminer or AB intraexaminer ) OR (TI intra-examiner or AB intra-examiner ) or (TI intra-examiner or AB intraexaminer ) or (TI interassay or AB interassay ) or ( TI inter-assay or AB inter-assay ) or ( TI intraassay or AB intraassay) or ( TI intra-assay or AB intra-assay ) or (TI interindividual or AB interindividual) or (TI inter-individual or AB inter-individual) OR (TI intraindividual or AB intraindividual) or (TI intra-individual or AB intra-individual) or (TI interparticipant or AB interparticipant) or (TI inter-participant or AB inter-participant ) or (TI intraparticipant or AB intraparticipant) or (TI intra-participant or AB intra-participant ) or (TI kappa or AB kappa) or (TI kappa’s or AB kappa’s ) or (TI kappas or AB kappas) or (TI repeatab\* or AB repeatab\*) or ( TI responsive\* or AB responsive\* ) or ( TI interpretab\* or AB interpretab\* )

## Appendix 8.1.4 Chapter Two; Criteria for Good Measurement Properties

Property	Rating	Quality Criteria
Reliability	+	ICC/weighted kappa $\geq 0.70$
	?	ICC or weighted kappa not reported.
	-	ICC/weighted kappa $< 0.70$
Criterion validity	+	Correlation with gold standard $\geq 0.70$ OR AUC $\geq 0.70$
	?	Not all information for '+' reported.
	-	Correlation with gold standard $< 0.70$ OR AUC $< 0.70$

'+' sufficient rating, '?' indeterminate rating, '-' insufficient rating

(Terwee et al. 2007; Prinsen et al. 2016)

AUC= area under the curve, ICC= intraclass correlation coefficient

**Appendix 8.1.5 Chapter Two; Instruction on the use of the modified GRADE approach  
(Mokkink et al. 2017; Prinsen et al. 2018; Terwee et al. 2018)**

<b>Quality of Evidence</b>	<b>Lower if</b>
High	Risk of bias -1 Serious -2 Very serious -3 Extremely serious  Inconsistency -1 Serious -2 Very Serious  Imprecision -1 total n=50-100 -2 total n<50  Indirectness -1 Serious -2 Very serious
Moderate	
Low	
Very Low	

n=sample size

<b>Risk of Bias</b>	<b>Downgrading for Risk of Bias</b>
No	There are multiple studies of at least adequate quality, or there is one study of very good quality available
Serious	There are multiple studies of doubtful quality available, or there is only one study of adequate quality
Very serious	There are multiple studies of inadequate quality, or there is only one study of doubtful quality available
Extremely serious	There is only one study of inadequate quality available

## Appendix 8.1.6 Chapter Three; COREQ Checklist

### COREQ (CONsolidated criteria for REporting Qualitative research) Checklist

A checklist of items that should be included in reports of qualitative research. You must report the page number in your manuscript where you consider each of the items listed in this checklist. If you have not included this information, either revise your manuscript accordingly before submitting or note N/A.

Topic	Item No.	Guide Questions/Description	Reported on Page No.
<b>Domain 1: Research team and reflexivity</b>			
<i>Personal characteristics</i>			
Interviewer/facilitator	1	Which author/s conducted the interview or focus group?	Methods
Credentials	2	What were the researcher's credentials? E.g. PhD, MD	Methods
Occupation	3	What was their occupation at the time of the study?	Methods
Gender	4	Was the researcher male or female?	Methods
Experience and training	5	What experience or training did the researcher have?	Methods
<i>Relationship with participants</i>			
Relationship established	6	Was a relationship established prior to study commencement?	Methods
Participant knowledge of the interviewer	7	What did the participants know about the researcher? e.g. personal goals, reasons for doing the research	Methods
Interviewer characteristics	8	What characteristics were reported about the interviewer/facilitator? e.g. Bias, assumptions, reasons and interests in the research topic	Methods
<b>Domain 2: Study design</b>			
<i>Theoretical framework</i>			
Methodological orientation and Theory	9	What methodological orientation was stated to underpin the study? e.g. grounded theory, discourse analysis, ethnography, phenomenology, content analysis	Methods
<i>Participant selection</i>			
Sampling	10	How were participants selected? e.g. purposive, convenience, consecutive, snowball	Methods
Method of approach	11	How were participants approached? e.g. face-to-face, telephone, mail, email	Methods
Sample size	12	How many participants were in the study?	Results
Non-participation	13	How many people refused to participate or dropped out? Reasons?	Results
<i>Setting</i>			
Setting of data collection	14	Where was the data collected? e.g. home, clinic, workplace	Methods
Presence of non-participants	15	Was anyone else present besides the participants and researchers?	Methods
Description of sample	16	What are the important characteristics of the sample? e.g. demographic data, date	Results
<i>Data collection</i>			
Interview guide	17	Were questions, prompts, guides provided by the authors? Was it pilot tested?	Methods
Repeat interviews	18	Were repeat interviews carried out? If yes, how many?	Methods
Audio/visual recording	19	Did the research use audio or visual recording to collect the data?	Methods
Field notes	20	Were field notes made during and/or after the interview or focus group?	Methods
Duration	21	What was the duration of the interviews or focus group?	Methods
Data saturation	22	Was data saturation discussed?	Methods
Transcripts returned	23	Were transcripts returned to participants for comment and/or	Methods

Topic	Item No.	Guide Questions/Description	Reported on Page No.
		correction?	
<b>Domain 3: analysis and findings</b>			
<i>Data analysis</i>			
Number of data coders	24	How many data coders coded the data?	Methods
Description of the coding tree	25	Did authors provide a description of the coding tree?	Methods
Derivation of themes	26	Were themes identified in advance or derived from the data?	Methods
Software	27	What software, if applicable, was used to manage the data?	Methods
Participant checking	28	Did participants provide feedback on the findings?	Methods
<i>Reporting</i>			
Quotations presented	29	Were participant quotations presented to illustrate the themes/findings? Was each quotation identified? e.g. participant number	Results
Data and findings consistent	30	Was there consistency between the data presented and the findings?	Results
Clarity of major themes	31	Were major themes clearly presented in the findings?	Results
Clarity of minor themes	32	Is there a description of diverse cases or discussion of minor themes?	Results & Discussion

Developed from: Tong A, Sainsbury P, Craig J. Consolidated criteria for reporting qualitative research (COREQ): a 32-item checklist for interviews and focus groups. *International Journal for Quality in Health Care*. 2007. Volume 19, Number 6: pp. 349 – 357

Once you have completed this checklist, please save a copy and upload it as part of your submission. DO NOT include this checklist as part of the main manuscript document. It must be uploaded as a separate file.

## Appendix 8.1.7 Chapter Four; COREQ Checklist

### COREQ (Consolidated criteria for REporting Qualitative research) Checklist

A checklist of items that should be included in reports of qualitative research. You must report the page number in your manuscript where you consider each of the items listed in this checklist. If you have not included this information, either revise your manuscript accordingly before submitting or note N/A.

Topic	Item No.	Guide Questions/Description	Reported on Page No.
<b>Domain 1: Research team and reflexivity</b>			
<i>Personal characteristics</i>			
Interviewer/facilitator	1	Which author/s conducted the interview or focus group?	Methods
Credentials	2	What were the researcher's credentials? E.g. PhD, MD	Methods
Occupation	3	What was their occupation at the time of the study?	Methods
Gender	4	Was the researcher male or female?	Methods
Experience and training	5	What experience or training did the researcher have?	Methods
<i>Relationship with participants</i>			
Relationship established	6	Was a relationship established prior to study commencement?	Methods
Participant knowledge of the interviewer	7	What did the participants know about the researcher? e.g. personal goals, reasons for doing the research	Methods
Interviewer characteristics	8	What characteristics were reported about the interviewer/facilitator? e.g. Bias, assumptions, reasons and interests in the research topic	Methods
<b>Domain 2: Study design</b>			
<i>Theoretical framework</i>			
Methodological orientation and Theory	9	What methodological orientation was stated to underpin the study? e.g. grounded theory, discourse analysis, ethnography, phenomenology, content analysis	Methods
<i>Participant selection</i>			
Sampling	10	How were participants selected? e.g. purposive, convenience, consecutive, snowball	Methods
Method of approach	11	How were participants approached? e.g. face-to-face, telephone, mail, email	Methods
Sample size	12	How many participants were in the study?	Results
Non-participation	13	How many people refused to participate or dropped out? Reasons?	Results
<i>Setting</i>			
Setting of data collection	14	Where was the data collected? e.g. home, clinic, workplace	Methods
Presence of non-participants	15	Was anyone else present besides the participants and researchers?	Methods
Description of sample	16	What are the important characteristics of the sample? e.g. demographic data, date	Results
<i>Data collection</i>			
Interview guide	17	Were questions, prompts, guides provided by the authors? Was it pilot tested?	Methods
Repeat interviews	18	Were repeat interviews carried out? If yes, how many?	N/A
Audio/visual recording	19	Did the research use audio or visual recording to collect the data?	Methods
Field notes	20	Were field notes made during and/or after the interview or focus group?	Methods
Duration	21	What was the duration of the interviews or focus group?	Methods
Data saturation	22	Was data saturation discussed?	Methods
Transcripts returned	23	Were transcripts returned to participants for comment and/or	Methods

Topic	Item No.	Guide Questions/Description	Reported on Page No.
		correction?	
<b>Domain 3: analysis and findings</b>			
<i>Data analysis</i>			
Number of data coders	24	How many data coders coded the data?	Methods
Description of the coding tree	25	Did authors provide a description of the coding tree?	Methods
Derivation of themes	26	Were themes identified in advance or derived from the data?	Methods
Software	27	What software, if applicable, was used to manage the data?	Methods
Participant checking	28	Did participants provide feedback on the findings?	Methods
<i>Reporting</i>			
Quotations presented	29	Were participant quotations presented to illustrate the themes/findings? Was each quotation identified? e.g. participant number	Results
Data and findings consistent	30	Was there consistency between the data presented and the findings?	Results
Clarity of major themes	31	Were major themes clearly presented in the findings?	Results
Clarity of minor themes	32	Is there a description of diverse cases or discussion of minor themes?	Results & Disc

Developed from: Tong A, Sainsbury P, Craig J. Consolidated criteria for reporting qualitative research (COREQ): a 32-item checklist for interviews and focus groups. *International Journal for Quality in Health Care*. 2007. Volume 19, Number 6: pp. 349 – 357

**Once you have completed this checklist, please save a copy and upload it as part of your submission. DO NOT include this checklist as part of the main manuscript document. It must be uploaded as a separate file.**

## **Appendix 8.1.8 Chapter Five; Feasibility Trial Protocol as Registered on Open Science**

### **Framework**

#### **Abstract**

#### **Background**

Evidence supports the efficacy of exercise-based group rehabilitation programmes for people with chronic conditions. Telerehabilitation, referring to the remote delivery of rehabilitation using telecommunication technology, has the potential to increase service accessibility, uptake, and adherence to rehabilitation programmes. Telerehabilitation research has previously evaluated condition-specific programmes, such as cardiac telerehabilitation programmes delivered specifically to cardiac populations. However, recent evidence examining traditional in-person rehabilitation programmes points to the potential of rehabilitation programmes for mixed-condition patient groups as an efficient and pragmatic alternative approach to rehabilitation service delivery. The proposed study aims to examine the feasibility and acceptability of an exercise-based telerehabilitation programme delivered to groups of people with a mixture of different chronic conditions.

#### **Methods**

A mixed methods feasibility trial will be conducted to examine the feasibility of an exercise-based telerehabilitation programme for groups of people with mixed chronic health conditions. The 6-week intervention will involve exercise, educational, and social components. The intervention will include two different exercise group levels, one conducting a seat-based exercise class and the other a standing-based exercise class. Participants will take part in one synchronous group exercise session per week delivered via videoconferencing. This session will be followed by the opportunity to engage in a guided

social discussion with peers via the videoconferencing platform. The social component of the intervention will be loosely structured and aims to provide a social dimension to the intervention, which has been previously identified by stakeholders as an important component of telerehabilitation programmes. The social discussion will be driven by patient preference and may refer to clinical issues such as supports or issues related to chronic conditions, or non-clinical issues related to current news/events. Participants will be provided access to a synchronous online self-management educational webinar each week also delivered via videoconferencing. Access to recordings of the exercise classes and educational webinars will also be provided to allow participants to engage with the sessions at their convenience during the intervention period. Data will be collected and analysed to address outcomes of feasibility and acceptability including recruitment, retention, intervention adherence including adherence with synchronous exercise and education sessions and with recorded exercise and education content, participant satisfaction, safety, participant experiences and clinical effectiveness of the intervention.

## **Discussion**

The proposed feasibility trial will guide new iterations and evaluation and potentially a future definitive randomised control trial evaluating the use of exercise-based telerehabilitation interventions for groups of people with mixed chronic health conditions. The proposed intervention has been designed with the aim of developing a sustainable, cost-effective, and efficacious healthcare delivery method to tackle the increasing demand for rehabilitation programmes for people with chronic health conditions.

## **Keywords**

Telerehabilitation; chronic health conditions; physiotherapy; feasibility; exercise

## Background

Chronic conditions, including arthritis, cardiovascular and respiratory disease and multiple sclerosis, are a leading cause of morbidity and disability worldwide (Darker *et al.* 2015). Due to the ageing nature of our population, the prevalence and burden of chronic conditions is expected to increase significantly over the coming years, with estimations that by 2030 70% of global disease burden will be attributed to chronic conditions (Mathers and Loncar 2006; Nuño *et al.* 2012; Hernández *et al.* 2019). The increasing prevalence of chronic disease and multimorbidity presents a significant socioeconomic burden and will persistently challenge health care services (Hernández *et al.* 2019).

Group rehabilitation programmes emphasising patient education and exercise promote independent management of one's own health and well-being (Bolton *et al.* 2013; Price *et al.* 2013; Pasanen *et al.* 2017; Long *et al.* 2019). The recent COVID-19 pandemic forced healthcare services to embrace a lesser used and more flexible method of rehabilitation delivery for people with chronic conditions, including telerehabilitation. Telerehabilitation refers to the remote delivery of rehabilitation using telecommunication technologies such as videoconferencing and telephone calls. Evidence suggests that telerehabilitation may be as effective as traditional in-person rehabilitation and may also increase service accessibility and patient uptake by overcoming barriers to in-person rehabilitation including transport and time limitations (Desveaux *et al.* 2016; Bourne *et al.* 2017; Cottrell *et al.* 2017a; Jiang *et al.* 2018; Oates *et al.* 2019; Hinman *et al.* 2024).

Previous literature has examined the use of telerehabilitation for condition-specific rehabilitation programme delivery, such as cardiac telerehabilitation for people with cardiac conditions (Rawstorn *et al.* 2016; Selzler *et al.* 2018; Dias *et al.* 2021). However, the design and content of group rehabilitation programmes delivered to different chronic populations

are remarkably similar with programmes often including exercise training and education to promote self-management and improve general health and well-being (Mulligan *et al.* 2019; Hevey *et al.* 2020). Similar intervention components are useful for people with different chronic conditions, despite differences in their underlying medical conditions. Thus disease-agnostic rehabilitation programmes can allow for economies of scale and greater clinician flexibility by optimising the use of resources, improving efficiency, and providing more flexible and tailored care to a diverse patient population. These programmes have the potential to overcome the limitations that may be present when only programmes tailored to small pools of patients affected by specific conditions are available. Disease-agnostic programmes can reduce the reliance on specialised expertise for specific conditions, by encouraging clinicians to expand their expertise to a broader range of patients with diverse conditions, thus addressing the challenges of staff shortfalls and gaps in service delivery. Recent evidence supports the development of disease-agnostic exercise-based group rehabilitation programmes which suit a wide range of chronic conditions, rather than condition-specific programmes (Health Information Quality Authority 2015; Barker *et al.* 2018; Hevey *et al.* 2020).

While the COVID-19 pandemic and social distancing requirements have accelerated the shift towards telerehabilitation, there is little evidence exploring the delivery of disease-agnostic telerehabilitation programmes to mixed-condition groups. The proposed intervention is a feasibility trial of a disease-agnostic physiotherapy-led exercise-based telerehabilitation programme for people with a range of chronic conditions. Given the range of different chronic conditions being addressed by this intervention, the functional abilities of the participants may differ and therefore the appropriate intensity and level of exercise for participants may vary. Therefore, we will explore the use of a novel intervention which will

include two different exercise group levels with an individualised approach to guide exercise intensity using the BORG Rate of Perceived Exertion (RPE) Scale. One exercise group will involve in a seated class performing exercises in sitting. The other exercise group will participate in a standing exercise class performing exercises in a range of standing/dynamic/functional positions). Allocation to exercise group levels will be based on participants' baseline functional mobility level which will be assessed using the Activities-specific Balance Confidence (ABC) Scale. The primary aim is to examine the feasibility of the intervention by examining recruitment and retention, adherence, adverse events, and satisfaction with the programme among people with chronic conditions. A secondary aim is to examine the effect of the intervention on outcomes of physical function and quality of life for people with chronic conditions.

## **Methods**

### **Design**

This is a mixed-methods feasibility trial which will examine the feasibility of a disease-agnostic physiotherapy-led exercise-based telerehabilitation programme for people with chronic conditions. The SPIRIT (Standard Protocol Items: Recommendations for Interventional Trials) checklist was used to guide this protocol to ensure standardised reporting (Appendix 8.1.9) (Chan *et al.* 2013). As the SPIRIT checklist is primarily designed for the reporting of clinical trials of effectiveness, an adapted version of the checklist was used (in the context of assessment of feasibility as the primary aim) to guide the reporting of the protocol for this feasibility trial (Thabane and Lancaster 2019). The feasibility trial will be reported in accordance with the CONSORT 2010 statement extension to pilot and feasibility trials (Schulz *et al.* 2010; Eldridge *et al.* 2016) and the Template for Intervention Description and Replication guidelines for better reporting of interventions (TIDieR)

checklist (Hoffmann *et al.* 2014). Ethical approval was obtained from the HSE Southeastern Area Research Ethics Committee. The trial will be registered on ClinicalTrials.gov and Open Science Framework.

Figure 1 Study schedule diagram

	Study Period			
	Enrolment	Allocation	Post-allocation	
Timepoint	0	0	6 weeks	8 weeks
<b>Enrolment:</b>				
Informed consent	X			
Eligibility screen	X			
Allocation		X		
<b>Intervention:</b>				
Telerehabilitation intervention		◆	◆	
<b>Assessments:</b>				
Activities-Specific Balance Confidence (ABC) Scale	X			
Physical Activity Readiness Questionnaire (PAR-Q)	X			
Baseline Questionnaire	X			
30 second chair stand test (30-CST)	X			X
EURO-QoL-5D questionnaire	X			X
Client Satisfaction Questionnaire-8 (CSQ-8)				X
Focus Groups				X

**Setting**

This study is coordinated by the University of Limerick, Ireland. Pre-intervention and post-intervention assessments will be administered remotely via telehealth including electronic questionnaires and videoconferencing. The intervention will also be delivered remotely via telehealth including email and videoconferencing. Participants will be based in their own home environments for the duration of the study.

### **Population & recruitment**

Eligible participants will be informed of the study by treating physiotherapists across various community physiotherapy sites and provided with an outline of the study with relevant contact details of research team members. Those who express interest in participating will be screened for eligibility based on the inclusion/exclusion criteria by the research team. Those eligible for inclusion will be provided with an information leaflet and will be given the opportunity to ask questions about the research project. Informed consent will then be obtained via electronic consent forms from those willing to participate in the study. Participants will be sent orientation documents and pre-intervention questionnaires via email prior to participating in the intervention. These documents will contain information including a telehealth set-up checklist and the BORG Rate of Perceived Exertion (RPE) Scale self-monitoring test to guide appropriate exercise intensity. Participants will also be invited to a synchronous online orientation session with the primary author (CBW) via videoconferencing to guide set up and to conduct pre-intervention assessments including the 30 second chair stand test (30-CST) (Lawford *et al.* 2022).

### **Eligibility criteria**

#### **Inclusion Criteria**

- Community-dwelling adults (aged  $\geq 18$  years old) with a confirmed diagnosis of any chronic cardiorespiratory, neurological, or musculoskeletal condition. We will use the ICD-10-CM definition of a chronic condition being one lasting greater than 12 months and resulting in the need for ongoing medical intervention and limiting self-care, independent living, and social interaction.
- Person is medically stable and appropriate to participate in the exercise-based intervention independently and safely as deemed by self-declaration. Participants who fulfil the criteria will undergo screening by the research team to gather relevant medical history and will be required complete the Physical Activity Readiness Questionnaire (PAR-Q) form. If any concerns arise from the PAR-Q form, participants will be advised to discuss their suitability for participation in the intervention with their GP in advance of signing the disclaimer prior to participation. Participants will be required to sign a disclaimer to agree voluntary participation in the exercise intervention at their own risk prior to participating.
- Access to an appropriate technological device with an internet connection and email address to facilitate participation in the telerehabilitation intervention.
- Willing to provide informed consent to participate in the study.
- Good level of spoken and written English.

### **Exclusion criteria**

- Adults who are medically unstable as deemed by referring physiotherapist or who have uncontrolled medical conditions limiting participation in exercise interventions including uncontrolled hypertension or recent acute cardiovascular events, uncontrolled atrial fibrillation, etc.

- Significant orthopaedic, psychological, neurological, or cognitive conditions or mobility difficulties that prevents participation in seated or standing exercise interventions as deemed by referring physiotherapist.
- Suspected underlying malignancy as deemed by referring physiotherapist.

The intervention will include two exercise level groups (one seated class group conducting exercises in sitting, the other standing class conducting exercises in a range of standing/dynamic/functional positions) and allocation to the appropriate exercise level will be based on participants' baseline functional mobility level. During pre-intervention assessment participants will complete the Activities-specific Balance Confidence (ABC) scale to determine their allocation to the appropriate intervention group. The ABC Scale is a subjective measure of confidence to perform various functional activities without losing balance or becoming unsteady. Allocation to the appropriate exercise level will be conducted by a member of the research team (CBW). A threshold score of 67% on the ABC Scale will be used to identify increased risk of falls (Lajoie and Gallagher 2004). Participants who score below the threshold will be allocated to the seated exercise class, while those who score above the threshold will be allocated to the standing exercise class.

There is currently no agreement on the appropriate sample size for pilot or feasibility trials with recommendations varying in the literature (Lewis *et al.* 2021; Totton *et al.* 2023). A total target sample size of 30 participants to be recruited across the two exercise levels will be used. A recent review of feasibility and pilot trials in the United Kingdom identified a median sample size of 30 participants across pilot and feasibility trials which satisfies some of the previous recommendations that have been made (Totton *et al.* 2023). The authors of this protocol acknowledge that there may be an uneven proportion of participants in each

exercise groups for this trial, as the number of participants in each group will depend on the participants' baseline mobility levels and ABC Scale scores.

### **Intervention**

The intervention will comprise of a 6-week disease-agnostic exercise-based telerehabilitation programme for people with chronic health conditions delivered by a chartered physiotherapist. The intervention will consist of weekly synchronous exercise sessions and guided social component, and synchronous educational webinars to promote self-management of health and well-being. The intervention has been developed in conjunction with focus groups of key stakeholders including both people with chronic conditions and physiotherapists involved in rehabilitation delivery (Barry Walsh *et al.* 2024b). Stakeholders expressed preference for the inclusion of these three components (exercise, educational and social components) within the overall intervention, and a delivery model including both synchronous and asynchronous methods.

### **Exercise component**

Synchronous group exercise sessions (including 5-15 participants), led by a physiotherapist, will be delivered weekly via videoconferencing software. The exercise programme, developed by the research physiotherapists and guided by existing rehabilitation programmes and guidance (Association of Chartered Physiotherapists in Cardiac Rehabilitation 2015; NHS Ayrshire and Arran 2017; NHS Coventry and Warwickshire 2021), will be structured to include a warm-up, main exercise session including resistance, aerobic, balance and flexibility training, and a cool down. As discussed earlier, there will be two exercise groups based on baseline functional mobility levels with one group performing seated exercises while the other group will perform standing-based exercises. Exercises will be instructed and

demonstrated by a physiotherapist. Participants will be informed of appropriate self-monitoring techniques (e.g., BORG Rate of Perceived Exertion Scale) in advance of group exercise sessions to guide appropriate exercise intensity during programme performance. Participants will be encouraged to exercise at an intensity of 12-14 on the BORG RPE scale during the exercise sessions. Participants will be asked to record their rate of perceived exertion in each exercise session via a self-reported logbook. Recordings of exercise sessions will be made available. Participants will be advised to perform additional exercise sessions at their own convenience to supplement the synchronous exercise sessions and facilitate adherence to physical activity guideline recommendations.

### **Educational component**

Participants will be invited to attend one 45-minute synchronous educational webinar each week to promote self-management of health and well-being. Stakeholders noted the value of self-management educational content in telerehabilitation programmes (Barry Walsh *et al.* 2024b). Educational webinars will be delivered by relevant healthcare professionals and will explore various aspects of self-management including exercise and physical activity, goal setting, mental health, nutrition, fatigue, and smoking cessation. These topics are guided by recommendations from the HSE Living Well with a Chronic Condition Framework (Chronic Conditions Working Group 2017) and the Stanford Chronic Disease Self-Management Programme (Hudon *et al.* 2016). Recordings of the educational webinars will be made available to participants for the duration of the intervention. Participants will be advised to record any engagement with the recorded educational webinars via electronic self-report logbook.

### **Social component**

At the end of each weekly synchronous group exercise session, participants will have the opportunity to engage in a 10–15-minute synchronous online social interaction with other participants in their exercise group via videoconferencing. Social elements were valued by stakeholders as a necessary component of telerehabilitation interventions (Barry Walsh *et al.* 2024b). The social component may be guided by the research team with theme driven discussions based on the educational topics explored in the webinars, or unregulated and left to participants to discuss subjects of their choice.

### **Data collection**

Outcome measures will be administered by a member of the research team and qualified physiotherapist (CBW). Data will be collected in electronic format. All subjective questionnaires will be completed by participants independently and remotely on a telehealth platform. These will include the baseline demographic questionnaire, and Euro-QoL-5D pre-intervention, and the Euro-QoL-5D and CSQ-8 questionnaire post-intervention. However, a member of the research team (CBW) will be available to provide assistance if required. The 30-second chair stand test will be administered remotely by a qualified physiotherapist (CBW) via videoconferencing software both pre- and post-intervention (Lawford *et al.* 2022). Qualitative focus groups will be conducted remotely within 2 weeks following intervention completion and will be conducted via videoconferencing software. All electronic data will be stored on a GDPR compliant, and password protected OneDrive cloud service storage system. Each participant in the study will be assigned a numerical code to link data collected at baseline to the data collected post intervention. Therefore, the data will be pseudonymised and the primary investigator (CBW) will retain the key to re-identify the participants based on the numerical codes assigned. Co-investigators (RC & KOS) will have access to pseudonymised qualitative data for the purpose of data analysis.

## **Feasibility outcomes**

Data relating to recruitment and retention rates, adherence, satisfaction, adverse events and qualitative data relating to participant experiences of the programme via semi-structured focus groups will be collected to examine the feasibility and acceptability of the intervention. Recruitment will be recorded as the number of participants recruited over a 4-week recruitment period. Retention rates will be recorded as the percentage of enrolled participants who complete the post-intervention assessments and focus groups. Adherence to various components of the programme will be recorded including attendance at the orientation session and adherence to the synchronous group exercise classes, social components and educational webinars which will be recorded by the researchers. Participants will be advised to record rate of perceived exertion during the synchronous exercise classes using the BORG RPE Scale and recording the score via a self-report logbook. Engagement with recorded sessions will be measured via self-reported logbooks in which participants will be encouraged to record time spent performing unsupervised exercise each week, BORG RPE ratings for unsupervised exercise sessions, and engagement with recordings of education webinars. Participant satisfaction will be examined using the Client Satisfaction Questionnaire 8 (CSQ-8) to assess satisfaction with the intervention overall (Nguyen *et al.* 1983). Participant satisfaction with individual components of the intervention (orientation session, exercise, education, and social components) will be assessed using Numerical Rating Scales (NRS) during post-intervention assessments. Participants will be asked during the post-intervention assessment to report the occurrence of any adverse events during the intervention period via a custom questionnaire. Adverse events will be defined as any problems or injuries experienced during the study that is deemed by the participant to be more likely resulting from participation in the intervention, rather than resulting from disease

progression (Forster *et al.* 2003; Barbara *et al.* 2016; Hinman *et al.* 2024). Serious adverse events will be defined as any medical occurrence resulting in death, threat to life, hospital admission or significant disability (Hinman *et al.* 2024). Qualitative semi-structured focus groups will be carried out remotely via videoconferencing to collect data regarding patient experiences and acceptability of the intervention. Focus groups will be video recorded and transcribed.

Quantitative feasibility measures will be evaluated using a traffic-light system including red (stop until solutions found), amber (amend and proceed) and green (proceed) indicating progression criteria to evaluate progression to a main trial (Avery *et al.* 2017). The thresholds for each outcome are outlined in Table 1. An adherence rate of 70% adherence to synchronous group exercise sessions will be used based on previously published research on exercise-based interventions (Nagpal *et al.* 2021). Retention rates will be measured using post-intervention outcome measure completion rates. A rate of 70% retention will be used based upon target completion rates for pulmonary rehabilitation services in the UK (Royal College of Physicians 2020). Satisfaction rates will be measured using the CSQ-8 scale which rates satisfaction on a 4-point Likert scale with totals ranging from 8 to 32. A rate of 75% will be used based on the 4-point scale to indicate good-excellent satisfaction levels, with 50-75% indicating fair satisfaction and less than 50% indicating poor satisfaction.

*Table 1 Traffic light system indicating progression criteria to evaluate progression to a main trial.*

<b>Criteria</b>	<b>Red (stop)</b>	<b>Amber (amend and proceed)</b>	<b>Green (proceed)</b>
<b>Recruitment rate</b>	<b>2 per week (8 in 4 weeks)</b>	<b>4 per week (16 in 4 weeks)</b>	<b>6+ per week (24+ in 4 weeks)</b>
<b>Retention rate</b>	<b>&lt;50%</b>	<b>60-70%</b>	<b>≥70%</b>
<b>Adherence rate</b>	<b>&lt;60%</b>	<b>60-70%</b>	<b>≥70%</b>

<b>Adverse events</b>	<b>&gt;2 serious adverse events</b>	<b>1-2 serious adverse events</b>	<b>No serious adverse events</b>
<b>Satisfaction</b>	<b>&lt;50% satisfied</b>	<b>50-75% satisfied</b>	<b>≥75% satisfied</b>

### **Clinical outcomes**

Clinical outcomes of interest include self-reported quality of life and objective physical function. The Euro-QoL-5D will be administered in pre-intervention and post-intervention assessments to assess the effect of the intervention on quality of life. The 30 second chair stand test (30CST) will be administered to assess the effect of the intervention on objective physical function. Outcome measures will be administered remotely via videoconferencing by a research physiotherapist.

### **Data analysis**

Descriptive statistics will be used to describe the participant characteristics at baseline including proportions, percentages, ranges, means and standard deviations.

Visual plots and the Shapiro Wilk test of normality will be used to assess numeric data for skewness. Primary feasibility and adherence outcomes will be reported as proportions. Analysis of clinical outcomes will involve comparison of pre and post intervention scores using mean differences with associated 95% confidence intervals.

Semi-structured focus groups will be recorded and transcribed. Focus groups transcriptions will be sent to participants via email to confirm their accuracy. Participants will be invited to send any comments or edits to the research team within one week of receiving the transcripts. Open inductive coding through line-by-line reading of the transcripts of semi-structured interviews will be undertaken using the principles of grounded theory. Thematic analysis following the six steps of the Braun and Clarke framework (Braun and Clarke 2006) will be conducted by the research team as follows: 1. Familiarizing the data 2. Generating initial

codes 3. Searching for themes 4. Reviewing themes 5. Defining and naming themes 6. Producing the report.

### **Dissemination of information**

The findings of this study will be disseminated via peer-reviewed publications and conference presentations.

### **Discussion**

Previous evidence supports the use of telerehabilitation for a range of different chronic health conditions. Given the increasing prevalence and burden of chronic conditions and multimorbidity, disease-agnostic programmes for mixed-condition groups have been more recently recognised as an efficient method of healthcare delivery. However, the feasibility and acceptability of a disease-agnostic telerehabilitation programme has not been previously explored. This is a protocol for a planned feasibility trial which is reported in accordance with the SPIRIT checklist. The proposed intervention has been designed with the aim of developing sustainable and efficient healthcare delivery method to tackle the increasing demand for rehabilitation programmes for people with chronic health conditions. This feasibility trial will provide important data required to guide future evaluation and potentially a future definitive randomised control trial evaluating the use of disease-agnostic telerehabilitation interventions for people with chronic health conditions.

## Appendix 8.1.9 Chapter Five; SPIRIT Checklist



SPIRIT 2013 Checklist: Recommended items to address in a clinical trial protocol and related documents\*

Section/item	Item No	Description	Addressed in Section
<b>Administrative information</b>			
Title	1	Descriptive title identifying the study design, population, interventions, and, if applicable, trial acronym	Title page
Trial registration	2a	Trial identifier and registry name. If not yet registered, name of intended registry	Abstract
	2b	All items from the World Health Organization Trial Registration Data Set	
Protocol version	3	Date and version identifier	Abstract
Funding	4	Sources and types of financial, material, and other support	Funding
Roles and responsibilities	5a	Names, affiliations, and roles of protocol contributors	Title page
	5b	Name and contact information for the trial sponsor	

- 5c Role of study sponsor and funders, if any, in study design; collection, management, analysis, and interpretation of data; writing of the report; and the decision to submit the report for publication, including whether they will have ultimate authority over any of these activities
- 5d Composition, roles, and responsibilities of the coordinating centre, steering committee, endpoint adjudication committee, data management team, and other individuals or groups overseeing the trial, if applicable (see Item 21a for data monitoring committee)

**Introduction**

Background rationale	and 6a	Description of research question and justification for undertaking the trial, including summary of relevant studies (published and unpublished) examining benefits and harms for each intervention	Background
	6b	Explanation for choice of comparators	
Objectives	7	Specific objectives or hypotheses	Background
Trial design	8	Description of trial design including type of trial (eg, parallel group, crossover, factorial, single group), allocation ratio, and framework (eg, superiority, equivalence, noninferiority, exploratory)	Methods: Design

**Methods: Participants, interventions, and outcomes**

Study setting	9	Description of study settings (eg, community clinic, academic hospital) and list of countries where data will be collected. Reference to where list of study sites can be obtained	Methods: Setting
Eligibility criteria	10	Inclusion and exclusion criteria for participants. If applicable, eligibility criteria for study centres and individuals who will perform the interventions (eg, surgeons, psychotherapists)	Methods: Eligibility Criteria
Interventions	11a	Interventions for each group with sufficient detail to allow replication, including how and when they will be administered	Methods: Intervention

	11b	Criteria for discontinuing or modifying allocated interventions for a given trial participant (eg, drug dose change in response to harms, participant request, or improving/worsening disease)	
	11c	Strategies to improve adherence to intervention protocols, and any procedures for monitoring adherence (eg, drug tablet return, laboratory tests)	
	11d	Relevant concomitant care and interventions that are permitted or prohibited during the trial	
Outcomes	12	Primary, secondary, and other outcomes, including the specific measurement variable (eg, systolic blood pressure), analysis metric (eg, change from baseline, final value, time to event), method of aggregation (eg, median, proportion), and time point for each outcome. Explanation of the clinical relevance of chosen efficacy and harm outcomes is strongly recommended	Methods:Data Collection
Participant timeline	13	Time schedule of enrolment, interventions (including any run-ins and washouts), assessments, and visits for participants. A schematic diagram is highly recommended (see Figure)	Figure 1
Sample size	14	Estimated number of participants needed to achieve study objectives and how it was determined, including clinical and statistical assumptions supporting any sample size calculations	N/A
Recruitment	15	Strategies for achieving adequate participant enrolment to reach target sample size	N/A

**Methods: Assignment of interventions (for controlled trials)**

Allocation:

Sequence generation	16a	Method of generating the allocation sequence (eg, computer-generated random numbers), and list of any factors for stratification. To reduce predictability of a random sequence, details of any planned restriction (eg, blocking) should be provided in a separate document that is unavailable to those who enrol participants or assign interventions	Methods: Population& Recruitment
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Allocation concealment mechanism	16b	Mechanism of implementing the allocation sequence (eg, central telephone; sequentially numbered, opaque, sealed envelopes), describing any steps to conceal the sequence until interventions are assigned	
Implementation	16c	Who will generate the allocation sequence, who will enrol participants, and who will assign participants to interventions	
Blinding (masking)	17a	Who will be blinded after assignment to interventions (eg, trial participants, care providers, outcome assessors, data analysts), and how	N/A
	17b	If blinded, circumstances under which unblinding is permissible, and procedure for revealing a participant's allocated intervention during the trial	

**Methods: Data collection, management, and analysis**

Data collection methods	18a	Plans for assessment and collection of outcome, baseline, and other trial data, including any related processes to promote data quality (eg, duplicate measurements, training of assessors) and a description of study instruments (eg, questionnaires, laboratory tests) along with their reliability and validity, if known. Reference to where data collection forms can be found, if not in the protocol	Methods:Data Collection
	18b	Plans to promote participant retention and complete follow-up, including list of any outcome data to be collected for participants who discontinue or deviate from intervention protocols	
Data management	19	Plans for data entry, coding, security, and storage, including any related processes to promote data quality (eg, double data entry; range checks for data values). Reference to where details of data management procedures can be found, if not in the protocol	Methods:Data Collection
Statistical methods	20a	Statistical methods for analysing primary and secondary outcomes. Reference to where other details of the statistical analysis plan can be found, if not in the protocol	Methods:Data Analysis
	20b	Methods for any additional analyses (eg, subgroup and adjusted analyses)	

20c Definition of analysis population relating to protocol non-adherence (eg, as randomised analysis), and any statistical methods to handle missing data (eg, multiple imputation)

**Methods: Monitoring**

Data monitoring 21a Composition of data monitoring committee (DMC); summary of its role and reporting structure; Methods:Data statement of whether it is independent from the sponsor and competing interests; and reference to where Collection further details about its charter can be found, if not in the protocol. Alternatively, an explanation of why a DMC is not needed

21b Description of any interim analyses and stopping guidelines, including who will have access to these interim results and make the final decision to terminate the trial

Harms 22 Plans for collecting, assessing, reporting, and managing solicited and spontaneously reported adverse Governance and events and other unintended effects of trial interventions or trial conduct oversight of study

Auditing 23 Frequency and procedures for auditing trial conduct, if any, and whether the process will be independent Governance and from investigators and the sponsor oversight of study

**Ethics and dissemination**

Research ethics 24 Plans for seeking research ethics committee/institutional review board (REC/IRB) approval Methods: Design approval

Protocol 25 Plans for communicating important protocol modifications (eg, changes to eligibility criteria, outcomes, Governance and amendments analyses) to relevant parties (eg, investigators, REC/IRBs, trial participants, trial registries, journals, oversight of study regulators)

Consent or assent 26a Who will obtain informed consent or assent from potential trial participants or authorised surrogates, and Methods: Population & how (see Item 32) Recruitment

	26b	Additional consent provisions for collection and use of participant data and biological specimens in ancillary studies, if applicable	
Confidentiality	27	How personal information about potential and enrolled participants will be collected, shared, and maintained in order to protect confidentiality before, during, and after the trial	Methods:Data Collection
Declaration of interests	28	Financial and other competing interests for principal investigators for the overall trial and each study site	Conflicts of interest
Access to data	29	Statement of who will have access to the final trial dataset, and disclosure of contractual agreements that limit such access for investigators	Methods:Data Collection
Ancillary and post-trial care	30	Provisions, if any, for ancillary and post-trial care, and for compensation to those who suffer harm from trial participation	N/A
Dissemination policy	31a	Plans for investigators and sponsor to communicate trial results to participants, healthcare professionals, the public, and other relevant groups (eg, via publication, reporting in results databases, or other data sharing arrangements), including any publication restrictions	Dissemination of information
	31b	Authorship eligibility guidelines and any intended use of professional writers	
	31c	Plans, if any, for granting public access to the full protocol, participant-level dataset, and statistical code	
<b>Appendices</b>			
Informed consent materials	32	Model consent form and other related documentation given to participants and authorised surrogates	Appendices
Biological specimens	33	Plans for collection, laboratory evaluation, and storage of biological specimens for genetic or molecular analysis in the current trial and for future use in ancillary studies, if applicable	N/A

## Appendix 8.1.10 Chapter Six; CONSORT Checklist

CONSORT checklist of information to include when reporting a pilot trial*			
Section/topic and item No	Standard checklist item	Extension for pilot trials	Page No where item is reported
<b>Title and abstract</b>			
1a	Identification as a randomised trial in the title	Identification as a pilot or feasibility randomised trial in the title	Title
1b	Structured summary of trial design, methods, results, and conclusions (for specific guidance see CONSORT for abstracts)	Structured summary of pilot trial design, methods, results, and conclusions (for specific guidance see CONSORT abstract extension for pilot trials)	Abstract
<b>Introduction</b>			
Background and objectives:			
2a	Scientific background and explanation of rationale	Scientific background and explanation of rationale for future definitive trial, and reasons for randomised pilot trial	Introduction
2b	Specific objectives or hypotheses	Specific objectives or research questions for pilot trial	Introduction
<b>Methods</b>			
Trial design:			
3a	Description of trial design (such as parallel, factorial) including allocation ratio	Description of pilot trial design (such as parallel, factorial) including allocation ratio	Materials & methods: design
3b	Important changes to methods after trial commencement (such as eligibility criteria), with reasons	Important changes to methods after pilot trial commencement (such as eligibility criteria), with reasons	Materials & methods
Participants:			
4a	Eligibility criteria for participants		Materials & methods
4b	Settings and locations where the data were collected		Materials & methods
4c		How participants were identified and consented	Materials & methods
Interventions:			
5	The interventions for each group with sufficient details to allow replication, including how and when they were actually administered		Materials & methods: intervention & Appendix 8.1.10
Outcomes:			
6a	Completely defined prespecified primary and secondary outcome measures, including how and when they were assessed	Completely defined prespecified assessments or measurements to address each pilot trial objective specified in 2b, including how and when they were assessed	Materials & methods: Data collection
6b	Any changes to trial outcomes after the trial commenced, with reasons	Any changes to pilot trial assessments or measurements after the pilot trial commenced, with reasons	Materials & methods
6c		If applicable, prespecified criteria used to judge whether, or how, to proceed with future definitive trial	Table 6.6

<b>Sample size:</b>			
7a	How sample size was determined	Rationale for numbers in the pilot trial	N/A
7b	When applicable, explanation of any interim analyses and stopping guidelines		
<b>Randomisation:</b>			
Sequence generation:			
8a	Method used to generate the random allocation sequence		N/A
8b	Type of randomisation; details of any restriction (such as blocking and block size)	Type of randomisation(s); details of any restriction (such as blocking and block size)	N/A
Allocation concealment mechanism:			
9	Mechanism used to implement the random allocation sequence (such as sequentially numbered containers), describing any steps taken to conceal the sequence until interventions were assigned		N/A
Implementation:			
10	Who generated the random allocation sequence, enrolled participants, and assigned participants to interventions		N/A
<b>Blinding:</b>			
11a	If done, who was blinded after assignment to interventions (eg, participants, care providers, those assessing outcomes) and how		N/A
11b	If relevant, description of the similarity of interventions		
<b>Analytical methods:</b>			
12a	Statistical methods used to compare groups for primary and secondary outcomes	Methods used to address each pilot trial objective whether qualitative or quantitative	<b>Materials &amp; methods: Statistical analysis</b>
12b	Methods for additional analyses, such as subgroup analyses and adjusted analyses	Not applicable	N/A
<b>Results</b>			
Participant flow (a diagram is strongly recommended):			
13a	For each group, the numbers of participants who were randomly assigned, received intended treatment, and were analysed for the primary outcome	For each group, the numbers of participants who were approached and/or assessed for eligibility, randomly assigned, received intended treatment, and were assessed for each objective	<b>Results</b>
13b	For each group, losses and exclusions after randomisation, together with reasons		<b>Results</b>
<b>Recruitment:</b>			

14a	Dates defining the periods of recruitment and follow-up		Materials & methods, Results & Table 6.5
14b	Why the trial ended or was stopped	Why the pilot trial ended or was stopped	Materials & methods
<b>Baseline data:</b>			
15	A table showing baseline demographic and clinical characteristics for each group		Table 6.4
<b>Numbers analysed:</b>			
16	For each group, number of participants (denominator) included in each analysis and whether the analysis was by original assigned groups	For each objective, number of participants (denominator) included in each analysis. If relevant, these numbers should be by randomised group	Results
<b>Outcomes and estimation:</b>			
17a	For each primary and secondary outcome, results for each group, and the estimated effect size and its precision (such as 95% confidence interval)	For each objective, results including expressions of uncertainty (such as 95% confidence interval) for any estimates. If relevant, these results should be by randomised group	Results, Table 6.7
17b	For binary outcomes, presentation of both absolute and relative effect sizes is recommended	Not applicable	
<b>Ancillary analyses:</b>			
18	Results of any other analyses performed, including subgroup analyses and adjusted analyses, distinguishing prespecified from exploratory	Results of any other analyses performed that could be used to inform the future definitive trial	N/A
<b>Harms:</b>			
19	All important harms or unintended effects in each group (for specific guidance see CONSORT for harms)		Results
19a		If relevant, other important unintended consequences	
<b>Discussion</b>			
<b>Limitations:</b>			
20	Trial limitations, addressing sources of potential bias, imprecision, and, if relevant, multiplicity of analyses	Pilot trial limitations, addressing sources of potential bias and remaining uncertainty about feasibility	Discussion
<b>Generalisability:</b>			
21	Generalisability (external validity, applicability) of the trial findings	Generalisability (applicability) of pilot trial methods and findings to future definitive trial and other studies	Discussion
<b>Interpretation:</b>			
22	Interpretation consistent with results, balancing benefits and harms, and considering other relevant evidence	Interpretation consistent with pilot trial objectives and findings, balancing potential benefits and harms, and considering other relevant evidence	Discussion
22a		Implications for progression from pilot to future definitive trial, including any proposed amendments	
<b>Other information</b>			

Registration:			
23	Registration number and name of trial registry	Registration number for pilot trial and name of trial registry	Materials & methods
Protocol:			
24	Where the full trial protocol can be accessed, if available	Where the pilot trial protocol can be accessed, if available	Materials & methods
Funding:			
25	Sources of funding and other support (such as supply of drugs), role of funders		Declarations
26		Ethical approval or approval by research review committee, confirmed with reference number	Materials & methods

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\*Here a pilot trial means any randomised study conducted in preparation for a future definitive RCT, where the main objective of the pilot trial is to assess feasibility.



## **TECC (Telerehabilitation and Exercise for Chronic Conditions) Programme**

### **Orientation Documents**

This document provides information to help you to prepare for taking part in the live exercise classes. Please review this information before you participate in these classes.

#### **Safe Home Exercise Checklist**

What you will need to participate safely:

- An appropriate technological device (laptop, iPad, etc.) with an internet connection and access to an email address to attend the online classes via videoconferencing.
- A stable surface to place your computer device on such as a table.
- Comfortable clothes and footwear to perform the exercise class.
- Sufficient safe space to perform each exercise. This space should be clear of any obstacles or trip hazards such as rugs, carpets, or pets. Try to make sure the space you are in is quiet so that you can hear the physiotherapist providing instructions.
- A family member, friend or carer may be present nearby if you feel that this is necessary.
- A stable surface to hold during the exercises if required such as a stable armchair.
- A supportive chair, preferably with arms and no wheels, for doing exercises from and resting on.
- A bottle of water if required.
- Two light weights such as two bottles filled with water or two tins of peas.
- No pets present that may cause you to trip or fall.
- Stop exercising immediately if you experience any of the following chest pain, dizziness/feeling faint or extreme shortness of breath.

### Exercise safety guidelines:

- To ensure you are exercising at the appropriate intensity we want you to use the BORG Rate of Perceived Exertion (RPE) Scale (See Figure below) to rate your perception of exertion or how strenuous the exercise feels to you. This scale runs from 6 to 20 with a level of 6 indicating “no feeling of exertion at all”, and level 20 indicating “maximal exertion”. Your rate of perceived exertion will depend on the strain and fatigue in your muscles and the feeling of breathlessness in your chest. By the end of the warmup, you should be at an RPE level of less than 11. During the main exercise session, you should be working at a level of 11-14. This level indicates that you are exercising at a level that is “somewhat hard”, but you feel ok to keep going. Your level of perceived exertion is based on your own feeling of effort and exertion so try to monitor it as honestly as possible.
- Stop exercising immediately if you experience any of the following: chest pain, dizziness or feeling faint, extreme shortness of breath, excessive wheezing or coughing up blood.

6	No exertion at all
7	
8	Extremely light
9	Very light
10	
11	Light
12	
13	Somewhat hard
14	
15	Hard (heavy)
16	
17	Very hard
18	
19	Extremely hard
20	Maximal exertion

Borg RPE scale  
© Gunnar Borg, 1970, 1985, 1994, 1998

*Figure 2 BORG RPE Scale*

Appendix 8.1.12 Chapter Six; TECC Diary Logbook



Supplementary File 6 TECC Diary

Logbook



WEEK 1				
	Exercise (Mins & type)	RPE 6-20	Video (Tick)	Useful 1-10
Monday			<input type="checkbox"/>	
Tuesday			<input type="checkbox"/>	
Wednesday			<input type="checkbox"/>	
Thursday			<input type="checkbox"/>	
Friday			<input type="checkbox"/>	
Saturday			<input type="checkbox"/>	
Sunday			<input type="checkbox"/>	

WEEK 2				
	Exercise (Mins & type)	RPE 6-20	Video (Tick)	Useful 1-10
Monday			<input type="checkbox"/>	
Tuesday			<input type="checkbox"/>	
Wednesday			<input type="checkbox"/>	
Thursday			<input type="checkbox"/>	
Friday			<input type="checkbox"/>	
Saturday			<input type="checkbox"/>	
Sunday			<input type="checkbox"/>	

WEEK 3				
	Exercise (Mins & type)	RPE 6-20	Video (Tick)	Useful 1-10
Monday			<input type="checkbox"/>	
Tuesday			<input type="checkbox"/>	
Wednesday			<input type="checkbox"/>	
Thursday			<input type="checkbox"/>	
Friday			<input type="checkbox"/>	
Saturday			<input type="checkbox"/>	
Sunday			<input type="checkbox"/>	

WEEK 4				
	Exercise (Mins & type)	RPE 6-20	Video (Tick)	Useful 1-10
Monday			<input type="checkbox"/>	
Tuesday			<input type="checkbox"/>	
Wednesday			<input type="checkbox"/>	
Thursday			<input type="checkbox"/>	
Friday			<input type="checkbox"/>	
Saturday			<input type="checkbox"/>	
Sunday			<input type="checkbox"/>	

WEEK 5				
	Exercise (Mins & type)	RPE 6-20	Video (Tick)	Useful 1-10
Monday			<input type="checkbox"/>	
Tuesday			<input type="checkbox"/>	
Wednesday			<input type="checkbox"/>	
Thursday			<input type="checkbox"/>	
Friday			<input type="checkbox"/>	
Saturday			<input type="checkbox"/>	
Sunday			<input type="checkbox"/>	

WEEK 6				
	Exercise (Mins & type)	RPE 6-20	Video (Tick)	Useful 1-10
Monday			<input type="checkbox"/>	
Tuesday			<input type="checkbox"/>	
Wednesday			<input type="checkbox"/>	
Thursday			<input type="checkbox"/>	
Friday			<input type="checkbox"/>	
Saturday			<input type="checkbox"/>	
Sunday			<input type="checkbox"/>	

### Appendix 8.1.13 Chapter Six; Intervention Attendance

<b>Intervention component</b>	<b>Mean attendance (SD)</b>	<b>Attendance rate (%)</b>
Synchronous group exercise sessions	7 (1.3)	43.8
Synchronous education sessions	5.2 (2.3)	32.3
All synchronous sessions (exercise and education)	6.1 (2.0)	38.0
Optional social component	1.3 (2.4)	8.3

## Appendix 8.1.14 Chapter Six; Participant Satisfaction

### *Client Satisfaction Questionnaire 8 (CSQ-8)*

<b>Question</b>	<b>Mean score (SD)</b>
1. How would you rate the quality of the programme you have received?	4 (0)
2. Did you get the kind of programme you wanted?	3.5 (0.5)
3. To what extent has this treatment programme met your needs?	3.3 (0.9)
4. If a friend were in need of similar help, would you recommend this programme to them?	4 (0)
5. How satisfied are you with the amount of help received?	3.9 (0.3)
6. Have the services you received helped you to deal more effectively with problems?	3.5 (0.7)
7. Overall, or in a general sense, how satisfied are you with the programme you have received?	3.9 (0.3)
8. If you were to seek this kind of help again, would you come back to this programme for help?	3.8 (0.4)
Total score (range 8-32)	30 (2.4)

*A 4-point Likert scale was employed across questions (4 indicating high levels of satisfaction and a score of 1 indicating low levels of satisfaction)*

*Participant Satisfaction with individual intervention components*

<b>Question</b>	<b>Mean Score (SD)</b>
1. Please indicate on the scale from 0-10 how satisfied you were with the <b><u>orientation video call</u></b> that was carried out before you commenced the programme	8.6 (2.2)
2. Please indicate on the scale from 0-10 how satisfied you were with the <b><u>exercises classes</u></b> that were provided during the programme	9.5 (0.9)
3. Please indicate on the scale from 0-10 how satisfied you were with the <b><u>educational talks</u></b> that were provided within the programme	8.4 (1.6)
4. Please indicate on the scale from 0-10 how satisfied you were with the <b><u>social component</u></b> (option to chat with others after the exercise class) of the programme	3.6 (2.9)

*10-point Numerical Rating Scale employed across questions (1= 'extremely not satisfied'; 10= 'extremely satisfied')*

## **Appendix 8.2 Invitation Leaflets**

### **Appendix 8.2.1 Chapter Three; Participant Invitation Leaflet**

**EHSREC No: 2021\_03\_05\_EHS**



#### **Exploring the attitudes of patients on the use of telerehabilitation for chronic health populations**

##### **Who are we looking for?**

We are looking for adults aged 18 years or over with long-term health conditions who are willing to share their thoughts on participating in physiotherapy rehabilitation programmes that use internet and communication technology to facilitate communication between physiotherapists and patients such as telephone or video calls (telerehabilitation). You do not need to have previous experience of participating in telerehabilitation programmes to take part in this research.

##### **What is the aim of the study?**

The aim of the study is to explore the thoughts and experiences of people with long-term health conditions on participation in telerehabilitation programmes. This information could help us to identify the factors that may comprise the best possible telerehabilitation programme, and also identify any barriers and facilitators that may affect such a programme. We hope to be able to develop such a programme based on your input and other information.

##### **What will I have to do?**

You will be asked to participate in a focus group with three to seven other people with long-term health conditions telling us your thoughts of participating in telerehabilitation programmes. We will ask you a few questions about yourself, such as some details about your health, and whether or not you have ever participated in telerehabilitation. We will also ask about the pros and cons of telerehabilitation.

**Where will the focus group take place?**

The focus group will take place online via video call, using Microsoft Teams. If you do not have access to the technology required to participate in an online video call your focus group will be conducted with a telephone conference call.

If you are interested in participating, further details are provided in the information sheet attached. For further details or if you have any questions regarding the study, please contact:

[Caoimhe.Barry.Walsh@ul.ie](mailto:Caoimhe.Barry.Walsh@ul.ie)

[Roisin.Cahalan@ul.ie](mailto:Roisin.Cahalan@ul.ie)

Many thanks!

*This research study has received Ethics approval from the Education and Health Sciences Research Ethics Committee [insert approval number].*

*If you have any concerns about this study and wish to contact someone independent you may contact the Chairman Education and Health Sciences Research Ethics Committee*

*EHS Faculty Office, University of Limerick*

*Tel (061) 234101*

*Email : [ehsresearchethics@ul.ie](mailto:ehsresearchethics@ul.ie)*



**Exploring the attitudes of patients and clinicians on the use of telerehabilitation for chronic health populations: A qualitative study**

**Who are we looking for?**

We are looking for physiotherapists who are willing to share their thoughts on the use of internet and communication technologies to facilitate the remote delivery of rehabilitation programmes and communication between clinicians and patients programmes (telerehabilitation) for chronic health populations. You are not required to have previous experience of telerehabilitation delivery.

**What is the aim of the study?**

The aim of the study is to explore the thoughts and experiences of clinicians on the use of telerehabilitation for rehabilitation service delivery for various chronic populations and establish the optimal characteristics of telerehabilitation programmes as perceived by clinicians. This information could help us to identify the factors that may comprise the optimal telerehabilitation programme and also identify any barriers and facilitators that may affect such a programme. We hope that your input along with other information will help to guide the development of an optimal telerehabilitation programme.

**What will I have to do?**

You will be asked to fill in a short questionnaire to provide some information about your current clinical area of work, your geographical location and previous experience with telerehabilitation. You will then be asked to attend a focus group with other clinicians telling us your thoughts towards the use of telerehabilitation programmes for chronic health populations. We will also ask about barriers and facilitators to telerehabilitation, and potential characteristics that you believe would optimise these programmes.

**Where will the focus group take place?**

The focus group will take place online via video call. If you do not have access to the technology required to participate in an online video call the focus group will be conducted via telephone conference call.

If you are interested in participating, further details are provided in the information sheet attached. For further details or if you have any questions regarding the study, please contact:

[Caoimhe.Barry.Walsh@ul.ie](mailto:Caoimhe.Barry.Walsh@ul.ie)

Many thanks!

*This research study has received Ethics approval from the Education and Health Sciences Research Ethics Committee [insert approval number].*

*If you have any concerns about this study and wish to contact someone independent you may contact the Chairman Education and Health Sciences Research Ethics Committee*

*EHS Faculty Office, University of Limerick*

*Tel (061) 234101*

*Email : [ehsresearchethics@ul.ie](mailto:ehsresearchethics@ul.ie)*

## **Appendix 8.3 Information Sheets**

### **Appendix 8.3.1 Chapter Three; Participant Information Leaflet**

EHSREC No: 2021\_03\_05\_EHS



#### **Exploring the attitudes of patients on the use of telerehabilitation for chronic health populations: A qualitative study**

##### **What is the study about?**

We are investigating what people who have long-term health conditions think about physiotherapy rehabilitation delivered remotely using technology such as telephone or video calls to facilitate communication between physiotherapists and patients (telerehabilitation). We want to find out what you believe are the pros and cons of telerehabilitation and what factors you believe would make the best telerehabilitation class. You do not need to have previous experience of participating in telerehabilitation programmes to take part in this study.

##### **Who can take part in this study?**

To take part in this study, you must be 18 years or older and have a diagnosis of any long-term health condition. You must have fluent spoken and written English.

##### **What will I have to do?**

If you wish to take part in the study, you will be asked to answer some short questions about yourself.

Then you will be required to participate in a focus group with three to seven other people with long-term health conditions which will involve a group discussion of your thoughts on telerehabilitation. During the focus group I will ask a number of questions and members of the group can contribute answers. Everyone in the group will get a chance to offer their

opinion. The group discussion will be audio recorded. This should take about one hour in total.

**Where will the focus group take place?**

The focus group will take place online via video call using Microsoft Teams.

**What are the benefits of participating in this study?**

This study will help in understanding the patient's perspectives toward the use of telerehabilitation. It will also help us to identify the best features of these programmes from a service user's perspective. This information could help to guide the development of future telerehabilitation programmes for people with various chronic health conditions, including yourself.

**What are the risks of participating in this study?**

Minimal risk is involved with this study. Participation in the focus groups will require you to express your thoughts in the presence of other group members. We will ask all members of the focus groups to maintain confidentiality and not discuss the contents of the discussion or the identity of the group participants with anyone.

**What if I do not want to take part?**

Taking part in this study is purely voluntary. There is no obligation to participate. If you don't want to be in the study, you don't have to be. It won't affect you if you want to take part in other studies.

**What if I change my mind about taking part in the study?**

You may withdraw from the study at any time and your data may be withdrawn at any stage up until data analysis has started. You can do this by contacting the lead investigator listed below.

**What happens to the information?**

The information that you provide to the research team will be kept confidential and anonymous. Information will be stored securely on cloud based servers. Only the people

running the study will look at this information. After seven years paper data will be shredded, and electronic data will be electronically deleted from the servers.

### **What happens at the end of the study?**

After all the information is collected, it will be analysed, and a report of the main findings will be written and published in relevant academic journals and may be presented at conferences. All the data will be stored and destroyed as outlined above.

### **What if I have more questions or do not understand something?**

If you have any questions, you can contact me at the details listed below at any time before, during or following the study. You can ask any questions you might have when you fill in the questionnaire, or during the focus group.

### **Contact name and email details of Research Investigators**

Name: Caoimhe Barry Walsh  
Email: [Caoimhe.Barry.Walsh@ul.ie](mailto:Caoimhe.Barry.Walsh@ul.ie)

Name: Roisin Cahalan  
Email: [Roisin.Cahalan@ul.ie](mailto:Roisin.Cahalan@ul.ie)

*This research study has received Ethics approval from the Education and Health Sciences Research Ethics Committee [insert approval number].*

*If you have any concerns about this study and wish to contact someone independent you may contact the Chairman Education and Health Sciences Research Ethics Committee*

*EHS Faculty Office, University of Limerick*

*Tel (061) 234101*

*Email : [ehsresearchethics@ul.ie](mailto:ehsresearchethics@ul.ie)*



**Exploring the attitudes of patients and clinicians on the use of telerehabilitation for chronic health populations: A qualitative study**

**What is the study about?**

This study aims to explore the attitudes and experiences of clinicians on the use of telehealth for the delivery of rehabilitation programmes (telerehabilitation) for chronic health populations. This will help us to understand the benefits and challenges associated with the delivery of telerehabilitation from a clinician's perspective and help us to develop the optimal telerehabilitation programme for various chronic health populations.

**Who can take part in this study?**

To take part in this study, you must be a clinician involved in the delivery of physiotherapy rehabilitation for chronic populations. You do not need to have previously participated in telerehabilitation programme delivery. You must have fluent written and spoken English.

**What will I have to do?**

You will also be asked to fill in a short questionnaire to provide information about your current clinical work area, geographical location and previous experience of telerehabilitation.

Then you will be required to attend a focus group with up to eight other clinicians, which will be audio and video recorded and discuss your thoughts and experiences of the use of telerehabilitation for chronic health populations. This should take about one hour in total.

**Where will the focus group take place?**

The focus group will take place online via video call (Microsoft Teams). If you do not have access to the technology required to participate in an online video call the focus group will be conducted via telephone conference call.

**What are the benefits of participating in this study?**

This study will help in understanding the perspectives of patients and clinician's regarding the use of telerehabilitation to deliver physiotherapy rehabilitation programmes for chronic health populations. It will also help us to identify the perceived optimal features of these programmes. This will potentially guide the development of future telerehabilitation programmes for people with various chronic health conditions and help to optimise the care provided to these patients.

**What are the risks of participating in this study?**

Minimal risk is involved with this study. Participation in the focus groups will require you to express your thoughts in the presence of other group members. We will ask all focus group members to maintain confidentiality and not discuss the contents of the discussion or the identity of the group participants with anyone.

**What if I do not want to take part?**

Taking part in this study is purely voluntary. There is no obligation to participate. If you don't want to be in the study, you don't have to be. It won't affect you if you want to take part in other studies.

**What if I change my mind about participating in the study?**

You may withdraw from the study at any time and your data may be withdrawn at any stage up until data analysis has started. You can do this by contacting the lead investigator listed below.

**What happens to the information?**

The information that you provide to the research team will be kept confidential and anonymous. Information will be stored securely on cloud based servers. Only the people running the study will look at this information. After seven years paper data will be shredded, and electronic data will be electronically deleted from the servers.

**What happens at the end of the study?**

After all the information is collected, it will be analysed, and a report of the main findings will be written and published. All the data will be stored and destroyed as outlined above.

**What if I have more questions or do not understand something?**

If you have any questions, you can contact me at the details listed below at any time before, during or following the study. You can ask any questions you might have when you fill in the questionnaire, or during the physical screening.

**Contact name and email details of Research Investigators**

Name: Caoimhe Barry Walsh

Email: [Caoimhe.Barry.Walsh@ul.ie](mailto:Caoimhe.Barry.Walsh@ul.ie)

*This research study has received Ethics approval from the Education and Health Sciences Research Ethics Committee [insert approval number].*

*If you have any concerns about this study and wish to contact someone independent you may contact the Chairman Education and Health Sciences*

*Research Ethics Committee*

*EHS Faculty Office, University of Limerick*

*Tel (061) 234101*

*Email : [ehsresearchethics@ul.ie](mailto:ehsresearchethics@ul.ie)*



## **PARTICIPANT INFORMATION SHEET**

### **TECC- Telerehabilitation and Exercise for Chronic Conditions**

Dear Participant,

You are invited to take part in a research project run by the University of Limerick which will investigate the impact of a group exercise and education programme on the health, wellbeing, and quality of life of people with long-term health conditions.

#### **What is the study about?**

The study aims to find out if people who take part in a group exercise and education programme delivered remotely via technology called “TECC” enjoy and benefit from the project. We know that various long-term health conditions can be challenging and lead to reduced levels of physical activity. Long-term health conditions can also impact patient quality of life and overall wellbeing. This study will see if the TECC programme is acceptable for participants, and if it has any impact on one’s health and wellbeing.

#### **What will I have to do?**

You will be invited to take part in a 1-hour group exercise session each week for 6 weeks. The sessions will include a gentle physical warm-up, main exercise session and a cool down. The classes will take place online via Zoom. You will be allocated to a particular exercise group depending on your level of mobility, which will be assessed before commencing the

programme. After the class, there will be an opportunity to meet and socialise with other participants in an online breakout room. Exercise classes will be recorded and sent to people to practice if they choose during the week at their own convenience. We will also provide access to live educational webinars delivered by healthcare professionals online through Zoom which will cover different topics that to help you to manage your overall health and wellbeing.

Should you agree to participate in the study, you will be required to complete a Physical Activity Readiness Questionnaire (PAR-Q) form to indicate your readiness to participate in the exercise class. If any concerns are identified in this screening questionnaire, you will be encouraged to discuss your participation with your GP prior to signing a disclaimer and participating in the study. You will be required to sign a disclaimer to agree voluntary participation at your own risk. You will be asked to complete a questionnaire before the start of the study – this will gather basic data including your sex, age, education and job status and a few questions on your diagnosis. You will also complete a brief questionnaire which will establish your mobility level and determine which is the most appropriate exercise class level for you. You will also complete a questionnaire to assess the impact of your long-term condition on various aspects of your life. These questionnaires should take a combined time of about 10-15 minutes. You will also complete a physical assessment with one of our investigators. This involves performing as many sit-to-stand movements from a chair as you can over a 30 second period to measure your level of physical function. You will repeat one of the questionnaires and the 30 second sit-to-stand test after the 6-week programme has ended. At the end of the 6-week programme you will also complete a brief questionnaire to assess your level of satisfaction with the programme.

Finally, you will be invited to take part in focus groups after the 6 weeks end to offer opinions and feedback on what went well in the study, and what could be improved. The focus groups will be video recorded to allow us to transcribe what you say. Tapes will be destroyed within 2 weeks of recording. Focus groups will also take place online via video call.

### **What are the benefits?**

Studies of exercise and educational rehabilitation programmes for various long-term health conditions have shown that these types of group programmes can really help to improve the physical and general wellbeing of participants. Studies that focus on these programmes delivered remotely through technology have shown that these programmes can be as effective as in-person programmes. We hypothesise that TECC will have positive effects on the physical and general health of participants.

### **What are the risks?**

Previous studies like this have reported minimal adverse events for patients. You will be encouraged to go at your own pace. You will be advised on how to monitor and perform at the most appropriate exercise level for you. In the focus group, you might decide that you don't want to answer a question. If this happens, you do not have to answer any question you do not wish to.

### **What if I do not want to take part?**

Participation in this study is voluntary, and you can choose not to take part or to stop your involvement in this study at any time. You are free to withdraw my participation without having to explain or give a reason, up to when the data analysis begins.

### **What happens to the information?**

The information that is collected will be kept private and stored securely and safely on stored on UL approved cloud-based storage One Drive. Your name will not appear on any information. You will be assigned a code when the information is being written in a report by the researcher. The information that is gathered in the study will be kept for seven years. After this time, it will be destroyed.

**Who else is taking part?**

People with different types of long-term health conditions will be invited to participate. Participants must be 18 years or older, have good spoken and written English and be medically stable.

**What if something goes wrong?**

In the unlikely event that something goes wrong during the classes, the class will stop immediately, and appropriate medical advice will be sought. If something goes wrong during a focus group session, the interview session will immediately stop until the researcher and participant(s) are ready to restart the session or the session would be stopped completely.

**What happens at the end of the study?**

At the end of the study the information will be used to present results. The information will be completely anonymous. No participant's name will appear in any of the results. All data gathered from the research will be stored securely and safely by the researcher in their office for 7 years. Information that is stored on the OneDrive cloud will be accessed by Ms Caoimhe Barry Walsh on a computer that is password-protected. It is planned to present the findings of the study at a conference and publish them in a journal. There will also be a summary of findings available to you after the study if you would like to have one.

**What if I have more questions or do not understand something?**

If you have any questions about the study, you may contact either of the researchers. It is important that you feel that all your questions have been answered.

**What happens if I change my mind during the study?**

At any stage should you feel that you want to stop taking part in the study, you are free to stop and take no further part. There are no consequences for changing your mind about being in the study.

**Contact name and number of Project Investigators.**

Ms Caoimhe Barry Walsh, School of Allied Health,

University of Limerick, Tel (061) 202959

Email: [caoimhe.barry.walsh@ul.ie](mailto:caoimhe.barry.walsh@ul.ie)

Associate Professor Roisin Cahalan, School of Allied Health,

University of Limerick, Tel (061) 202959

Email: [roisin.cahalan@ul.ie](mailto:roisin.cahalan@ul.ie)

Thank you for taking the time to read this. I would be grateful if you would consider participating in this study.

Yours sincerely,

Ms Caoimhe Barry Walsh

Assoc Prof Roisin Cahalan

\_\_\_\_\_

\_\_\_\_\_

***This research study has received Ethics approval from the HSE South Eastern Area Research Ethics Committee***



**TECC (Telerehabilitation and Exercise for Chronic Conditions) Programme  
Orientation Document**

This document provides information to help you to prepare for taking part in the live exercise classes. Please review this information before you participate in these classes.

**Safe Home Exercise Checklist**

What you will need to participate safely:

- An appropriate technological device (laptop, iPad, etc.) with an internet connection and access to an email address to attend the online classes via videoconferencing.
- A stable surface to place your computer device on such as a table.
- Comfortable clothes and footwear to perform the exercise class.
- Sufficient safe space to perform each exercise. This space should be clear of any obstacles or trip hazards such as rugs, carpets, or pets. Try to make sure the space you are in is quiet so that you can hear the physiotherapist providing instructions.
- A family member, friend or carer may be present nearby if you feel that this is necessary.
- A stable surface to hold during the exercises if required such as a stable armchair.
- A supportive chair, preferably with arms and no wheels, for doing exercises from and resting on.
- A bottle of water if required.
- Two light weights such as two bottles filled with water or two tins of peas.
- No pets present that may cause you to trip or fall.
- Stop exercising immediately if you experience any of the following chest pain, dizziness/feeling faint or extreme shortness of breath.

### Exercise safety guidelines:

- To ensure you are exercising at the appropriate intensity we want you to use the BORG Rate of Perceived Exertion (RPE) Scale (See Figure below) to rate your perception of exertion or how strenuous the exercise feels to you. This scale runs from 6 to 20 with a level of 6 indicating “no feeling of exertion at all”, and level 20 indicating “maximal exertion”. Your rate of perceived exertion will depend on the strain and fatigue in your muscles and the feeling of breathlessness in your chest. By the end of the warmup, you should be at an RPE level of less than 11. During the main exercise session, you should be working at a level of 11-14. This level indicates that you are exercising at a level that is “somewhat hard”, but you feel ok to keep going. Your level of perceived exertion is based on your own feeling of effort and exertion so try to monitor it as honestly as possible.
- Stop exercising immediately if you experience any of the following: chest pain, dizziness or feeling faint, extreme shortness of breath, excessive wheezing or coughing up blood.

6	No exertion at all
7	
8	Extremely light
9	Very light
10	
11	Light
12	
13	Somewhat hard
14	
15	Hard (heavy)
16	
17	Very hard
18	
19	Extremely hard
20	Maximal exertion

Borg RPE scale  
© Gunnar Borg, 1970, 1985, 1994, 1998

*Figure BORG RPE Scale*

## **Appendix 8.4 Consent Sheets and Research Privacy Notices**

### **Appendix 8.4.1 Chapter Three; Participant Informed Consent Sheet**

**EHSREC No: 2021\_03\_05\_EHS**

**FACULTY OF EDUCATION AND HEALTH SCIENCES**

**RESEARCH ETHICS COMMITTEE (EHSREC)**



#### **Ethical Consent Form**

I, the undersigned, declare that I am willing to take part in research for the project entitled

**Exploring the attitudes of patients and clinicians on the use of telerehabilitation for chronic health populations: A qualitative study**

- I declare that I have been fully briefed on the nature of this study and my role in it and have been given the opportunity to ask questions before agreeing to participate.
- The nature of my participation has been explained to me, and I have full knowledge of how the information collected will be used.
- I am aware that my participation in this study will be audio/video recorded and I agree to this. However, should I feel uncomfortable at any time, I can request that the recording software be switched off.
- I am aware that such information may also be used in future academic presentations and publications about this study.
- I fully understand that there is no obligation on me to participate in this study.
- I fully understand that I am free to withdraw my participation without having to explain or give a reason, up to a period of two weeks after the data collection is completed.
- I know that I have been asked not to discuss the content of the focus group discussion, or the identity of its participants with anyone.
- I acknowledge that while the researcher has asked all focus groups participants to maintain confidentiality in the above manner, the researcher cannot guarantee that individual participants will adhere to this request.

- I acknowledge that the researcher does guarantee that they will not use my name or any other information that would identify me in any outputs of the research.
- I declare that I have read and fully understand the contents of the Research Privacy Notice.

Signature of Participant	Date
--------------------------	------

Signature of Investigator	Date
---------------------------	------

<b>Consent to Contact about Similar Future Research</b>	<b>Yes</b>	<b>No</b>
I explicitly consent to the University contacting me as part of current or similar future research and holding my contact details on its database for the purpose of contacting me.	<input type="checkbox"/>	<input type="checkbox"/>

## RESEARCH PRIVACY NOTICE

### Introduction

*This Research Privacy Notice governs the use and storage of your personal data by the University of Limerick (the “University”). The processing of this data is carried out in accordance with the General Data Protection Regulation (GDPR) / Data Protection Acts 1988-2018 (“Data Protection Law”) and in accordance with this Research Privacy Notice.*

*Any personal data which you provide to the University as part of this research project will be treated with the highest standards of security and confidentiality, in accordance with Irish and European Data Protection Law. This Notice sets out details of the information that we collect, how we process it and who we share it with. It also explains your rights under data protection law in relation to our processing of your data.*

### 1. Title and Purpose of the research project

1.1 Title: Exploring the attitudes and experiences of people with chronic health conditions and clinicians toward the use of telerehabilitation for chronic health populations: A qualitative study

1.2 The purpose of the research project is to explore the thoughts and experiences of people with chronic health conditions on participation in physiotherapy rehabilitation programmes that are delivered remotely using internet and communications

technologies. This will provide an understanding of the service user's perspective towards the use of technology to facilitate the delivery of physiotherapy rehabilitation. This information will help to guide the development of future rehabilitation programmes for people with various chronic health conditions.

## **2. Research Ethics Committee**

2.1 Ethical approval was granted by University of Limerick Research Ethics Committee (UL REC) on 18/03/2021. The research ethics approval number is 2021\_03\_05\_EHS.

## **3. Identity of the Data Controller(s)**

3.1 The Data Controller is:

- University of Limerick, Plassey, Limerick.

## **4. Identity and Contact Details of the Data Protection Officer of the Data Controller(s)/**

4.1 You can contact the University of Limerick's Data Protection Officer at [dataprotection@ul.ie](mailto:dataprotection@ul.ie) or by writing to Data Protection Officer, Room A1-073, University of Limerick, Limerick.

## **5. The Identity of the Principal Investigator**

5.1 The Principal Investigator for this research project is Dr. Roisin Cahalan, Senior Lecturer in Physiotherapy, School of Allied Health, University of Limerick.

## **6. How we will use your personal data**

6.1 The University must process your personal data in order to undertake research relating to this project/study. Personal data, including medical history, age, sex and previous rehabilitation history, will be collected from participants by the researchers through focus groups conducted online via Microsoft Teams. Data will be stored on the University of Limerick's GDPR One Drive in compliance with the policies and procedures of the University's Information and Technology Division (ITD). This personal data will be used to understand the perceptions of various groups of people with chronic health conditions in order to enhance the results of the research project and optimise future healthcare services for this population.

6.2 The personal data collected and used in this research will include: age, sex, medical history and physical rehabilitation history.

6.3 You provide us with your personal data to enable us to undertake the research project. Participation in this research project is voluntary and participants may withdraw without giving any reason. Should you wish to withdraw, you may do so by contacting the Principal Investigator at [Roisin.Cahalan@ul.ie](mailto:Roisin.Cahalan@ul.ie) or in writing to Dr. Roisin Cahalan, School of Allied Health, University of Limerick, Castletroy, Limerick

## **7. Lawful Basis for University Processing Personal Data**

7.1 *Data Protection Law requires that the University must have a valid legal reason to process and use your personal data. This is often called a 'lawful basis'. GDPR requires us to be explicit with you about the lawful basis upon which we rely in order to process information about you.*

7.2 *The University is carrying out this research in the public interest and for scientific, historical or statistical purposes. In doing so, we are relying on Article 6(1)(e) of the GDPR. Where we are processing special category or sensitive personal data, we are relying on Article 9(2)(j) of GDPR. As required under Data Protection Law, we have appropriate safeguards in place in order to protect your personal data; these are set out in the next section.*

## **8. Protecting Your Personal Data**

8.1 *We have the following measures in place to help ensure we keep your personal data safe:*

- *All researchers at the University must adhere to University policies and procedures that tell our staff and students how to collect and use your information safely;*
- *Training is made available to all researchers to ensure our staff and students understand the importance of data protection and how to protect your personal data;*
- *The University has security arrangements and technical measures in place that ensure your information is stored safely and securely;*
- *All research projects involving personal data are reviewed and approved by a research ethics committee in line with University policies and procedures;*
- *Where a research project may involve a high risk, we first carry out a data protection impact assessment to assess risks and ensure adequate safeguards are in place;*
- *Where your personal data is processed for health research, we will always obtain your explicit consent in advance (in line with the Health Research Regulations 2018).*

8.2 *Personal data collected for this research project will be pseudonymised within 6 months after collection and will be fully anonymised within 12 months. Truly anonymised data is not Personal Data. Once data is anonymised for the purposes of this research project, the terms of this Privacy Notice will no longer apply.*

## **9. Sharing Your Personal Data with Third Parties**

9.1 *The University will not disclose your personal data to third parties. [Anonymous data may be shared with third parties. In this situation, you will not be identifiable from any data we share with the third party.]*

## **10. How Long Will We Keep Your Data**

10.1 All Personal Data collected for this research project will be retained for 7 years.

## **11. Your Rights**

11.1 *Depending on the lawful basis which we rely on to process your Personal Data, you may have the right to request that we:*

- *provide you with information as to whether we process your data and details relating to our processing, and with a copy of your personal data;*
- *rectify any inaccurate data we might have about you without undue delay;*
- *complete any incomplete information about you;*
- *under certain circumstances, erase your Personal Data without undue delay;*
- *under certain circumstances, be restricted from processing your data;*
- *under certain circumstances, furnish you with the Personal Data which you provided us within a structured, commonly used and machine readable format;*

11.2 *Requests for any of the above should be addressed by email to the Principal Investigator at [Roisin.Cahalan@ul.ie](mailto:Roisin.Cahalan@ul.ie) AND the Data Protection Officer at [dataprotection@ul.ie](mailto:dataprotection@ul.ie). Your request will be processed within 30 days of receipt. Please note, however, it may not be possible to facilitate all requests, for example, where the University is required by law to collect and process certain personal data including that personal information that is required of any research participant.*

11.3 *It is your responsibility to let the Principal Investigator know if your contact details change.*

## **12. Queries, Contacts, Right of Complaint**

12.1 *Further information on Data Protection at the University of Limerick may be viewed at [www.ul.ie/dataprotection](http://www.ul.ie/dataprotection). You can contact the Data Protection Officer at [dataprotection@ul.ie](mailto:dataprotection@ul.ie) or by writing to Data Protection Officer, Room A1-073, University of Limerick, Limerick.*

12.2 *You have a right to lodge a complaint with the Office of the Data Protection Commissioner (Supervisory Authority). While we recommend that you raise any concerns or queries with us first at the following email address [Roisin.Cahalan@ul.ie](mailto:Roisin.Cahalan@ul.ie) you may contact that Office at [info@dataprotection.ie](mailto:info@dataprotection.ie) or by writing to the Data Protection Commission, 21 Fitzwilliam Square South, Dublin 2, D02 RD28.*

## Appendix 8.4.2 Chapter Four; Participant Informed Consent Sheet

EHSREC No: 2021\_03\_05\_EHS

FACULTY OF EDUCATION AND HEALTH SCIENCES

RESEARCH ETHICS COMMITTEE (EHSREC)



### Ethical Consent Form

I, the undersigned, declare that I am willing to take part in research for the project entitled

**Exploring the attitudes of patients and clinicians on the use of telerehabilitation for chronic health populations: A qualitative study**

- I declare that I have been fully briefed on the nature of this study and my role in it and have been given the opportunity to ask questions before agreeing to participate.
- The nature of my participation has been explained to me, and I have full knowledge of how the information collected will be used.
- I am aware that my participation in this study will be audio/video recorded and I agree to this. However, should I feel uncomfortable at any time, I can request that the recording software be switched off.
- I am aware that such information may also be used in future academic presentations and publications about this study.
- I fully understand that there is no obligation on me to participate in this study.
- I fully understand that I am free to withdraw my participation without having to explain or give a reason, up to a period of two weeks after the data collection is completed.
- I know that I have been asked not to discuss the content of the focus group discussion, or the identity of its participants with anyone.
- I acknowledge that while the researcher has asked all focus groups participants to maintain confidentiality in the above manner, the researcher cannot guarantee that individual participants will adhere to this request.
- I acknowledge that the researcher does guarantee that they will not use my name or any other information that would identify me in any outputs of the research.

- I declare that I have read and fully understand the contents of the Research Privacy Notice.

Signature of Participant	Date
Signature of Investigator	Date

<b>Consent to Contact about Similar Future Research</b>	<b>Yes</b>	<b>No</b>
I explicitly consent to the University contacting me as part of current or similar future research and holding my contact details on its database for the purpose of contacting me.	<input checked="" type="checkbox"/>	<input type="checkbox"/>

## **RESEARCH PRIVACY NOTICE**

### **Introduction**

*This Research Privacy Notice governs the use and storage of your personal data by the University of Limerick (the “University”). The processing of this data is carried out in accordance with the General Data Protection Regulation (GDPR) / Data Protection Acts 1988-2018 (“Data Protection Law”) and in accordance with this Research Privacy Notice.*

*Any personal data which you provide to the University as part of this research project will be treated with the highest standards of security and confidentiality, in accordance with Irish and European Data Protection Law. This Notice sets out details of the information that we collect, how we process it and who we share it with. It also explains your rights under data protection law in relation to our processing of your data.*

### **1. Title and Purpose of the research project**

1.1 Title: Exploring the attitudes and experiences of people with chronic health conditions and clinicians toward the use of telerehabilitation for chronic health populations: A qualitative study

1.3 The purpose of the research project is to explore the thoughts and experiences of clinicians on the use of telehealth for the delivery of physiotherapy rehabilitation programmes to chronic populations. This will provide an understanding of the service provider’s perspective towards the use of technology to facilitate the remote delivery of physiotherapy rehabilitation. This information will help to guide the development of future telerehabilitation programmes for people with various chronic health conditions.

## **2. Research Ethics Committee**

2.1 Ethical approval was granted by University of Limerick Research Ethics Committee (UL REC) on 18/03/2021. The research ethics approval number is 2021\_03\_05\_EHS

## **3. Identity of the Data Controller(s)**

3.1 The Data Controller is:

- University of Limerick, Plassey, Limerick.

## **4. Identity and Contact Details of the Data Protection Officer of the Data Controller(s)/**

4.1 You can contact the University of Limerick's Data Protection Officer at [dataprotection@ul.ie](mailto:dataprotection@ul.ie) or by writing to Data Protection Officer, Room A1-073, University of Limerick, Limerick.

## **5. The Identity of the Principal Investigator**

5.1 The Principal Investigator for this research project is Dr. Roisin Cahalan, Senior Lecturer in Physiotherapy, School of Allied Health, University of Limerick.

## **6. How we will use your personal data**

6.1 The University must process your personal data in order to undertake research relating to this project/study. Personal data, including medical history, age, sex and previous rehabilitation service delivery history, will be collected from participants by the researchers through focus groups conducted online via Microsoft Teams. Data will be stored on the University of Limerick's GDPR One Drive in compliance with the policies and procedures of the University's Information and Technology Division (ITD). This personal data will be used to understand the perceptions of clinicians involved in the delivery of rehabilitation to various cohorts in order to enhance the research output and optimise future healthcare service delivery.

6.2 The personal data collected and used in this research will include: age, sex and physical rehabilitation delivery history.

6.3 You provide us with your personal data to enable us to undertake the research project. Participation in this research project is voluntary and participants may withdraw without giving any reason. Should you wish to withdraw, you may do so by contacting the Principal Investigator at [Roisin.Cahalan@ul.ie](mailto:Roisin.Cahalan@ul.ie) or in writing to Dr. Roisin Cahalan, School of Allied Health, University of Limerick, Castletroy, Limerick

## **7. Lawful Basis for University Processing Personal Data**

7.1 *Data Protection Law requires that the University must have a valid legal reason to process and use your personal data. This is often called a 'lawful basis'. GDPR requires us to be explicit with you about the lawful basis upon which we rely in order to process information about you.*

7.2 *The University is carrying out this research in the public interest and for scientific, historical or statistical purposes. In doing so, we are relying on Article 6(1)(e) of the GDPR. Where we are processing special category or sensitive personal data, we are relying on Article 9(2)(j) of GDPR. As required under Data Protection Law, we have appropriate safeguards in place in order to protect your personal data; these are set out in the next section.*

## **8. Protecting Your Personal Data**

8.1 *We have the following measures in place to help ensure we keep your personal data safe:*

- *All researchers at the University must adhere to University policies and procedures that tell our staff and students how to collect and use your information safely;*
- *Training is made available to all researchers to ensure our staff and students understand the importance of data protection and how to protect your personal data;*
- *The University has security arrangements and technical measures in place that ensure your information is stored safely and securely;*
- *All research projects involving personal data are reviewed and approved by a research ethics committee in line with University policies and procedures;*
- *Where a research project may involve a high risk, we first carry out a data protection impact assessment to assess risks and ensure adequate safeguards are in place;*
- *Where your personal data is processed for health research, we will always obtain your explicit consent in advance (in line with the Health Research Regulations 2018).*

8.2 Personal data collected for this research project will be pseudonymised within 6 months after collection and will be fully anonymised within 12 months. Truly anonymised data is not Personal Data. Once data is anonymised for the purposes of this research project, the terms of this Privacy Notice will no longer apply.

## **9. Sharing Your Personal Data with Third Parties**

9.1 The University will not disclose your personal data to third parties. [Anonymous data may be shared with third parties. In this situation, you will not be identifiable from any data we share with the third party.]

## **10. How Long Will We Keep Your Data**

10.1 All Personal Data collected for this research project will be retained for 7 years.

## **11. Your Rights**

11.1 *Depending on the lawful basis which we rely on to process your Personal Data, you may have the right to request that we:*

- *provide you with information as to whether we process your data and details relating to our processing, and with a copy of your personal data;*
- *rectify any inaccurate data we might have about you without undue delay;*
- *complete any incomplete information about you;*
- *under certain circumstances, erase your Personal Data without undue delay;*
- *under certain circumstances, be restricted from processing your data;*
- *under certain circumstances, furnish you with the Personal Data which you provided us within a structured, commonly used and machine readable format;*

11.2 *Requests for any of the above should be addressed by email to the Principal Investigator at [Roisin.Cahalan@ul.ie](mailto:Roisin.Cahalan@ul.ie) AND the Data Protection Officer at [dataprotection@ul.ie](mailto:dataprotection@ul.ie). Your request will be processed within 30 days of receipt. Please note, however, it may not be possible to facilitate all requests, for example, where the University is required by law to collect and process certain personal data including that personal information that is required of any research participant.*

11.3 *It is your responsibility to let the Principal Investigator know if your contact details change.*

## **12. Queries, Contacts, Right of Complaint**

12.1 *Further information on Data Protection at the University of Limerick may be viewed at [www.ul.ie/dataprotection](http://www.ul.ie/dataprotection). You can contact the Data Protection Officer at [dataprotection@ul.ie](mailto:dataprotection@ul.ie) or by writing to Data Protection Officer, Room A1-073, University of Limerick, Limerick.*

12.2 *You have a right to lodge a complaint with the Office of the Data Protection Commissioner (Supervisory Authority). While we recommend that you raise any concerns or queries with us first at the following email address [Roisin.Cahalan@ul.ie](mailto:Roisin.Cahalan@ul.ie) you may contact that Office at [info@dataprotection.ie](mailto:info@dataprotection.ie) or by writing to the Data Protection Commission, 21 Fitzwilliam Square South, Dublin 2, D02 RD28.*

## Appendix 8.4.3 Chapter Six; Participant Informed Consent Sheet



### Ethical Consent Form

I, the undersigned, declare that I am willing to take part in research for the project entitled

#### **TECC- Telerehabilitation and Exercise for Chronic Conditions**

- I declare that I have been fully briefed on the nature of this study and my role in it and have been given the opportunity to ask questions before agreeing to participate.  
Yes  No
- The nature of my participation has been explained to me, and I have full knowledge of how the information collected will be used.  
Yes  No
- I am aware that my participation in this study will be audio/video recorded and I agree to this. However, should I feel uncomfortable at any time, I can request that the recording software be switched off.  
Yes  No
- I am aware that such information may also be used in future academic presentations and publications about this study.  
Yes  No
- I fully understand that there is no obligation on me to participate in this study.  
Yes  No
- I fully understand that I am free to withdraw my participation without having to explain or give a reason, up to a period of two weeks after the data collection is completed.  
Yes  No

- I acknowledge that the researcher does guarantee that they will not use my name or any other information that would identify me in any outputs of the research.

Yes  No

- I am 18 years of age or older.

Yes  No

_____	_____	_____
Name of Participant	Signature of Participant	Date
_____	_____	_____
Name of Investigator	Signature of Investigator	Date

***This research study has received Ethics approval from the HSE South Eastern Area Research Ethics Committee***

## **Research Privacy Notice**

### **Introduction**

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*Any personal data which you provide to the University as part of this research project will be treated with the highest standards of security and confidentiality, in accordance with Irish and European Data Protection Law. This Notice sets out details of the information that we collect, how we process it and who we share it with. It also explains your rights under data protection law in relation to our processing of your data.*

### **1. Title and Purpose of the research project**

1.1 Title: A physiotherapy-led generic telerehabilitation programme for people with chronic health conditions: a pilot feasibility trial

1.4 The purpose of the research project is to evaluate the feasibility and acceptability of a generic exercise-based telerehabilitation programme for people with chronic health conditions. This will provide an understanding of the best parts of the programme from a service user perspective and help to identify improvements that can be made to develop future telerehabilitation programmes for people with various chronic health conditions.

## **2. Research Ethics Committee**

2.1 Ethical approval was granted by the HSE South Eastern Area Research Ethics Committee on 19/03/2024. The research ethics approval reference number is 23.91.

## **3. Identity of the Data Controller(s)**

3.1 The Data Controller is:

- University of Limerick, Plassey, Limerick.

## **4. Identity and Contact Details of the Data Protection Officer of the Data Controller(s)/**

4.1 You can contact the University of Limerick's Data Protection Officer at [dataprotection@ul.ie](mailto:dataprotection@ul.ie) or by writing to Data Protection Officer, Room A1-073, University of Limerick, Limerick.

## **5. The Identity of the Principal Investigator**

5.1 The Principal Investigator for this research project is Ms. Niamh Julian, Clinical Specialist Physiotherapist, Respiratory Chronic Disease Management South Tipperary

## **6. How we will use your personal data**

6.1 The University must process your personal data in order to undertake research relating to this project/study. Personal data, including medical history, age, sex and previous rehabilitation history, will be collected from participants by the researchers through focus groups conducted online via Microsoft Teams. Data will be stored on the University of Limerick's GDPR One Drive in compliance with the policies and procedures of the University's Information and Technology Division (ITD). This personal data will be used to enhance the results of the research project and optimise future healthcare services for this population.

6.2 The personal data collected and used in this research will include: age, sex, medical history, and physical rehabilitation history.

6.3 You provide us with your personal data to enable us to undertake the research project. Participation in this research project is voluntary and participants may withdraw without giving any reason. Should you wish to withdraw, you may do so by contacting the co-investigator Caoimhe Barry Walsh at [Caoimhe.Barry.Walsh@ul.ie](mailto:Caoimhe.Barry.Walsh@ul.ie) or in writing to Ms Caoimhe Barry Walsh, School of Allied Health, University of Limerick, Castletroy, Limerick

## **7. Lawful Basis for University Processing Personal Data**

7.1 *Data Protection Law requires that the University must have a valid legal reason to process and use your personal data. This is often called a 'lawful basis'. GDPR requires us to be explicit with you about the lawful basis upon which we rely in order to process information about you.*

7.2 *The University is carrying out this research in the public interest and for scientific, historical or statistical purposes. In doing so, we are relying on Article 6(1)(e) of the GDPR. Where we are processing special category or sensitive personal data, we are relying on Article 9(2)(j) of GDPR. As required under Data Protection Law, we have appropriate safeguards in place in order to protect your personal data; these are set out in the next section.*

## **8. Protecting Your Personal Data**

8.1 *We have the following measures in place to help ensure we keep your personal data safe:*

- *All researchers at the University must adhere to University policies and procedures that tell our staff and students how to collect and use your information safely;*
- *Training is made available to all researchers to ensure our staff and students understand the importance of data protection and how to protect your personal data;*
- *The University has security arrangements and technical measures in place that ensure your information is stored safely and securely;*
- *All research projects involving personal data are reviewed and approved by a research ethics committee in line with University policies and procedures;*
- *Where a research project may involve a high risk, we first carry out a data protection impact assessment to assess risks and ensure adequate safeguards are in place;*
- *Where your personal data is processed for health research, we will always obtain your explicit consent in advance (in line with the Health Research Regulations 2018).*

8.2 Personal data collected for this research project will be pseudonymised within 6 months after collection and will be fully anonymised within 12 months. Truly anonymised data is not Personal Data. Once data is anonymised for the purposes of this research project, the terms of this Privacy Notice will no longer apply.

## **9. Sharing Your Personal Data with Third Parties**

9.1 The University will not disclose your personal data to third parties. [Anonymous data may be shared with third parties. In this situation, you will not be identifiable from any data we share with the third party.]

## **10. How Long Will We Keep Your Data**

10.1 All Personal Data collected for this research project will be retained for 7 years.

## **11. Your Rights**

- 11.1 *Depending on the lawful basis which we rely on to process your Personal Data, you may have the right to request that we:*
- *provide you with information as to whether we process your data and details relating to our processing, and with a copy of your personal data;*
  - *rectify any inaccurate data we might have about you without undue delay;*
  - *complete any incomplete information about you;*
  - *under certain circumstances, erase your Personal Data without undue delay;*
  - *under certain circumstances, be restricted from processing your data;*
  - *under certain circumstances, furnish you with the Personal Data which you provided us within a structured, commonly used and machine readable format;*
- 11.2 *Requests for any of the above should be addressed by email to the Co-investigator at [Caoimhe.Barry.Walsh@ul.ie](mailto:Caoimhe.Barry.Walsh@ul.ie) AND the Data Protection Officer at [dataprotection@ul.ie](mailto:dataprotection@ul.ie). Your request will be processed within 30 days of receipt. Please note, however, it may not be possible to facilitate all requests, for example, where the University is required by law to collect and process certain personal data including that personal information that is required of any research participant.*
- 11.3 *It is your responsibility to let the Principal Investigator know if your contact details change.*

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- 12.2 *You have a right to lodge a complaint with the Office of the Data Protection Commissioner (Supervisory Authority). While we recommend that you raise any concerns or queries with us first at the following email address [Caoimhe.Barry.Walsh@ul.ie](mailto:Caoimhe.Barry.Walsh@ul.ie) you may contact that Office at [info@dataprotection.ie](mailto:info@dataprotection.ie) or by writing to the Data Protection Commission, 21 Fitzwilliam Square South, Dublin 2, D02 RD28.*

## Appendix 8.5 Questionnaires

### Appendix 8.5.1 Chapter Three; Baseline Questionnaire

#### Baseline Questionnaire

Dear participant,

This research project is being conducted by the University of Limerick to investigate what people with chronic health conditions think about physiotherapy rehabilitation delivered remotely using technology such as telephone and video calls (telerehabilitation).

This questionnaire should only take you 4-5 minutes to complete. All of the information that you provide will be kept in confidence.

Please ensure that you have read the information sheet, privacy notice and consent form before completing the questionnaire. You can access these documents by clicking on this link:

<https://docs.google.com/document/d/1gVSTTgdXw3GJjgwBd03Vnh5E-PxNNOAE4vDTjeMK59E/edit?usp=sharing>

\* Indicates required question

#### Consent

Please complete the informed consent section below. The questionnaire will begin on the next page.

1. I have read the attached privacy notice and consent forms and I declare that I am willing to take part in this research project \*

Mark only one oval.

- Yes, I am willing to take part in the research project  
 No, I am not willing to take part in the research project

#### About you

This section will ask a little bit about you

2. What is your full name? \*

\_\_\_\_\_

3. Please provide your current email address: \*

\_\_\_\_\_

4. Please provide your current contact number: \*

(This will only be used to contact you in the case of technical difficulties during the focus group interview stage)

\_\_\_\_\_

5. What age are you? \*

Mark only one oval.

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- 105

6. What is your gender? \*

*Mark only one oval.*

- Male
- Female
- Prefer not to say
- Other: \_\_\_\_\_

7. What county are you currently residing in? \*

*Mark only one oval.*

- Antrim
- Armagh
- Carlow
- Cavan
- Clare
- Cork
- Derry
- Donegal
- Down
- Dublin
- Fermanagh
- Galway
- Kerry
- Kildare
- Kilkenny
- Laois
- Leitrim
- Limerick
- Longford
- Louth
- Mayo
- Meath
- Monaghan
- Offaly
- Roscommon
- Sligo
- Tipperary
- Tyrone
- Waterford
- Westmeath
- Wexford
- Wicklow

8. Would you consider your current residential area to be an urban or a rural area? \*

Mark only one oval.

- Urban area  
 Rural area

9. What is your primary medical diagnosis? \*

\_\_\_\_\_

10. Do you have any other health conditions? \*  
You can use any terms/language that you choose

Mark only one oval.

- Yes  
 No Skip to question 12

#### Other Health Conditions

11. Please specify any other health conditions that you have: \*  
You can use any terms/language that you choose

\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

#### Rehabilitation History

This section includes questions on your previous physiotherapy rehabilitation participation history

12. Have you ever previously participated in a physiotherapy telerehabilitation programme? \*

Mark only one oval.

- Yes  
 No Skip to question 14

#### Telerehabilitation History

13. Please specify which form of telerehabilitation you have previously participated in (You can choose more than one answer if relevant) \*

Check all that apply.

- Live video or telephone calls e.g. Zoom, Skype  
 Pre-recorded videos or images  
 Remote monitoring and tracking of exercise activity or medical information e.g. Fitbit, mobile phone app  
 Other: \_\_\_\_\_

To what extent would you agree or disagree with the following statements

14. (a) I am confident in my ability to use technology to engage in a physiotherapy telerehabilitation programme \*

Mark only one oval.

- Strongly Disagree  
 Disagree  
 Undecided  
 Agree  
 Strongly Agree

15. (b) Participating in physiotherapy telerehabilitation programmes is as effective \*  
as participating in traditional face-to-face physiotherapy rehabilitation

Mark only one oval.

- Strongly Disagree  
 Disagree  
 Undecided  
 Agree  
 Strongly Agree

16. (c) I would be willing to engage in a future group telerehabilitation \*  
programmes delivered by physiotherapists from a remote location with people  
with similar chronic health conditions as myself

Mark only one oval.

- Strongly Disagree  
 Disagree  
 Undecided  
 Agree  
 Strongly Agree

17. (d) I would be willing to engage in future group telerehabilitation programmes \*  
delivered by physiotherapists from a remote location with people with various  
other chronic health conditions

Mark only one oval.

- Strongly Disagree  
 Disagree  
 Undecided  
 Agree  
 Strongly Agree

Future Telerehabilitation Programmes

18. If you were to engage in a future group telerehabilitation programme which \*  
type of programme would you prefer:

Please select one answer

Mark only one oval.

- A programme which involves live rehabilitation classes with a physiotherapist  
scheduled for a specific time (e.g. live Zoom video calls)  
 A programme in which a physiotherapist provides pre-recorded material that  
can be accessed at any time (e.g. exercise videos and information leaflets)  
 A programme which involves a mixture of live sessions and pre-recorded  
material

19. If you were to engage in a future group telerehabilitation programme which \*  
type of programme would you prefer:

Please select one answer

Mark only one oval.

- All rehabilitation classes to be delivered remotely using technology  
 Some telerehabilitation classes along with some face-to-face rehabilitation  
classes

Thank you for your participation!

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Google Forms

## Appendix 8.5.2 Chapter Four; Baseline Questionnaire

### Baseline Questionnaire

Dear participant,

This research project is being conducted by the University of Limerick to investigate what clinicians think about the use of telehealth for physiotherapy rehabilitation delivery among patients with chronic health conditions.

This questionnaire should only take you 4-5 minutes to complete. All of the information that you provide will be kept in confidence.

Please ensure that you have read the information sheet, privacy notice and consent form before completing the questionnaire. You can access these documents by clicking on this link: <https://docs.google.com/document/d/1qVSTTgdXw3GJjqwBd03Vnh5E-PxNNQAE4yDTjeMK59E/edit?usp=sharing>

\* Indicates required question

#### Consent

Please complete the informed consent section below. The questionnaire will begin on the next page.

1. I have read the attached privacy notice and consent forms and I declare that I am willing to take part in this research project \*

Mark only one oval.

- Yes, I am willing to take part in the research project  
 No, I am not willing to take part in the research project

#### About you

2. What is your full name? \*

\_\_\_\_\_

3. Please provide your current email address \*

\_\_\_\_\_

4. What age are you? \*

\_\_\_\_\_

5. What is your gender? \*

Mark only one oval.

- Male  
 Female  
 Prefer not to say

#### Clinical Practice

Please tick the answer(s) most relevant to your current area of practice:

6. Which describes your current clinical area of practice? (You can choose more than one answer) \*

Check all that apply.

- Respiratory  
 Neurological  
 Musculoskeletal  
 Cardiology  
 Care of the Elderly  
 Paediatrics  
 Critical Care  
 Other: \_\_\_\_\_

7. What is your current workplace setting? \*

Mark only one oval.

- Public Healthcare  
 Private Clinic

8. Which best describes your current workplace setting? \*

Mark only one oval.

- Rural setting  
 Urban setting

9. How many years have you been practicing as a physiotherapist? \*

\_\_\_\_\_

Rehabilitation History

10. Have you ever previously delivered a telerehabilitation programme? \*

Mark only one oval.

- Yes  
 No Skip to question 13

Telerehabilitation Programme Delivery

11. If yes, please outline the clinical population involved e.g. knee osteoarthritis

\_\_\_\_\_

12. If yes, please provide detail of the delivery mode, frequency and duration of the telerehabilitation programme e.g. live video calls using Zoom software weekly for eight weeks:

\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

To what extent would you agree or disagree with the following statements:

13. (a) I am confident in using telehealth to deliver rehabilitation programmes \*

Mark only one oval.

- Strongly disagree  
 Disagree  
 Undecided  
 Agree  
 Strongly Agree

14. (b) Telerehabilitation programmes can be as effective as traditional face-to-face physiotherapy rehabilitation programmes \*

Mark only one oval.

- Strongly disagree  
 Disagree  
 Undecided  
 Agree  
 Strongly agree

15. (c) I have received sufficient training or education to deliver telerehabilitation programmes \*

Mark only one oval.

- Strongly disagree  
 Disagree  
 Undecided  
 Agree  
 Strongly agree

16. (d) I would be willing to deliver simultaneous telerehabilitation programmes to a cohort of patients with different chronic conditions e.g. knee osteoarthritis and COPD \*

*Mark only one oval.*

- Strongly disagree  
 Disagree  
 Undecided  
 Agree  
 Strongly agree

#### Future Telerehabilitation Programme Delivery

17. Please tick the option which you believe would create an 'optimal' telerehabilitation programme: \*

*Mark only one oval.*

- Live/real-time telerehabilitation (e.g. video-conferencing)  
 Store and forward/pre-recorded telerehabilitation (e.g. pre-recorded online videos)  
 A mixture of live and pre-recorded material

18. Please tick the option which you believe would create an 'optimal' telerehabilitation programme: \*

*Mark only one oval.*

- All rehabilitation classes to be delivered remotely using technology  
 Some telerehabilitation classes along with some face-to-face rehabilitation

Thank you for your participation!

## Appendix 8.5.3 Chapter Six; Baseline Questionnaire

### TECC (Telerehabilitation and Exercise for Chronic Conditions) Programme

Dear participant,

This research project is being conducted by the University of Limerick to investigate the feasibility and acceptability of a generic telerehabilitation programme for people with chronic health conditions.

This questionnaire should only take you 10-15 minutes to complete. All of the information that you provide will be kept in confidence.

Please ensure that you have read the information sheet, privacy notice and consent form before completing the questionnaire. You can access these documents by clicking on this link: <https://docs.google.com/document/d/15s6Cabz7M3hPr7B3s-Gln0g5-6QjCHQVjEnEPYjmeWp0/edit?usp=sharing>

\* Required

1. Full name \*

2. Email address

3. Age \*

4. Sex \*

- Male
- Female
- Prefer not to say
- Other

5. What county are you currently residing in? \*

6. Which would you consider your residential area to be? \*

- Urban area
- Rural area

7. What is your primary medical diagnosis? \*

8. Do you have any other health conditions? \*

- Yes
- No

9. If yes please specify the other health conditions that you have

10. Have you previously participated in an exercise programme that was delivered remotely via technology? \*

- Yes
- No

### Safety Information

The following information will only be used if required in the case of an emergency during the live exercise classes

11. Please provide emergency contact information including name and contact number \*

12. Please provide the Eircode for the location at which you plan to engage with the live exercise classes \*

### Activities-specific Balance Confidence Scale

For each of the following activities, please indicate your level of confidence in doing the activity without losing your balance or becoming unsteady from choosing one of the percentage points on the scale from 0% to 100%. If you do not currently do the activity in question, try and imagine how confident you would be if you had to do the activity.  
If you have any questions about answering any of these items, please contact me at [Cacimha Barry Walsh@ul.ie](mailto:Cacimha.Barry.Walsh@ul.ie)

13. How confident are you that you will not lose your balance or become unsteady when you...  
...walk around the house? \*

- 0% (no confidence)
- 10%
- 20%
- 30%
- 40%
- 50%
- 60%
- 70%
- 80%
- 90%
- 100% (completely confident)

14. How confident are you that you will not lose your balance or become unsteady when you...  
...walk up or down stairs? \*

- 0% (no confidence)
- 10%
- 20%
- 30%
- 40%
- 50%
- 60%
- 70%
- 80%
- 90%
- 100% (completely confident)

15. How confident are you that you will not lose your balance or become unsteady when you...  
...bend over and pick up a slipper from the front of a closet floor? \*

- 0% (no confidence)
- 10%
- 20%
- 30%
- 40%
- 50%
- 60%
- 70%
- 80%
- 90%
- 100% (completely confident)

16. How confident are you that you will not lose your balance or become unsteady when you...  
...reach for a small can off a shelf at eye level? \*

- 0% (no confidence)
- 10%
- 20%
- 30%
- 40%
- 50%
- 60%
- 70%
- 80%
- 90%
- 100% (completely confident)

17. How confident are you that you will not lose your balance or become unsteady when you...  
...stand on your tiptoes and reach for something above your head? \*

- 0% (no confidence)
- 10%
- 20%
- 30%
- 40%
- 50%
- 60%
- 70%
- 80%
- 90%
- 100% (completely confident)

18. How confident are you that you will not lose your balance or become unsteady when you...  
...stand on a chair and reach for something? \*

- 0% (no confidence)
- 10%
- 20%
- 30%
- 40%
- 50%
- 60%
- 70%
- 80%
- 90%
- 100% (completely confident)

19. How confident are you that you will not lose your balance or become unsteady when you...  
...sweep the floor? \*

- 0% (no confidence)
- 10%
- 20%
- 30%
- 40%
- 50%
- 60%
- 70%
- 80%
- 90%
- 100% (completely confident)

20. How confident are you that you will not lose your balance or become unsteady when you...  
...walk outside the house to a car parked in the driveway? \*

- 0% (no confidence)
- 10%
- 20%
- 30%
- 40%
- 50%
- 60%
- 70%
- 80%
- 90%
- 100% (completely confident)

21. How confident are you that you will not lose your balance or become unsteady when you...  
...get into or out of a car? \*

- 0% (no confidence)
- 10%
- 20%
- 30%
- 40%
- 50%
- 60%
- 70%
- 80%
- 90%
- 100% (completely confident)

22. How confident are you that you will not lose your balance or become unsteady when you...  
...walk across a parking lot to the mall? \*

- 0% (no confidence)
- 10%
- 20%
- 30%
- 40%
- 50%
- 60%
- 70%
- 80%
- 90%
- 100% (completely confident)

23. How confident are you that you will not lose your balance or become unsteady when you...  
...walk up or down a ramp? \*

- 0% (no confidence)
- 10%
- 20%
- 30%
- 40%
- 50%
- 60%
- 70%
- 80%
- 90%
- 100% (completely confident)

24. How confident are you that you will not lose your balance or become unsteady when you...  
...walk in a crowded mall where people rapidly walk past you? \*

- 0% (no confidence)
- 10%
- 20%
- 30%
- 40%
- 50%
- 60%
- 70%
- 80%
- 90%
- 100% (completely confident)

25. How confident are you that you will not lose your balance or become unsteady when you...  
...are bumped into by people as you walk through the mall? \*

- 0% (no confidence)
- 10%
- 20%
- 30%
- 40%
- 50%
- 60%
- 70%
- 80%
- 90%
- 100% (completely confident)

26. How confident are you that you will not lose your balance or become unsteady when you...  
...step onto or off an escalator while you are holding onto a railing? \*

- 0% (no confidence)
- 10%
- 20%
- 30%
- 40%
- 50%
- 60%
- 70%
- 80%
- 90%
- 100% (completely confident)

27. How confident are you that you will not lose your balance or become unsteady when you...  
...step onto or off an escalator while holding onto parcels such that you cannot hold onto the railing? \*

- 0% (no confidence)
- 10%
- 20%
- 30%
- 40%
- 50%
- 60%
- 70%
- 80%
- 90%
- 100% (completely confident)

28. How confident are you that you will not lose your balance or become unsteady when you...  
...walk outside on icy sidewalks? \*

- 0% (no confidence)
- 10%
- 20%
- 30%
- 40%
- 50%
- 60%
- 70%
- 80%
- 90%
- 100% (completely confident)

### Physical Activity Readiness Questionnaire (PAR-Q)

Regular exercise is associated with many health benefits; yet any change of activity may increase the risk of injury. Completion of this questionnaire is a first step when planning to increase the amount of physical activity in your life.

Please read each question carefully and answer every question honestly; (Tick the appropriate answer). If you answer yes to any of the below questions, we encourage you to talk with your doctor BEFORE you participate in the study. Tell your doctor of your intention to exercise as part of this study and which questions you answered 'yes' to. If at any stage your health changes, resulting in a 'yes' answer to any of the above questions, please seek guidance from a GP.

29. Do you have a heart condition and should only do physical activity recommended by a physician? \*

- Yes
- No

30. When you do physical activity, do you feel pain in your chest? \*

- Yes
- No

31. When you were not doing physical activity, have you had chest pain in the past month? \*

- Yes
- No

32. Do you ever lose consciousness or do you lose your balance because of dizziness? \*

- Yes
- No

33. Do you have a joint or bone problem that may be made worse by a change in your physical activity? \*

- Yes
- No

34. Is a physician currently prescribing medications for your blood pressure or heart condition? \*

- Yes
- No

35. Are you pregnant? \*

- Yes
- No

36. Do you know of any other reason you should not exercise or increase your physical activity? \*

- Yes
- No

---

This content is neither created nor endorsed by Microsoft. The data you submit will be sent to the form owner.



## Appendix 8.6 Focus Group Interview Guides

### Appendix 8.6.1 Chapter Three; Focus Group Interview Guide

*[Ensure informed consent has been obtained, the baseline demographic questionnaire has been completed and the recorder (phone and teams) and captions are switched on]*

*[This is a sample questioning route, and it is possible that there may be minor deviations from these specific lists for reasons including the following:*

- (i) Additional questions may be included as a follow-up to patient responses to questions for clarification purposes.*
- (ii) After conducting a number of initial focus groups, the questioning process may become more streamlined]*

1. How do you feel about participating in physiotherapy telerehabilitation programmes, such as physiotherapy programmes delivered using telephone and video calls or online videos?

[Prompts: use of technology, convenience, group setting, improved health outcomes, social support]

2. If you have previously participated in a telerehabilitation programme:
  - (a) What were the positive aspects of participating in telerehabilitation? /What did you like about these programmes?
  - (b) What were the negative aspects of participating in telerehabilitation? /What did you dislike about these programmes?

[Prompts:

- (a) Ease of use, programme content, mode of delivery (telephone, video, live/real time communication with therapist), convenience, use of technology and confidence with same, accessibility, affordability, social support, flexibility.
- (b) Technology-related issues, lack of face-to-face contact, reduced quality of feedback, equipment set up, alienation]

3. If you have not previously participated in a telerehabilitation programme, why not, and:

- (a) What do you believe are the advantages of participating in telerehabilitation?
- (b) What do you believe are the disadvantages of participating in telerehabilitation?

[Prompts:

- (a) Accessibility, affordability, flexibility, convenience, programme content, health benefits, social support, motivation
- (b) Technology (literacy, reduced access, connectivity issues), lack of face-to-face contact, feedback quality, alienation]

4. Why do you think there has been a recent shift towards the use of telerehabilitation?  
What are your views on this increased use of telerehabilitation?

[Prompts: Is the increase related to COVID restrictions? Anything other than COVID restrictions? Will the shift to telerehabilitation continue into long-term?]

5. What is your opinion on replacing face-to-face physiotherapy rehabilitation programmes with telerehabilitation programmes?
6. What safety concerns do you have, if any, about participating in telerehabilitation programmes?  
Are there any strategies that you believe can be implemented to mitigate these concerns?
7. Would you be willing to participate in future rehabilitation programmes that are delivered using technology by a physiotherapist from a remote location?
8. What is your opinion on participating in group rehabilitation programmes with other people who have been diagnosed with similar health conditions as yourself?
9. How would you feel about participating in a group rehabilitation programme with other people who have different chronic health conditions?
10. Do you have any suggestions as to how rehabilitation programmes delivered remotely through technology can be improved?
11. What is your ideal form of physiotherapy rehabilitation delivered using internet and communication technologies?  
How long do you think the duration of an overall telerehabilitation programme should be?  
How long do you think the duration of a group telerehabilitation class should be?  
How often do you think group telerehabilitation classes should take place?  
What do you think should be included in these telerehabilitation classes?

## Appendix 8.6.2 Chapter Four; Focus Group Interview Guide

*[Ensure informed consent has been obtained, the baseline demographic questionnaire has been completed and the recorder is switched on]*

*[This is a sample questioning route, and it is possible that there may be minor deviations from these specific lists for reasons including the following:*

- (i) Additional questions may be included as a follow-up to participant responses to questions for clarification purposes.*
- (ii) After conducting a number of initial focus groups, the questioning process may become more streamlined]*

1. How do you feel about the use of telerehabilitation for the delivery of rehabilitation programmes to chronic populations?
2. If you have previously delivered telerehabilitation:  
What were the positive aspects of your telerehabilitation experience?  
What challenges did you encounter when delivering telerehabilitation?  
[Prompts: convenience, technological issues, programme set-up, ease of use, participant uptake and compliance, increased workload]
3. If you have not previously delivered telerehabilitation:  
What do you believe are the advantages of using telerehabilitation?  
What do you believe are the disadvantages of using telerehabilitation?  
[Prompts: convenience, accessibility, no direct face-to-face contact with participants, technology issues]
4. Do you have any preferences regarding the mode of telerehabilitation delivery (modes include live telerehabilitation, pre-recorded telerehabilitation or remote patient monitoring)?

[Prompts: visual, audio, live/real-time/synchronous e.g., Zoom/Skype, store and forward/asynchronous e.g. Salaso]

5. What are the barriers to telerehabilitation service delivery for chronic rehabilitation programmes?

[Prompts: resistance to change and adoption of technology by patients and clinicians, lack of access to technology, broadband access, digital literacy, preference for in-person treatment, resource limitations, organisational barriers]

6. What are the facilitators of telerehabilitation service delivery for chronic rehabilitation programmes?

[Prompts: skills training and education re tele rehab service delivery]

7. What is your opinion on the effectiveness of telerehabilitation programmes in comparison to conventional face-to-face rehabilitation programmes for chronic patients?

8. What training/education, if any, did you receive on the delivery of telerehabilitation?

What was good/bad about this training?

What more training, if any, would you like to receive?

9. Do you feel confident in your ability to deliver telerehabilitation programmes?

10. What safety concerns regarding the delivery of telerehabilitation programmes to chronic populations do you have?

Is there any strategies that you believe can be implemented to mitigate these concerns?

11. Why do you believe there has been a recent shift towards the adoption of telerehabilitation programme delivery?

What are your views, both positive and negative, on this increased adoption of telerehabilitation?

12. What is your opinion on the suitability of telerehabilitation as a long-term replacement of conventional rehabilitation programmes for chronic patient cohorts?
13. How would you feel about delivering a group telerehabilitation programme to a cohort of patients with various different chronic conditions i.e. a patient cohort including chronic respiratory, neurological, musculoskeletal and cardiac populations?
14. What changes do you believe are necessary in order to optimise future telerehabilitation programmes for chronic populations?
15. How long do you think the duration of an overall telerehabilitation programme for chronic health populations should be?

What do you think is the optimal duration of a group telerehabilitation class?

What is the optimal mode of delivery for telerehabilitation programmes for chronic populations?

How often do you think group telerehabilitation classes should take place?

What content should be included in group telerehabilitation classes for chronic health populations?



**A physiotherapy-led generic telerehabilitation programme for people with chronic health conditions: a pilot feasibility trial**

**This is a sample questioning route, and it is possible that there may be minor deviations from these specific lists for reasons including the following:**

- (iii) Additional questions may be included as a follow-up to patient responses to questions for clarification purposes.**
- (iv) After conducting several initial interviews, the questioning process may become more streamlined.**
  1. How was your overall experience of participating in the online programme?
  2. What were the positive or enjoyable aspects of participating in the online programme?
  3. What were the negative or challenging aspects of participating in the online programme?
  4. Would you recommend this programme to other people who have similar health conditions as yourself?
  5. Would you be willing to participate in future online programmes that are delivered using technology by a physiotherapist from a remote location?
  6. How did you feel about participating in a group programme with other people who have different chronic health conditions?
  7. Is there anything that you would change about this programme to improve it for the future?

## Appendix 8.7 Peer Reviewed Publications

### Appendix 8.7.1

Barry Walsh, C., Cahalan, R., Hinman, R.S. & O'Sullivan, K. (2022) 'Psychometric properties of performance-based measures of physical function administered via telehealth among people with chronic conditions: A systematic review', *Plos one*, 17(9), p.e0274349.

PLOS ONE

RESEARCH ARTICLE

## Psychometric properties of performance-based measures of physical function administered via telehealth among people with chronic conditions: A systematic review

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### OPEN ACCESS

**Citation:** Barry Walsh C, Cahalan R, Hinman RS, O' Sullivan K (2022) Psychometric properties of performance-based measures of physical function administered via telehealth among people with chronic conditions: A systematic review. *PLoS ONE* 17(9): e0274349. <https://doi.org/10.1371/journal.pone.0274349>

**Editor:** Fatih Özden, Mugla Sıtkı Koçman Üniversitesi, TURKEY

**Received:** May 16, 2022

**Accepted:** August 25, 2022

**Published:** September 9, 2022

**Peer Review History:** PLOS recognizes the benefits of transparency in the peer review process; therefore, we enable the publication of all of the content of peer review and author responses alongside final, published articles. The editorial history of this article is available here: <https://doi.org/10.1371/journal.pone.0274349>

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**Data Availability Statement:** All relevant data are within the manuscript and its [Supporting Information files](#).

### Abstract

#### Background

Telehealth could enhance rehabilitation for people with chronic health conditions. This review examined the psychometric properties of performance-based measures of physical function administered via telehealth among people with chronic health conditions using the Consensus-Based Standards for the Selection of Health Measurement Instruments (COSMIN) approach.

#### Methods

This systematic review was registered with Prospero (Registration number: CRD42021262547). Four electronic databases were searched up to June 2022. Study quality was evaluated by two independent reviewers using the COSMIN risk of bias checklist. Measurement properties were rated by two independent reviewers in accordance with COSMIN guidance. Results were summarised according to the COSMIN approach and the modified GRADE approach was used to grade quality of the summarised evidence.

#### Results

Five articles met the eligibility criteria. These included patients with Parkinson's Disease (n = 2), stroke (n = 1), cystic fibrosis (n = 1) and chronic heart failure (n = 1). Fifteen performance-based measures of physical function administered via videoconferencing were investigated, spanning measures of functional balance (n = 7), other measures of general functional capacity (n = 4), exercise capacity (n = 2), and functional strength (n = 2). Studies were conducted in Australia (n = 4) and the United States (n = 1). Reliability was reported for twelve measures, with all twelve demonstrating sufficient inter-rater and intra-rater reliability. Criterion validity for all fifteen measures was reported, with eight demonstrating sufficient validity and the remaining seven demonstrating indeterminate validity. No studies reported data on measurement error or responsiveness.

## Appendix 8.7.2

Barry Walsh, C., Cahalan, R., Hinman, R.S. & O'Sullivan, K. (2024) 'Exploring attitudes of people with chronic health conditions towards the use of group-based telerehabilitation: A qualitative study', *Clinical Rehabilitation*, 38(1), pp.130-142.

Original Research Article

 CLINICAL  
REHABILITATION

# Exploring attitudes of people with chronic health conditions towards the use of group-based telerehabilitation: A qualitative study

Clinical Rehabilitation  
2024, Vol. 38(1) 130–142

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DOI: 10.1177/02692155231197385

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### Abstract

**Objective:** The study explores the attitudes of people with chronic health conditions towards the use of group-based telerehabilitation.

**Design:** A qualitative research study.

**Setting:** The setting involved semi-structured focus groups via videoconferencing software.

**Participants:** A purposive sample of 18 people with chronic health conditions including cardiorespiratory, neurological and musculoskeletal conditions was recruited via national patient advocacy and support groups in Ireland and clinical contacts. The sample included both those who had, and had not, previously engaged in telerehabilitation programmes.

**Procedures:** An online questionnaire collected demographic information and data regarding previous telerehabilitation participation and telerehabilitation preferences. Focus groups were conducted using videoconferencing software, in accordance with the Consolidated Criteria for Reporting Qualitative Research (COREQ) Checklist, and analysed using thematic analysis following Braun and Clarke's methodology. Findings were triangulated with quantitative questionnaire data.

**Results:** Four focus groups were conducted including participants with chronic cardiorespiratory ( $n = 8$ ), neurological ( $n = 6$ ) and musculoskeletal ( $n = 4$ ) conditions. Three themes were identified regarding telerehabilitation: (a) benefits and facilitators (including convenience, increased service accessibility, social connection and technological support), (b) challenges and barriers (including technological access and literacy, limited 'hands-on' therapy, safety concerns and social limitations), and (c) preferences (regarding mode of delivery, content, duration and generic programmes for mixed-condition groups).

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## Appendix 8.7.3

Barry Walsh, C., Cahalan, R., Hinman, R.S. & O'Sullivan, K. (2023) 'Exploring attitudes of people with chronic conditions towards telerehabilitation: A qualitative study', *European Journal of Public Health*, 33(Supplement\_2), pp. ckad160-1140.

**Abstract citation ID: ckad160.1140**

**Exploring attitudes of people with chronic conditions towards telerehabilitation: A qualitative study**

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### **Background:**

Patient attitudes towards telerehabilitation have been explored in condition-specific cohorts. However, less is known about how patients perceive generic group telerehabilitation programmes for a range of chronic conditions. The aim of this research is to explore the attitudes of people with a range of chronic health conditions towards group-based telerehabilitation, and the acceptability of generic telerehabilitation programmes.

### **Methods:**

We conducted a qualitative research study using semi-structured focus groups via videoconferencing software. A purposive sample of 18 people with chronic health complaints including cardiorespiratory, neurological and musculoskeletal conditions were recruited. The sample included both those who had (n = 11), and had not (n = 7), previously engaged in telerehabilitation programmes. An online questionnaire collected demographic information and data regarding previous telerehabilitation participation and preferences. Focus groups were conducted via videoconferencing, in accordance with the Consolidated Criteria for Reporting Qualitative Research Checklist, and analysed using thematic analysis following Braun and Clarke's methodology. Findings were triangulated with quantitative questionnaire data.

### **Results:**

Four focus groups were conducted including participants with chronic cardiorespiratory (n = 8), neurological (n = 6) and musculoskeletal (n = 4) conditions. Three themes were identified regarding telerehabilitation: 1. Benefits and Facilitators 2. Challenges and Barriers, and 3. Preferences

### **Conclusion(s):**

Telerehabilitation is convenient for people with chronic conditions, however, concerns exist regarding technology and the limitations of this healthcare delivery method. The role of telerehabilitation is valued, and future programmes should acknowledge patient preferences including a hybrid model of care, exercise and educational content, social interaction, and synchronous components.

### **Key messages:**

- Patients value the role of telerehabilitation in the future as an adjunct to traditional in-person rehabilitation, not as a replacement.
- The acceptability of a generic telerehabilitation programme for a group of people with a range of chronic conditions remains unclear, and may differ between groups.

## Appendix 8.8 Conference Proceedings

**Appendix 8.8.1 Conference:** Irish Society of Chartered Physiotherapists Conference 2022

**Location:** Online

**Year:** 2022

**Format:** Parallel Oral Presentation

**Title:** Psychometric Properties of Performance-Based Measures of Physical Function Administered via Telehealth Among People with Chronic Health Conditions: A systematic review

**Objective:** Telehealth has the potential to increase access to rehabilitation services and programmes for people with chronic health conditions. However, uncertainty remains regarding the accuracy and reliability of measuring physical function via telehealth. The aim of this review was to examine the psychometric properties (reliability, criterion validity, measurement error and responsiveness) of performance-based measures of physical function administered via telehealth among people with chronic health conditions using the COSMIN (Consensus-Based Standards for the Selection of Health Measurement Instrument) approach.

**Method:** The protocol for this systematic review was registered with Prospero (Registration number: CRD42021262547). The review was conducted in accordance with COSMIN methodology (Prinsen et al., 2018). Electronic searches of PubMed, EMBASE, CINAHL and PsycINFO via EBSCOhost were performed up to June 2021. The methodological quality of each study was evaluated by two independent reviewers using the COSMIN risk of bias checklist. The measurement properties were rated by two independent reviewers in accordance with COSMIN guidance. The results were summarised according to the COSMIN approach and the modified GRADE approach was used to grade quality of the summarised evidence.

**Results:** Five articles met the eligibility criteria. Fifteen performance-based measures were investigated, spanning measures of exercise capacity (n= 2), functional strength (n= 2), functional balance (n= 7) and other measures of general functional capacity (n= 4). Reliability was reported for twelve of the measures, with all twelve demonstrating sufficient reliability. Of the studies that reported the reliability of the included measures, ten measures demonstrated adequate quality while three demonstrated inadequate quality. Criterion validity for all fifteen measures was reported, with eight demonstrating sufficient validity and the remaining seven demonstrating indeterminate validity when compared to face-to-

face administration. Of the studies that reported criterion validity of the measures, eight measures demonstrated very good quality and ten demonstrated inadequate quality. No studies reported data on measurement error or responsiveness.

**Conclusion:** Several performance-based measures of physical function across the domains of exercise capacity, strength, balance and general functional capacity have sufficient reliability and criterion validity when administered via telehealth. However, the evidence is of low-very low quality, reflecting the small number of studies conducted and the small sample sizes included in the studies. Future research is needed to explore the measurement error, responsiveness, interpretability and feasibility of these measures administered via telehealth.

## **Appendix 8.8.2 Conference:** Irish Society of Chartered Physiotherapists Conference 2023

**Location:** Online                      **Year:** 2023                      **Format:** On-Demand Oral Presentation

**Title:** Exploring attitudes of clinicians towards the delivery of group-based telerehabilitation for people with chronic health conditions: A qualitative study

**Objectives:** Telerehabilitation has the potential to increase service accessibility for people with chronic health conditions. Establishing the barriers, facilitators, and acceptability of generic group telerehabilitation programmes for people with various chronic conditions is needed before attempting widespread implementation. The aim of this research is to explore the attitudes of clinicians towards the delivery of group-based telerehabilitation for people with different chronic health conditions, including both those who have and have not previously delivered telerehabilitation.

**Methods:** A qualitative research study was conducted using semi-structured focus groups via videoconferencing software and reported in accordance with the Consolidated Criteria for Reporting Qualitative Research (COREQ) Checklist (Tong *et al.*, 2007). A purposive sample of ten physiotherapists involved in the delivery of exercise-based rehabilitation for patients with various chronic conditions, specifically patient cohorts with cardiorespiratory, neurological and musculoskeletal conditions, were recruited via the existing clinical networks of the authors. The sample included both those who had previous experience of delivering telerehabilitation (n= 8), and those who had no experience (n= 2). Demographic information and data regarding previous telerehabilitation delivery and preferences were collected via an online questionnaire. Data were analysed using thematic analysis following Braun and Clarke's (2006) methodology. Findings were triangulated with quantitative questionnaire data.

**Results:** Two focus groups were conducted. Most participants (n=7) viewed telerehabilitation to be equally effective as in-person rehabilitation. Just half of participants were comfortable to deliver a generic telerehabilitation programme to patients with different chronic conditions. Only four participants agreed that they had received sufficient training and education to deliver telerehabilitation programmes with five participants stating that they were confident in their ability to deliver telerehabilitation programmes. All participants expressed preference for a hybrid model for future telerehabilitation delivery including a

mixture of both telerehabilitation and in-person rehabilitation, as opposed to a full telerehabilitation programme. Three themes were identified relating to telerehabilitation: 1. Benefits: including convenience and efficiencies, safety, and new skills; 2. Challenges: associated with the use of technology, clinical delivery issues, and safety issues; and 3. The future of telerehabilitation: a hybrid model of delivery featuring both synchronous and asynchronous methods was favoured. Important factors cited were the need for initial in-person assessment, gathering important patient information to optimise patient safety, and the inclusion of a social component to sessions. A desire for further training on adapting in-person clinical skills was highlighted. The acceptability of generic telerehabilitation for mixed-condition patient groups remains unclear with some concerns raised regarding the practical challenges, however some were open to this, particularly for certain components of programmes such as generic education sessions. The value of telerehabilitation for certain cohorts was noted, and the need to promote the value of telerehabilitation among healthcare staff and patients was recommended.

**Conclusion:** Clinicians acknowledged the benefits and value of telerehabilitation, but also noted the challenges associated with telerehabilitation delivery. Clinicians have learned from previous experience of delivering telerehabilitation and recommended strategies to optimise future delivery and implementation of programmes. The acceptability of a generic telerehabilitation for people with different chronic conditions remains unclear, and concerns were raised by clinicians. Consideration of the benefits, challenges and the recommendations provided by clinicians may enable greater uptake and success of future telerehabilitation programmes for people with chronic health conditions.

**Appendix 8.8.3 Conference:** Chartered Society of Physiotherapy Annual Conference 2023

**Location:** Belfast, Northern Ireland **Year:** 2023 **Format:** Oral Platform Presentation

**Title:** Exploring attitudes of people with chronic health conditions towards the use of telerehabilitation: A qualitative study

**Purpose:** To explore the attitudes of people with chronic health conditions towards the use of telerehabilitation.

**Methods:** We conducted a qualitative research study using semi-structured focus groups via videoconferencing software. A purposive sample of 18 people with chronic health complaints including cardiorespiratory, neurological, and musculoskeletal conditions were recruited via national patient advocacy and support groups in Ireland and clinical contacts of the authors. The sample included both those who had (n= 11), and had not (n= 7), previously engaged in telerehabilitation programmes. An online questionnaire collected demographic information and data regarding previous telerehabilitation participation and telerehabilitation preferences. Focus groups were conducted using videoconferencing software, in accordance with the Consolidated Criteria for Reporting Qualitative Research (COREQ) Checklist and analysed using thematic analysis following Braun and Clarke's methodology. Findings were triangulated with quantitative questionnaire data.

**Results:** Four focus groups were conducted including participants with chronic cardiorespiratory (n= 8), neurological (n= 6) and musculoskeletal (n= 4) conditions. The majority of participants were willing to engage in future telerehabilitation programmes with other people with similar chronic conditions (n= 17), or generic telerehabilitation programmes with people with various chronic health conditions (n= 15). One half of participants (n= 9) viewed telerehabilitation to be equally effective as in-person rehabilitation, while ten participants stated that they were confident in their ability to use telerehabilitation.

The majority (n= 14) expressed preference for a hybrid model for future telerehabilitation programmes including both telerehabilitation and in-person rehabilitation, as opposed to a full telerehabilitation programme. Three themes were identified regarding telerehabilitation:

1. Benefits and Facilitators (including convenience, increased service accessibility, social connection, technological support),
2. Challenges and Barriers (including technological access and literacy, limited 'hands-on' therapy, safety concerns and social limitations), and
3. Preferences (regarding future use- patients viewed the role of telerehabilitation as an adjunct to traditional in-person rehabilitation, but not as a replacement; mode of delivery- hybrid model using synchronous modes with some recorded content; content- exercise, education and social interaction; duration- 45 mins-1 hour class, 6-8 week programme with some preference for follow-up after this period; and generic programmes for mixed-condition groups- some programme components such as education and social components are more applicable for mixed-condition groups as opposed to others such as the exercise components).

**Conclusion(s):** People with chronic health conditions acknowledged the benefits of telerehabilitation, but also highlighted the challenges that may be associated with this method of healthcare delivery. Perspectives on the future role of telerehabilitation and preferred design of these interventions identified both commonalities, as well as differences, between programmes supporting people with varying chronic health conditions. The degree to which people with different chronic conditions would engage in a common telerehabilitation programme remains unclear and may differ between groups. Consideration of the barriers, facilitators and preferences expressed may enable greater uptake and success of future telerehabilitation programmes for this cohort.

**Impact:** Consideration of these perceptions and experiences by clinicians and policy makers could help to inform the development of future telerehabilitation programmes and facilitate greater uptake and success of these interventions.

#### **Appendix 8.8.4 Conference:** 16<sup>th</sup> European Public Health Conference

**Location:** Dublin, Ireland    **Year:** 2023    **Format:** E-Poster Display

**Title:** Exploring attitudes of people with chronic conditions towards telerehabilitation (TR):  
A qualitative study

**Background:** Patient attitudes towards telerehabilitation have been explored in condition-specific cohorts. However, less is known about how patients perceive generic group telerehabilitation programmes for a range of chronic conditions. The aim of this research is to explore the attitudes of people with a range of chronic health conditions towards group-based telerehabilitation, and the acceptability of generic telerehabilitation programmes.

**Methods:** We conducted a qualitative research study using semi-structured focus groups via videoconferencing software. A purposive sample of 18 people with chronic health complaints including cardiorespiratory, neurological and musculoskeletal conditions were recruited. The sample included both those who had (n= 11), and had not (n= 7), previously engaged in telerehabilitation programmes. An online questionnaire collected demographic information and data regarding previous telerehabilitation participation and preferences. Focus groups were conducted via videoconferencing, in accordance with the Consolidated Criteria for Reporting Qualitative Research Checklist and analysed using thematic analysis following Braun and Clarke's methodology. Findings were triangulated with quantitative questionnaire data.

**Results:** Four focus groups were conducted including participants with chronic cardiorespiratory (n=8), neurological (n=6) and musculoskeletal (n=4) conditions. Three themes were identified regarding telerehabilitation: 1. Benefits and Facilitators 2. Challenges and Barriers, and 3. Preferences

**Conclusion(s):** Telerehabilitation is convenient for people with chronic conditions, however, concerns exist regarding technology and the limitations of this healthcare delivery method. The role of telerehabilitation is valued, and future programmes should acknowledge patient preferences including a hybrid model of care, exercise and educational content, social interaction, and synchronous components.

- Hybrid model of care including TR and in-person rehabilitation
- Value of both synchronous and asynchronous delivery

- Small group sizes
- Inclusion of exercise, education and social components
- Delivery by a healthcare professional
- 45-60 min classes for 6-8 weeks

**Main Messages:**

- Patients value the role of telerehabilitation in the future as an adjunct to traditional in-person rehabilitation, not as a replacement.
- The acceptability of a generic telerehabilitation programme for a group of people with a range of chronic conditions remains unclear and may differ between groups.

# Exploring attitudes of people with chronic conditions towards telerehabilitation (TR): A qualitative study



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## Introduction

- TR refers to rehabilitation delivered via telecommunication technologies e.g., videoconferencing or telephone calls.
- TR has potential to increase service accessibility and patient engagement with rehabilitation.
- Attitudes towards TR have been previously explored in condition-specific cohorts e.g., cardiac TR.
- Rehabilitation programmes for various different chronic conditions are remarkably similar.

## Purpose

To explore attitudes of people with a range of chronic conditions towards group-based TR & the acceptability of generic TR programmes for mixed-condition groups.

## Methods

- Qualitative approach using semi-structured focus groups via videoconferencing.
- Online questionnaire to collect demographic data and attitudes towards TR.
- Focus groups conducted in accordance with COREQ guidelines (1) and analysed using thematic analysis following Braun and Clarke's methodology (2).
- Qualitative findings triangulated with quantitative questionnaire data.

## Results

- N=18 people with chronic conditions including cardiorespiratory (n=8), neurological (n=6) & musculoskeletal (n=4) conditions
- N=11 previous TR participation experience
- N=10 (55.6%) males
- Mean age (SD): 58.7 (12.8) years

### Benefits & Facilitators

- Convenience
- Technology
- Patient safety
- Social benefits

### Challenges & Barriers

- Technology
- Quality of TR
- Social & safety limitations

### Preferences

- Hybrid model
- Synchronous delivery & recorded content
- Content: exercise, education & social
- Duration: 45-60 min classes x 6-8 weeks

Fig 1. Themes and Subthemes

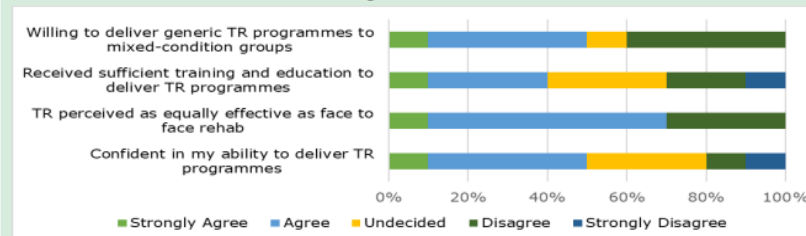


Fig 2. Participant attitudes towards TR

## Recommendations

- Offering training and support could help patients overcome challenges associated with TR participation.
- Future programmes should use hybrid delivery models, synchronous and recorded content and include exercise, educational and social components.
- It is still uncertain if a generic group TR programme for different chronic conditions would be acceptable among patients.

## Acknowledgements

- Faculty of Education and Health Sciences Research Ethics Committee in the University of Limerick (EHSREC 10\_RA01)
- Thanks to all participants
- Irish Research Council GOIPG Scholarship

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**Appendix 8.8.5 Conference:** International Society for Research on Internet (ISRII) 12<sup>th</sup> Scientific Meeting

**Location:** Limerick, Ireland

**Year:** 2024

**Format:** Oral Presentation

**Title:** Exploring attitudes of physiotherapists towards group-based telerehabilitation delivery and the acceptability of mixed-condition group programmes for people with chronic conditions: A qualitative study

**Context:** Telerehabilitation has the potential to increase service accessibility for people with chronic health conditions. Establishing the barriers, facilitators, and acceptability of generic group telerehabilitation programmes for people with various chronic conditions is needed before attempting widespread implementation. The aim of this research is to explore the attitudes of physiotherapists towards group-based telerehabilitation delivery for people with different chronic conditions and the acceptability of a generic telerehabilitation programme for a mixed-condition group.

**Methods:** This study employed a qualitative design using semi-structured focus groups conducted via videoconferencing and is reported in accordance with the Consolidated Criteria for Reporting Qualitative Research (COREQ) checklist. An online questionnaire collected baseline demographic data and attitudes towards telerehabilitation delivery. Physiotherapists involved in rehabilitation delivery to cohorts with chronic cardiorespiratory, neurological, and musculoskeletal conditions were recruited via clinical contacts of the authors. Qualitative data were analysed using thematic analysis following Braun and Clarke's methodology and findings were triangulated with quantitative questionnaire data.

**Results:** Ten physiotherapists were recruited from various public (n=8) and private (n=2) healthcare settings, and two focus groups were conducted. Three themes were identified regarding telerehabilitation: 1) Benefits: including convenience and efficiencies, safety, and new skills; 2) Challenges: including technology, clinical delivery issues and safety issues; and 3) The future of telerehabilitation: including preference and recommendations for future delivery and acceptability generic telerehabilitation programmes for mixed-condition groups.

**Conclusion:** Participants acknowledged the benefits and value of telerehabilitation, but also noted the challenges associated with telerehabilitation delivery. Clinicians have learned from previous experience of delivering telerehabilitation and recommended strategies to optimise future delivery and implementation of programmes, including the desire for further training,

guidance and support for clinicians, and the need for promotion of the availability and efficacy of telerehabilitation. A desire for further training on adapting in-person clinical skills was also highlighted. The acceptability of a generic telerehabilitation for people with different chronic conditions remains unclear, and concerns were raised by clinicians.

**Implications:** Telerehabilitation is considered a valuable and convenient method of healthcare service delivery for people with chronic health conditions by clinicians, however challenges associated with the delivery of these services exist. Several recommendations have been made which can support and optimise future telerehabilitation implementation and delivery.

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