

# Developing a chair based exercise programme for older people in a community setting

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# **Abstract**

## **Background**

Exercise has well known health benefits for older people, however, for some older people with compromised health and mobility participating in exercise is challenging. Chair based exercise is a pragmatic and accessible form of exercise that may be offered in this context, however, there is a lack of good quality evidence and a lack of standardisation in delivery.

## **Method**

This thesis used the Medical Research Council's framework for the development and evaluation of complex interventions to develop a community delivered chair based exercise intervention – Progressive Assisted Chair Exercise (PACE). Multiple research methods were undertaken to develop a theoretically driven intervention with a clear rationale for how it was anticipated to work. This included an expert consensus development process, a systematic review of randomised controlled trial literature, and identification of literature on the physiological and behaviour change principles of exercise for older people. The PACE intervention was then tested in a pre and post cohort study in an NHS community service to establish the feasibility of the intervention and whether it resulted in the anticipated outcomes. The acceptability of the intervention was explored through focus groups with older people.

## **Results**

Experts agreed on a set of 46 principles of chair based exercise through a Delphi technique. The systematic review of randomised controlled trials identified a lack of consistent and good quality evidence for the health benefits of existing programmes. Greater focus on the development of programmes that were underpinned by a sound theoretical framework was recommended.

Using the findings from the expert consensus, the systematic review and published guidelines on exercise for older people the PACE intervention was developed to include a 12 week multi-component progressive group or home based programme delivered by a healthcare professional with the

knowledge and skills of working with older people and targeted at older people who were unable to participate in standing exercise programmes.

The pre and post cohort study demonstrated that the programme was feasible to deliver when tailored to account for individual preferences and the fluctuating health needs of older people. The programme was acceptable to older people when targeted appropriately at those unable to participate in standing programmes and when individual preferences and needs were accounted for. The primary criteria for success of clinically meaningful improvements in lower limb muscle strength and progression to supported standing exercise were observed.

## **Conclusions**

The PACE intervention as a complex intervention was sufficiently developed and modelled to warrant formal evaluation. Further feasibility work is needed to optimise the evaluation method through a feasibility randomised controlled trial. Further development work for care home and acute rehabilitation populations is indicated.

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## Outputs

The findings of this thesis have been disseminated throughout the PhD process and the outputs include:

### Peer reviewed publications

- Robinson KR, Leighton P, Logan P, Gordon AL, Anthony K, Harwood R, Gladman JRF and Masud TM. *Developing the principles of chair based exercise for older people: a modified Delphi study*. BMC Geriatrics 2014, **14** (1): pp. 65.
- Robinson KR, Masud TM and Hawley-Hague H. *Instructor's perceptions of mostly seated exercise classes: Exploring the concept of chair based exercise*. BioMed Research International, vol. 2016 Article ID: 3241873, 8 pages, DOI: 10.1155/2016/3241873.

### Poster presentations

- Robinson KR, Leighton P, Logan P, Gordon AL, Anthony K, Harwood R Gladman JRF and Masud TM. *Developing the principles of chair based exercise for older people: a modified Delphi study*. British Geriatrics Spring Conference, 2014. (Awarded Eva Huggins Prize for best poster submitted by an Allied Health Professional).
- Robinson KR, Logan P, Gladman JRF, Masud TM and Hood V. *The health benefits of chair based exercise: A Systematic Review*. Physiotherapy UK, 2015.
- Robinson KR, Hood V, Masud TM, Gladman JRF and Logan P. *Barriers and facilitators to delivering a chair based exercise programme*. The European Union Geriatric Medicine Society Conference, 2016.

### Oral presentations

- Robinson KR. *Chair based exercise for older people*. Physiotherapy UK, 2014 (Invited speaker).
- Robinson KR. *Delivering a chair based exercise programme in an NHS community setting*. Nottinghamshire Healthcare NHS Trust Research Showcase, 2015.
- Robinson KR. *Developing chair based exercise for older people in community settings*. East Midlands Falls Symposium, 2016.

### Online discussion papers

- Robinson KR, Gladman JRF, Masud TM, Logan P and Hood V. *Protocol for a systematic review of the physical health benefits of*

*chair based exercise for older people*. East Midlands into Ageing Network Discussion Paper Series 2015, Issue 6: October. Available from <http://www.nottingham.ac.uk/emran/documents/issue-6-emran-oct-2015.pdf>

- Robinson K, Gladman JRF, Masud TM, Logan P and Hood V. *Chair based exercise: a survey of care homes in Nottinghamshire*. East Midlands into Ageing Network Discussion Paper Series 2015, Issue 2: June Available from <http://www.nottingham.ac.uk/emran/documents/issue-2-emran-june-2015.pdf>

## **Abbreviations**

1RM	One Repetition Maximum
ACSM	American College of Sports Medicine
AE	Adverse Event
BBS	Berg Balance Scale
CBE	Chair Based Exercise
CI	Confidence Interval
CMO	Chief Medical Officers
CV	Cardiovascular
DoH	Department of Health
EQ-5D	EuroQol 5 Dimension
FG	Focus Group
FN	Field Note
GCP	Good Clinical Practice
GP	General Practitioner
IQR	Interquartile Range
kg	Kilogram
MCID	Minimum Clinically Important Difference
MMSE	Mini-Mental State Examination
MRC	Medical Research Council
N	Newtons
N-m	Newton metres
NHS	National Health Service
NICE	National Institute for Health and Care Excellence

PAR-Q	Physical Activity Readiness Questionnaire
PPI	Patient and Public Involvement
RCT	Randomised Controlled Trial
SAE	Serious Adverse Event
SD	Standard Deviation
SF-36	36 Item Short Form Survey
SOB	Shortness of Breath
TUGT	Timed Up and Go Test
UK	United Kingdom
WHO	World Health Organisation

## Glossary

The following terms are used throughout the thesis and therefore a definition is provided below.

**Older people:** *adults aged 65 years and over.*

**Community settings:** *geographical location where the intervention can be delivered which includes community groups, NHS community services, day centres, care homes and the homes of older people. Inpatient settings and intermediate care settings were not considered community settings.*

**Physical Activity:** *'any bodily movement produced by skeletal muscles that requires energy expenditure'* [World Health Organisation [1]].

**Exercise:** *'physical activity that is planned, structured, and repetitive for the purpose of conditioning any part of the body. Exercise is used to improve health, maintain fitness and is important as a means of physical rehabilitation'* [Medical Dictionary [2]].

**Complex Intervention:** *'an intervention that contains several interacting components, with a range of possible outcomes and/or variability in the target population'* [Medical Research Council [3]].

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# **1 Chapter One: Introduction**

The aim of this thesis in developing a complex intervention is stated at the start of this chapter along with the position of the researcher and how this work was developed. The chapter then outlines the background literature to summarise the focus of the thesis. The problem that chair based exercise addresses is outlined and the current delivery of chair based exercise across community settings is described. The research gaps are identified which form the basis of the work in this thesis.

## **1.1 Aim of the thesis**

This thesis describes the systematic development of a chair based exercise programme called PACE- Progressive Assisted Chair Exercise. The Medical Research Council Framework [3] for developing and evaluating complex interventions is used to provide a framework for the development of the PACE intervention (chapter two). This thesis describes the systematic development of the PACE intervention using the following four stages:

1. Developing the theory of the intervention (chapter three)
2. Identifying existing evidence to inform the intervention (chapter four)
3. Planning the intervention (chapter five)
4. Modelling the process and outcomes (chapter six)

The thesis then reflects on whether the PACE intervention has been sufficiently developed to warrant formal evaluation or whether more development work is needed (chapter seven).

## **1.2 Development of the research area**

The research area in this thesis was developed in collaboration with a range of stakeholders. These included clinicians delivering chair based exercises in local NHS settings who felt it was an important area to guide their practice and support discussions with commissioners over the provision of services. Providers of chair based exercise programmes, such as exercise instructors, were also consulted and considered it an area where further understanding would be useful.

The research area was discussed with older people and their carers attending existing community groups such as Age UK Nottinghamshire, Radford Care Group and Nuttall Memory group. The current participation and enjoyment in chair based exercise was evident, however, some older people stressed that there should be a group for those that can do standing exercises and those that can't and that it shouldn't be a default option for all older people. The difficulties in performing standing exercises were raised. Concerns over unsteadiness and poor balance were emphasised with a chair seen as a way of providing stability. The importance of well-being and enjoyment from exercise was stressed by carers who felt this should be included in programmes and evaluated in the research.

The views of the researcher, other NHS employed clinicians, older people, and their carers, and providers of chair based exercise programmes supported the development of the research in this thesis.

### **1.2.1 Influence and involvement with other work**

Prior to work completed in this thesis the author was part of a study team for the following components of work; a systematic review (lead reviewer Mr Kevin Anthony), a survey of local CBE provision in care homes and day centres and interviews with older people and care staff. These components of work are cited in this thesis, however, were not formal stages of the development of the PACE intervention. It is, however, recognised that involvement in these components of work will have influenced the work in this thesis and influenced the author's perspectives on the topic.

There was a feasibility study which was funded by the National Institute for Health Research (NIHR) of chair based exercise in care homes, day centres and community groups. This grant was funded from February 2015 to February 2017 and was led by Professor Tahir Masud. The co-applicants for the NIHR funded feasibility study included; Professor John Gladman, Professor Pip Logan, Professor Rowan Harwood, Mr Kevin Anthony, Dr Adam Gordon, Dr Ruth Pulikottil-Jacob, Dr Sarah Armstrong and Dr Paul Leighton. The author of this thesis was a co-applicant on this grant and was directly involved in the development of the grant as well as completing the qualitative component (which is not presented in this thesis). Two of the co-applicants of this grant (Professor Pip Logan and Professor John Gladman) acted as academic supervisors for this thesis and the lead

applicant (Professor Tahir Masud) acted as a clinical mentor to the author. The work in this thesis has been conducted by the author, however, it is acknowledged that it will have been influenced by the author's role in the NIHR funded feasibility study.

The consensus development process outlined in chapter three was primarily conducted for this thesis, however, the findings informed the NIHR funded feasibility study. The study management group referred to in chapter three comprised of members of the NIHR feasibility grant development group which included; Professor John Gladman, Professor Rowan Harwood, Professor Tahir Masud, Professor Pip Logan, Dr Adam Gordon, and Mr Kevin Anthony and was facilitated by the author.

A service evaluation was completed as part of this PhD thesis at the point of testing the PACE intervention (presented in Appendix A). It is cited in this chapter as background information on the use of chair based exercise and it is cited in chapter six to describe the setting where the PACE intervention was tested.

### **1.2.2 Position of the researcher**

The knowledge and belief of a researcher can influence the research process [4] and should be made explicit from the outset [5]. As a physiotherapist with experience of working with older people in community settings, I had pre-existing beliefs, knowledge and experiences that influenced this thesis. I had delivered chair based exercise programmes in community settings for older people. It was difficult to quantify what the programmes were achieving using standardised outcomes though there was a general sense that they were welcomed by older people attending. There was also a sense that the programmes were needed as there was a group of older patients that did not meet the criteria for formal rehabilitation programmes (for example falls prevention, cardiac rehabilitation, and pulmonary rehabilitation). Working as a physiotherapist with this patient group I was aware that not all professionals were as positive about this patient group or chair based exercise and considered that they only achieved very small changes that may not be worthwhile. My belief that chair based exercise programmes were needed in some format for a group of older people with compromised health will have influenced the research in this thesis. Reflexivity will be used throughout

the thesis to explore the impact of the researcher's beliefs on the research process and outcomes.

Physical activity and exercise are now discussed as the background to this thesis and the development of the PACE intervention.

### **1.3 Physical activity for older people**

Physical activity has been suggested as '*the most important intervention that would enhance population health*' [6, p. 72] and can help to maintain functional abilities and independence into older age. There is evidence for a direct link between physical inactivity and chronic health conditions and physical inactivity is one of the five leading risk factors for mortality [6]. Undertaking physical activity throughout the life course is associated with better health in older age [7] and physical activity can help to manage age-related diseases such as diabetes mellitus, hypertension and osteoarthritis [8-10]. The physiological changes that occur as a result of ageing enhance the impact of physical inactivity [11]. These include a loss of muscle mass, cognitive decline, poorer balance and reduced muscle strength. These physiological changes can result in a significant functional decline, a loss of independence, a poorer quality of life and reduced participation in society.

Global and national guidelines have been developed to describe the amount of physical activity required to achieve health benefits [12, 13]. The guidelines are typically separated into children, adults and older people recognising the physiological and contextual needs of the different age groups. Key messages from global and national guidance for older people include 150 minutes of moderate-intensity aerobic exercise a week, muscle strengthening and balance exercises on two days a week, the importance of remaining as physically active as possible and gradually building exercise tolerance. The main differences between the recommendations for younger and older adults are the importance of muscle strength, co-ordination and balance training for older people to reduce the risk of falls. As with other public health recommendations, such as nutrition, the recommended dosages have been challenged with a perception they may be too low to elicit health benefits [14]. Setting the bar too high may however deter participation and appear unachievable for some older people with lower levels of function [15]. There does then appear to be a balance between

presenting realistic levels of physical activity that appear attainable as well as making sure these are underpinned by a robust evidence base.

A summary of recommendations from the World Health Organisation [12] and the four Chief Medical Officers from the UK [13] are outlined in Table 1.

**Table 1: Summary of the physical activity recommendations**

<b>UK Chief Medical Officers Guidelines [13], p. 39]</b>	<b>World Health Organisation Guidelines [12], p. 8]</b>
Older people who participate in any amount of physical activity gain some health benefits, including maintenance of good physical and cognitive function. Some physical activity is better than none, and more physical activity provides greater health benefits.	If older people are unable to do the recommended amounts of physical activity due to health conditions, they should be as physically active as their abilities and conditions allow.
Older people should aim to be active daily. Over a week, activity should add up to at least 150 minutes (2½ hours) of moderate intensity activity in bouts of 10 minutes or more – one way to approach this is to do 30 minutes on at least 5 days a week.	At least 150 min of moderate-intensity aerobic activity, or at least 75 min of vigorous-intensity aerobic activity, or an equivalent combination Aerobic activity should be performed in bouts of at least 10 min duration.
For those who are already regularly active at moderate intensity, comparable benefits can be achieved through 75 minutes of vigorous intensity activity spread across the week or a combination of moderate and vigorous activity.	For additional health benefits, undertake up to 300 min of moderate-intensity or 150 min of vigorous-intensity aerobic activity, or an equivalent combination.
Older people should also undertake physical activity to improve muscle strength on at least two days a week.	Muscle-strengthening activities involving major muscle groups should be done on two or more days.
Older people at risk of falls should incorporate physical activity to improve balance and co-ordination on at least two days a week.	People with poor mobility should do balance exercise to prevent falls on 3 or more days.
All older people should minimise the amount of time spent sitting.	

The published guidelines on physical activity consider older people to be aged sixty-five years and older [12, 13]. There is a challenge with summarising evidence in order to make recommendations on physical activity for all older people due to individual differences. Chronological age has limited use for differentiating between groups of older people with varying levels of physical function and health that does not always correlate with age [13]. The Chief Medical Officers' report [13] and the British Heart Foundation National Centre for Physical Activity [15] propose grouping older people by their functional status to identify their activity needs which include; those who are already active, those whose function is declining but remain generally healthy and those who are frail or with low physical or cognitive function. The latter group require a more therapeutic

approach to initiating activity and many of this group will be in supported care environments or receiving support to remain in their own home [15]. In comparison, older people who are already active and in good health require an approach that encourages sustainability of their behaviours to continue to promote independence and well-being.

Both the Chief Medical Officers' [13] and World Health Organisation [12] guidelines acknowledge the likelihood that older people will be living with a range of health conditions which may influence their ability to undertake physical activity. There are condition-specific guidelines, for example the management of osteoarthritis [16] and cardiac rehabilitation [17], which provide specific recommendations which can supplement the population-wide guidance. There is, however, a challenge in providing a clear message to older people who may present with a range of conditions and where the recommendations for each condition may differ.

## **1.4 Exercise and older people**

For those older adults categorised as having low physical function a more structured and planned physical activity programme, defined as exercise [1], may provide the basis from which to start to increase physical activity and improve their health status. Multi-component exercise programmes have been suggested for older people with low physical function and may include progressive resistance strength training, aerobic training, balance training and flexibility training [18]. Formal exercise programmes for older people primarily focus on improving muscle strength and balance to reduce the risk of falling and improve mobility. Such programmes include the OTAGO exercise programme [19] which contains progressive strength training, dynamic balance and walking exercises. Similarly, the Falls Management Exercise Programme (FaME) includes progressive strength training, dynamic balance and floor exercises with the aim of reducing the risk of falling in older people [20]. Systematic reviews, [21, 22] of randomised controlled trial and quasi experimental evidence, support progressive strength and balance programmes for reducing falls and improving the health of older people, and these programmes are now widely employed in healthcare. A brief overview of progressive resistance strength training, cardiovascular exercise, flexibility exercise and balance exercise for older people is provided below.

#### **1.4.1 Progressive resistance strength training for older people**

In older people, progressive resistance strength training is designed to be a countermeasure for loss of muscle mass and subsequent muscle weakness that occurs with ageing and inactivity [23, 24]. Progressive resistance strength training can be defined as '*work against an external force that is increased as strength increases*' [25], p. 48]. The technique uses the overload principle where the load placed on the muscle is progressively challenged [26]. Previously there was a view that older people were not able to significantly respond to progressive strength training however, this was challenged through the work by Fiatarone et al in 1990 [27]. Large improvements in muscle strength ( $174\% \pm 31\%$ ) were observed in 90-year-old participants following a high-intensity progressive resistance training programme demonstrating that older people can respond to progressive training stimuli. More recent research has identified that older people do however differ from their younger counterparts in the response to resistance exercise and demonstrate an impaired protein synthesis response known as anabolic resistance [28]. Older people are still able to respond to resistance exercise however consideration of the dosage is needed to produce physiological adaptations and functional impact [29]. Breen et al [30] suggest that the volume of training may be an important factor for stimulating physiological adaptations and although investigated in younger adults low-load high volume resistance exercises have been demonstrated to be more effective in improving muscle protein synthesis [31]. In a randomised controlled trial of adults over 55 years of age, Nicholson et al [32] reported that low-load high repetition resistance training improved muscle strength and gait speed. The older people participating in this study were relatively healthy and active which does limit the generalisability of the findings to more sedentary older adults. Ongoing research is exploring the anabolic blunting effect and the optimal resistance for training protocols in older adults [33].

There is an acknowledgement that much of the progressive resistance strength training research has been conducted in a controlled environment on carefully selected research participants who meet strict inclusion criteria. The findings may not, therefore, be generalizable to the wider older adult population or the settings where exercise programmes are

delivered. A systematic review by Liu et al [34] aimed to evaluate the evidence for progressive strength training in all settings and older people with complex health needs. This review drew evidence from 121 randomised controlled trials which included 6,700 participants. The review findings supported the previous findings that progressive resistance strength training has a large effect (standardised mean difference= 0.84) on strength. Inconsistent evidence was reported for functional outcomes with no effect on timed walking (mean difference of -0.23 seconds from 8 studies of 208 participants), a modest and significant effect on gait speed (mean difference of 0.08 m/s from 24 studies of 1179 participants) and a large effect (standardised mean difference= 0.94, from 11 studies of 384 participants) on chair rising time. The clinical significance of these effects was however not explored. The standardised mean differences for strength were also much smaller in the higher quality studies (with blinded assessors =0.23, and where allocation was concealed =0.12) and much smaller in older people with functional limitations (13 studies including 784 participants, standardised mean difference = 0.30) and specific health problems (19 studies including 926 participants, standardised mean difference= 0.37). Many of the studies in this review used resistance training machines which may not be appropriate for all community settings and older people with physical limitations.

Strengthening exercises are recommended in both the Chief Medical Officers' report [13] and World Health Organisation guidelines [12] on physical activity. The specific prescription of progressive resistance training for increasing muscle strength is difficult to outline for all older people given the individual responses to exercise which are influenced by past experiences, individual responses to stress and pre-existing medical conditions [35]. Progressing the resistance in response to an increased strength is fundamental to the mechanism of this type of exercise. For older people, the rate of progression needs to be managed cautiously to manage the potential risks, such as fatigue, musculoskeletal pain or injury [24]. Variation in the exercise content, a gradual approach to progression and consideration of the recovery period after training are advised when facilitating progressive resistance training for older people [24]. The effective dosage of progressive resistance training for improving muscle strength is inconsistent across the published literature [36]. There is

limited evidence for the optimal frequency of strength training as identified in a systematic review by Steib et al [36]. From the available evidence (29 studies including 1313 participants), the review concluded that higher frequencies of training lead to greater gains in knee extensor muscle strength but for other muscle groups once a week training was comparable to twice a week. In a cohort study by Nakamura et al [37] (n=34) improvements in cardiorespiratory fitness with a training frequency of three times a week were observed when compared to lower frequencies however there were no differences reported for muscle strength. In summarising the evidence the American College of Sports Medicine [24] recommends progressive strength training should be undertaken at least two days per week but no more than four with 8-12 repetitions per set, with 1-3 sets. A systematic review (including 13 studies measuring muscle strength) by Cadore et al [38] supports this statement concluding that progressive resistance training protocols that are carried out 2-3 times a week using 8-12 repetitions and with increasing intensity can be tolerated and result in strength gains in frailer older adults or older adults with a decline in physical function.

Local muscular endurance can be defined as the ability of a muscle to repeatedly sustain a contraction against resistance for a period of time [39]. Muscular endurance is a component of muscle fitness (along with muscle strength) and important for functional activities [40]. Progressive resistance training can be used to target muscular endurance, however, there is less evidence for the optimal training protocol for endurance training compared to strength training in older adults. It is acknowledged that older people may need to increase muscle strength before they can increase muscular endurance [41]. The American College of Sports Medicine recommend lower intensities with increased repetitions as appropriate for improving muscular endurance in all populations [24]. There is however evidence that progressive strength training models as previously outlined increase muscular endurance in older adults [40].

#### **1.4.2 Cardiovascular training for older people**

Cardiovascular or aerobic training is defined as '*exercises in which the body's large muscles move in a rhythmic manner for a sustained period*' [40], p. 1511]. It is used for older people to maintain and improve

elements of heart and lung function, improve exercise tolerance and improve functional abilities [42].

Older people can physiologically adapt to cardiovascular exercise training with an improvement in  $VO_{2\text{ max}}$  (the maximal oxygen consumption) achievable [40]. Examples of cardiovascular exercise for older people include running, walking, cycling, swimming and dance based programmes. Due to the mobility limitation of some older people cardiovascular training may be challenging and non-weight bearing methods such as a seated bike may also be considered. In a systematic review by Huang et al [43] (41 trials which included 2102 community dwelling-older people) a 16.3% improvement in  $VO_{2\text{ max}}$  compared to control groups was reported, demonstrating the potential benefit of this type of exercise. As summarised by Liu and Fielding [44] in a narrative review, there is also more recent evidence that cardiovascular training can improve muscle mass [45]. As outlined in the review these findings are however inconsistent with previous research [46, 47]. More research is therefore needed to confirm whether aerobic exercise effects muscle mass given the contradictory research findings.

The intensity of cardiovascular training can be determined in a number of ways including the  $VO_{2\text{ max}}$ , maximal heart rate and self-perceived exertion scales. In a community setting, which may include the homes of older people or venues with limited space, a method that uses no equipment such as a self-perceived scale may be more appropriate. Exercise intensity can be measured based on an individual's capacity using a ten point scale, where one is considered the lowest intensity and ten is the highest intensity [12]. The World Health Organisation report suggests 5-6 out of 10 is considered moderate intensity and vigorous intensity as 7-8 out of 10 [12]. Moderate intensity is described by the Chief Medical Officers' report as '*activity that requires an amount of effort*' [12, p. 54] and with vigorous intensity activity it should be difficult to '*comfortably hold a conversation*' [12, p. 18].

The Chief Medical Officers' report recommends moderate intensity exercise on at least 5 days a week for those older adults who are not already active [13]. This is supported by the American College of Sports Medicine exercise prescription guidelines which advise 3-5 times per week of moderate or

vigorous intensity training [35]. Higher intensity training may, however, not be appropriate for all older people with higher cardiovascular risks and poorer attendance rates [48].

### **1.4.3 Flexibility training for older people**

Flexibility exercises involve stretching of the muscles and tendons in order to maintain range of movement and muscle length. There are different types of stretching exercises which include ballistic stretching, passive stretching, static stretching and developmental stretches [40, 49]. They are used for older people to maintain physical functioning and support activities of daily living. Maintaining range of movement can also prevent postural imbalances which can influence balance [50] and reduce the risk of falling [40, 49]. The American College of Sports Medicine [39] recommend that flexibility exercises need to be separate from the cool-down phase of an exercise programme as they have the different purpose of maintaining muscle length and joint movement.

The physiological mechanisms and prescription of flexibility training have less robust evidence than those for strength and cardiovascular training. There is a lack of evidence for the effectiveness of flexibility exercises for older people and less research to guide the principles of prescription [51]. The lack of a clear dose-response may be due to difficulties in extracting information specifically about flexibility exercises which are often part of multi-component exercise programmes for older people [49]. They are not included in the key recommendations from the Chief Medical Officers' [13] and the World Health Organisation [12] guidelines as these are based on the highest quality evidence which is lacking for flexibility exercises. Range of movement exercises are however recommended in condition-specific advice such as guidelines for osteoarthritis, a condition common in older people [52]. Benefits of flexibility training can include improving joint range of movement, however, there is little evidence that this translates to benefits in functional outcomes [51].

A systematic review by Stathokostas et al [51], which reviewed 22 studies including 1127 participants, identified a lack of good quality evidence on flexibility training for older people. The variation in training protocols limited the synthesis of the findings and no recommendations could be made on the optimal type and dosage of the training. Feland et al [53]

demonstrated, through a randomised controlled trial, greater improvements in knee range of movement with passive hamstring stretches for 60 seconds compared to 30 seconds in a sample of 62 older people with a mean age of 84.7 years. The American College of Sports Medicine recommend 30-60 seconds for the duration of stretches in older people [35, 40], however, the quality of the evidence (as judged by the American College of Sports Medicine authors) to support this recommendation is lower than recommendations for strength and cardiovascular training [35, 40].

The current evidence for flexibility exercises limits conclusions on the optimal delivery model and anticipated outcomes for older people [51]. Despite the lack of evidence they are commonly used in exercise programmes with the belief they are needed to maintain range of movement which will support functional abilities. Their inclusion in programmes does not pose any great health risks with no injuries identified [51], however, further research is needed to determine the optimum delivery and the mechanisms by which they are anticipated to achieve the desired outcomes.

#### **1.4.4 Balance training for older people**

Balance refers to *'the ability keep the body's centre of gravity within the base of support'* [54], p. 342] and impairments in balance can increase the risk of falling. Both static and dynamic balance need to be considered for older people [20]. Static balance refers to the ability to maintain the body position in a fixed posture (e.g. standing without moving) and dynamic balance refers to the ability to maintain stability when the body is in motion (e.g. walking) [54].

There is less robust evidence to support the recommendations for the type, intensity and frequency of balance exercises in comparison to the strength of the evidence for resistance strength training [55]. The Chief Medical Officers' report [13] and World Health Organisation [12] guidelines recommend performing balance exercise two to three times a week for older people with poor mobility. Balance exercises are often included as part of a multifactorial falls prevention programme (such as the OTAGO and FaME exercise programmes outlined previously) and it may, therefore, be difficult to extract this component from the other intervention

components. Sitting balance exercises have been incorporated into balance rehabilitation programmes where equipment is used to create an unstable base. These include sitting on an exercise ball [56] or the use of a cushion. It is clear that balance exercises need to be progressively challenging and carried out whilst standing in order to impact on falls-related outcomes [57], and reductions in falls have been demonstrated with Tai Chi [58] and other programmes that include dynamic balance exercises (such as the OTAGO and FaME programmes outlined previously).

## **1.5 Chair based exercise**

As outlined, exercise has well-established health benefits for older people. However for some older people participating in exercise may be difficult [59]. The ageing process can bring challenges to participating in exercise due to immobility, physical disabilities, fear of falling and fear of injury [60]. Francis [60] suggests that for older people with compromised health and mobility there should be appropriately designed exercise programmes that support participation. Older adults with more severe mobility limitations also report more barriers to participating in an exercise programme and these barriers include poor health and fear [61].

Chair based exercise is an accessible form of exercise that may be appropriate for older people who cannot take part in the evidenced strength and balance programmes (such as OTAGO and FaME outlined previously). Using a chair provides stability for older people who have difficulty with standing due to impaired mobility and balance. The potential for falling and fear of falling is reduced by sitting to exercise. It can allow older people to participate in exercise including strength, cardiovascular and flexibility training which they may not otherwise be able to do [41].

The author conducted a service evaluation of an NHS day rehabilitation service that provided community-based therapy groups for older people (a summary is provided in Appendix A). This evaluation highlighted that 50% of older people participating in rehabilitation were clinically considered (following an assessment by a physiotherapist) unable to participate in a standing group exercise programme due to poor balance, reduced confidence, dizziness, reduced exercise tolerance or poor mobility. Measures used to determine poor mobility and balance included the Timed

Up and Go Test and Berg Balance Scale. The Timed Up and Go Test is a functional measure that times how long in seconds it takes a patient to stand up walk three meters, turn around and return to sitting [62]. The Berg Balance Scale is a performance-based test of an individual's balance scored out of 56 with higher scores representing better balance [63]. The physiotherapists used clinical reasoning with the support of the above measures and their wider assessment to determine if an older person was able to participate in standing group exercises. Those patients who were not considered able to participate in the strength and dynamic standing balance programmes were offered a chair based exercise programme. This demonstrates that chair based exercise interventions are clinically used for older people with impaired mobility and health, being determined most appropriate for half of the people referred to an NHS rehabilitation service.

### **1.5.1 Chair based exercise interventions**

Chair based exercises have been described as '*gentle and easy to follow exercises*' that are appropriate for older people who are not currently very active [64]. A survey of care homes and day centres in Nottinghamshire (conducted by the author) defined chair based exercise as a '*structured and formal exercise programme where participants are seated for the majority of the session which includes the components of strength, endurance and cardiovascular fitness training*' [65]. This differentiates chair based exercise with other seated activity programmes for older people such as seated games. These are not usually structured and progressive exercise programmes and are primarily used for recreation. This thesis will focus on chair based exercise interventions which are structured and formal and not seated recreational activities.

Community settings in this thesis refer to the geographical location where chair based exercise can be delivered and include care homes, day centres, homes of older people and NHS community services. Inpatient hospital or intermediate care settings were not considered community settings. Across community settings chair based exercise may be carried out in care homes [65], sheltered living settings [66], community groups [67] and healthcare settings [68]. Specific examples of chair based exercise programmes delivered in community settings are presented in Table 2.

**Table 2: Examples of chair based exercise across community settings**

Type of provision	Name of provider	Detail of provision
Community NHS Services	Chronic Condition Management Team, Swansea [66]	8 week supervised session run in a group by healthcare support workers.
	Central London Community Trust [68]	Chair based exercise group as part of falls prevention team.
Voluntary Sector	Healthwatch, Portsmouth [69]	Exercise timetable across the community including chair based exercise.
	Age UK Leeds [67]	Chair based exercise run across sheltered accommodation by trained volunteers.
Care Homes	First Taste [70]	DVD of chair based exercises for care staff working with older people.
	Nottinghamshire care home survey [65]	Chair based exercise delivered across 31 care homes.
Local Authority	Long Meadow Day Centre, Nottingham City Council	A weekly session for older people attending day centre by care staff.
	Coventry City Council [71]	A range of classes run across different community settings.
Home based booklet	British Heart Foundation [72]	Booklet of chair based exercises to use at home for cardiac patients.

A local survey of care homes and day centres in Nottinghamshire (conducted by the author) reported that chair based exercise is often used as an '*enjoyable way of promoting exercise*' to residents who are unable to take part in other forms of exercise [65]. Eighty-three percent of the care homes and day centres that responded to the survey (respondents=35 from 182 surveys circulated) offered chair based exercise in their setting with comments suggesting it offers a way of promoting exercise to a vulnerable population who are often unable to take part in other forms of exercise. Benefits were suggested to include strength, mobility and general well-being. A lack of standardisation amongst programmes was identified with providers identifying the need for further guidance on how best to deliver programmes to maximise the benefits.

A Local Exercise Action Pilot (LEAP) undertaken in Nottingham City Primary Care Trust in 2002 mapped local activity provision for adults over fifty years of age [73]. Three percent of the mapped activity was attributed to chair based exercise [73]. The report suggested chair based exercise is needed for more isolated and fragile adults and a lack of appropriate training is a potential barrier to implementation. In the North East of England, a similar mapping exercise was undertaken for all physical activity

in adults with two percent of activity attributed to chair based exercise [74].

The delivery of chair based exercise targeted at older people across a range of settings demonstrates that there is a demand for the intervention.

### **1.5.2 Chair based exercise training and leaders**

The diversity of instructors leading chair based exercises is reflective of the range of settings where it is delivered. Instructors include volunteers [67], health professionals [68], exercise instructors [71] and care staff [70].

Multiple providers deliver training in how to deliver chair based exercise to a range of professions. LaterLife Training Limited provide a programme called '*Sit Tall, Stand Strong*' [41] that is offered to health and social care professionals, exercise instructors and to those with no formal qualifications but the experience of working with older people. Training is provided in the delivery of a chair based exercise programme developed from research conducted by Dawn Skelton and Susie Dinan-Young [75, 76] and was updated to meet the recommendations of the four Chief Medical Officers' guidelines in 2011 [13]. Another training provider is EXTEND [77] who provide training in delivering '*movement to music programmes for the over 60's and less able people*'. There are no formal qualifications required to access the training and instead previous experience and background knowledge is assessed.

Some NHS trusts provide chair based exercise training packages, such as the Falls and Bone Health Service of Nottingham CityCare Partnership, where clinical staff offer a theory and practical training programme for staff working in care homes and day centres with older people. Evaluation of this service (completed by the author) identified it was welcomed by care home staff in supporting older people to become more active; however delivery was challenged by a high staff turnover. In addition, staff reported a lack of confidence to implement programmes with older people presenting with complex needs and a number of health conditions [78].

With chair based exercise being delivered by a range of leaders with a range of backgrounds, experience and qualifications, it is likely to result in inconsistencies in the delivery of interventions which may impact on the effectiveness. The lack of confidence reported by care staff who had

received one-off training may result in low-intensity programmes that are considered safe; however they may not be at a sufficient intensity to elicit physiological changes. There is then a research gap in who are the most appropriate leaders and the skills and experience these leaders need in order to deliver appropriately intense programmes safely.

### **1.5.3 The views of older people**

Philips and Flesner [79] carried out focus groups with older people across six care homes and assisted living centres to explore the provision of physical activity. Chair exercise sessions were reported as being '*popular*' due to their accessibility for older people with compromised health and mobility [79] p. 44]. The popularity may, however, have been due to the fact that chair based programmes were most commonly delivered and therefore the most available option [79].

The views of older people participating in a chair based exercise group delivered by Age UK were explored in an interview study of seven older people by Hughes [80]. Chair based exercise was considered an accessible form of exercise by older people that provided physical and well-being benefits. The group delivery provided an opportunity for socialisation and friendship giving older people a sense of purpose. The study concluded that a wide range of physical benefits were reported however little detail was provided on the specific physical benefits. Amongst the older people who participated in an interview, there were few barriers to engaging with and participating in chair based exercise. These views were taken from a small sample of older people who were predominantly female (86%) and therefore their views may not be generalizable to all older people.

There is a lack of published data on what older people think about chair based exercise, however, more informal evaluations related to specific projects provided further insight. Participants of a 12-week chair based exercise programme delivered by the Chronic Conditions Management Service in Swansea discussed how the programme helped to make them feel less isolated, develop friendships and improve their confidence [66].

Some older people have offered a more negative view on chair based exercise. As preliminary work for this thesis older adults attending a local authority day centre were consulted on their views on chair based exercise

[unpublished interview data available from the author]. Some older people stated that you '*can't do much from a chair can you?*' Anecdotally there appeared to be a need to target chair based exercise appropriately and ensure it was not offered to older people who may be able to achieve more. One older adult suggested that '*there should be a class for those that can do standing exercises*' and one for those that can't to ensure the level of exercise is appropriate and sufficiently challenging.

In developing chair based exercise interventions it would, therefore, appear important to ensure they are targeted at older people who are unable to do standing programmes and that the views of older people are considered to ensure interventions are appropriate and acceptable.

#### **1.5.4 Content of chair based exercise interventions**

The range of settings for chair based exercise has led to variety in both delivery and content. This was emphasised by the only published systematic review of chair based exercise [59] which reported differences in the duration, intensity and frequency of programmes. The specific exercise content included seated progressive resistance training [81-83], chair movement exercises that used music to enhance participation [84], and high paced complex movements for co-ordination [85]. One study reported progressive resistance exercises done in both sitting and standing [86].

Detail on the intensity of the programmes included in the systematic review literature was lacking with one study reporting a moderate intensity protocol [86] and one using 60% of the maximum heart rate to ensure a moderately intensive programme [85]. The intensity of chair assisted exercises was examined by Volkers et al [87] in a cross-sectional study. Forty-seven healthy volunteers with a mean age of 84.1 years undertook 30 minutes of chair assisted exercises which included a combination of endurance, strength and balance exercise. Participants were asked to perform the exercises at a comfortable level. Physiological measures were taken to estimate the maximum rate of oxygen consumption ( $VO_{2max}$ ), heart rate and energy expenditure. The findings indicated that participants were able to work with at least a moderate intensity. This identifies that chair assisted exercise can be considered as being of a moderate intensity which is in line with recommended guidelines [13]. This study was however

conducted in healthy older people and may not, therefore, be representative of some older people taking part in chair based exercise with compromised health. Previous research has explored chair based exercise as part of cardiac rehabilitation [88]; however there is little detail with only the abstract accessible and no further information available from the author. Ongoing research is continuing to explore the physiological demands of chair based exercise for older people with compromised health such as cardiac conditions [89].

There are differences in the delivery of chair based exercise programmes across community settings which emphasise a lack of clarity over the intervention and the anticipated outcomes. Existing evidence provides little detail on the chair based exercise interventions and a lack of adherence to underlying physiological principles. This indicates that chair based exercise interventions need to be developed to have a clear rationale, with the delivery underpinned by a clear theoretical framework.

#### **1.5.5 Maximising chair based exercise participation**

Evidence supports the positive impact of exercise on physical and mental health; however participation remains low across all age ranges [90]. Activity levels decrease with age and the 2012 Health Survey for England [90] findings demonstrate that only 30% of men and 13% of women 75 years and over meet the Chief Medical Officers' [13] recommended levels of aerobic activity and these levels are lower than younger age groups [90]. There appears to be a lack of appropriate information given to older adults regarding the benefits of exercise and Buttery et al [91] concluded that opportunities where the benefits of exercise could be promoted are not always taken by professionals. Although this work was carried out in a post-acute hospital setting the findings may also be relevant for community settings where opportunities to promote the benefits of physical activity also need to be taken. In a survey of 409 community-dwelling older adults 96% considered physical activity to be beneficial however participation in activity was low, with 36% reporting not undertaking any level of physical activity [92]. This study did, however, focus on leisure time physical activity rather than structured exercise programmes and included a range of older adults with a third being under the age of seventy. Muscle weakness and low physical activity have been suggested to result in lower

participation in structured exercise programmes [93] and these characteristics may be representative of people who may be suitable for and benefit from chair based exercise. The low level of participation and difficulties with participation indicates that exercise programmes may need to consider strategies to encourage and sustain participation.

Theoretical frameworks of behaviour change provide an understanding of the process of changing a behaviour, such as starting an exercise programme. A scoping review by Davis et al [94] in 2015 identified the behaviour change theories that have been reported across social and behavioural science research of which 26% of the interventions were targeting physical activity. A summary of the most commonly reported frameworks from the scoping review is presented in Table 3. Other theoretical frameworks include control theory where a goal and feedback are used to provide a behavioural change target [95] and operant conditioning where positive and negative consequences encourage behaviour change [96]. The COM-B model which identifies three components of capability, motivation and opportunity that interact to influence behaviour has been developed as a framework to address some of the limitations of the other frameworks and support the development of behaviour change interventions [97]. This framework was not used in any of the studies identified in the scoping review [94], however, this could be due to the fact the model was published in 2011 and may therefore take more time to be adopted into systematic review literature.

**Table 3: Summary of behaviour change theories**

Theoretical framework	Overview
Theory of planned action/behaviour	Focuses on individual motivational factors for changing behaviour. The framework is underpinned by the assumption that the intention towards the behaviour is the strongest influence on adopting the behaviour [98]. The intention is influenced by an individual's attitude towards the behaviour as well as social perceptions of the behaviour.
Social Cognitive Theory	A change in behaviour is underpinned by a sense of self-control and the belief that a person feels they can make a change. If a person believes that they can change a behaviour they are more inclined and motivated to change [99].
Information-motivation-behavioural skills model	Underpinned by three constructs that influence the behaviour [100]: <ul style="list-style-type: none"> <li>• Information and knowledge</li> <li>• Motivation to carry out the behaviour</li> <li>• Skills necessary to carry out the behaviour</li> </ul>
Stages of change	Developed by Prochaska and DiClemente. Suggests that individuals move through stages in order to change behaviour which pre-contemplation, contemplation, preparation, action and maintenance [101].

Abraham and Michie [102] collated information on specific behaviour change techniques that could be included in health interventions and developed a taxonomy of 26 behaviour change techniques mapped to the theoretical frameworks (examples are presented in Table 4). This was in response to criticism that the theoretical frameworks did not offer specific, practical strategies to support behaviour change with a lack of clear reporting within behaviour change intervention literature.

**Table 4: Examples of behaviour change techniques**

Technique	Theoretical framework
Provide information about the behaviour	Information-motivation-behavioural skills model
Provide general encouragement	Social cognitive theory
Specific goal setting	Stages of change Control theory
Self-monitoring	Control theory

Modified from Abraham and Michie [102]

The taxonomy was updated through a Delphi consensus process with experts and now includes 93 behaviour change techniques [103]. This work provided a way to more clearly standardise the reporting of behaviour change techniques. Although the taxonomy may improve the reporting there is still a lack of clarity over the most effective behaviour change theory and techniques for supporting exercise behaviours in older people [104]. French et al [104] reported, in a systematic review (24 studies of

community dwelling older people), that self-regulating strategies such as self-monitoring and goal setting did not improve self-efficacy or the levels of physical activity in older people. This review did exclude clinical populations as the authors considered there would be condition specific barriers to physical activity that may reduce the wider applicability of the results. Participants of chair based exercise programmes are likely to have multiple health conditions and findings from clinical populations may therefore also be of relevance. Self-monitoring through a home recording sheet was trialled in a clinically delivered falls prevention exercise programme and was viewed differently by individual participants. Although generally considered to be useful there were discrepancies between how older people felt such self-monitoring techniques should be included in programmes and the authors concluded that it may be more appropriate to allow older people to decide if and how they wish to use such tools. Older people in this study did, however, report that having knowledge and skills of the exercise behaviour was integral to supporting their participation in the falls prevention programme [105]. This was a small feasibility study (n=13) and these findings have yet to be evaluated in a larger and more robust trial, however, the findings may still be useful in the development of exercise programmes for older people.

The literature identified in the systematic review of chair based exercise interventions [59] provided little detail on behaviour change strategies used to encourage participation. Behaviour change frameworks and strategies reported in the wider chair based exercise literature include '*Brief Negotiation*' [106] and the '*Health Belief Model*' [107]; however little detail was provided on the impact of these strategies on participation. Further attention is needed to explore appropriate behaviour change strategies to support participation in chair based exercise programmes.

#### **1.5.6 Effects of chair based exercise interventions**

Chair based exercise programmes delivered in the community often claim health benefits which include improving strength, improving walking, and improving the ability to perform daily tasks. The only systematic review of chair based exercise (previously reported), had a specific focus on frail older people [59] and reported on six papers [81-86]. The narrow focus on frail older adults was recognised as a limitation due to the difficulties in

defining frailty [59]. The review determined that there was a lack of good quality literature on the effects of chair based exercise limiting the conclusions that could be drawn and acknowledged the difficulties of identifying relevant literature with a lack of a clear understanding surrounding the intervention.

There were limitations with the search strategy used in the systematic review and a broader review of the evidence identified further literature evaluating chair based exercise across a range of community settings. These included care homes [108, 109], senior community centres [110-113] and assisted living homes [114]. Physical outcomes included; quadriceps strength [109], grip strength [110], pain [113], mobility [113], power [114], balance [112], falls [106], activity [107] and function [108]. Cognition [109] and depression [108] were reported as mental health outcomes. Inconsistent findings for the health benefits of chair based exercise were reported across these studies and the studies used different research designs.

Improvements in muscle strength [109, 110, 114] were reported that were significantly different between the exercise and control groups, however, there was concern over the clinical relevance of these changes. Conflicting evidence was reported from single group pre and post studies addressing pain outcomes. Yan et al [106] reported a significant reduction in pain scores, however, no changes in pain scores were reported by Park et al [111]. No significant differences in mobility were reported in two controlled trials [112, 113]. Improvements in cognitive function were reported in care home residents with dementia [108], however, the differences between the control and the exercise groups were not reported. In contrast McMurdo and Rennie [109] reported no statistically significant improvements in cognition between the exercise and control groups in care home residents.

A lack of random allocation increases the risk of potential for bias to have influenced the outcome of some of these studies. For example, Park et al [113] allocated all participants with Alzheimer's disease to chair yoga which may have introduced selection and allocation bias. Thurm et al [108] conducted their study over two care homes which were allocated to chair based exercise or a waiting list control. There could have been potential bias from differences within the homes such as the way they were

managed or the type of older residents and this may have influenced the outcomes [108]. The single group pre and post design of some of these studies [111, 114] limits the confidence in drawing conclusions about effectiveness with a lack of comparison group and difficulty in accounting for confounding variables [115].

In summary, there is a lack of a good quality synthesis of the evidence for the physical and mental health benefits of chair based exercise and a lack of good quality evidence to determine the optimal intervention package. Identifying appropriate literature has been recognised as a challenge due to the lack of clarity over the concept and parameters of chair based exercise interventions [59].

## **1.6 Conclusion**

This chapter has emphasised the importance of physical activity throughout the life course and into older age in order to sustain and improve health. The optimal exercise protocols for older people identified the benefits of strength, balance and aerobic training for improving muscle strength, functional abilities and reducing the risk of falls. Supporting older people with compromised health and mobility to engage in these exercises programmes was identified as a challenge with chair based exercise offered as a pragmatic approach.

Chair based exercise is delivered across community settings to fragile and vulnerable older people and appears to be welcomed by older people and providers. There is, however, a lack of standardisation in the delivery and a lack of clarity over the intervention which makes formal evaluation challenging. Interventions previously evaluated have not been underpinned by the principles of exercise for older people and have not considered appropriate behaviour change strategies to maximise participation.

In exploring the current delivery and existing evidence for chair based exercise the research gaps have been identified. These include the need to clarify the concept of chair based exercise, identify the underlying theory, establish the optimum delivery package and determine if it is acceptable to older people. Having identified the research gaps the next chapter will explain why a chair based exercise intervention is a complex intervention and how the research gaps will be addressed by this thesis.

## **2 Chapter Two: Complex interventions**

In chapter one, chair based exercise as an intervention was outlined and the research gaps highlighted. This chapter introduces complex interventions in healthcare, describing what makes chair based exercise a complex intervention. The Medical Research Council's Developing and Evaluating Complex Interventions Framework [3] is presented as an approach to address the research gaps for a complex intervention. The programme of work that is conducted in this thesis to develop a chair based exercise intervention referred to as PACE (Progressive Assisted Chair Exercise) is described.

### **2.1 Complex interventions**

Healthcare delivery can be complex and involve multi-faceted interactions and decisions. For example, a therapist working with an older person on their rehabilitation following a fall is required to consider the physical, social and psychosocial needs of the patient. This multi-factorial rehabilitation requires a successful collaboration between a range of professionals and organisations. Additionally, it needs to be tailored to the individual patient and there may be several intended outcomes of the intervention.

Interventions that are influenced by environmental or contextual factors can be considered more complex as the context interacts with key components of the intervention influencing the outcomes [116]. It is therefore not just the complicated content of the intervention, variability in the target population, and variability in outcomes that need to be considered. Contextual factors [117] such as the physical environment, the culture of the organisation, funding mechanisms and professional regulations all define and constrain the interventions adding to the complexity.

Chair based exercise can be considered a complex intervention as it involves a number of interacting components, it is delivered across different settings and has multiple outcomes of interest (outlined in chapter one). Programmes are tailored to individual participant needs and can be delivered in a range of formats such as group-based or one-to-one. Chair

based exercise is prescribed for patients with either, or both, physical and mental health issues, which reflects the range of anticipated outcomes of the intervention. Current chair based exercise programmes are delivered with a degree of flexibility involving multiple components of different types of exercise and delivered with varying frequency and duration [59]. Table 5 outlines what makes chair based exercise a complex intervention.

**Table 5: What makes chair based exercise a complex intervention?**

<b>What makes an intervention Complex?</b>	<b>What makes chair based exercise a complex intervention?</b>
Degree of flexibility of intervention	Programmes do not follow an algorithm style approach, instead respond to the changing needs of older people.
Number of health behaviours required by patient and professional	Participants are required to actively engage in the exercise programme. Professionals are required to demonstrate multiple health behaviours adapting the delivery of programmes to individual needs.
Difficulty of health behaviours	Exercise participation demands a breadth of challenging skills from both participants and professionals.
Number and variability of outcomes of intervention	Outcomes can be dependent on uncontrollable factors such as exacerbations of pre-existing conditions. A range of physical and mental health outcomes are anticipated.
Interaction between components	The promotion of health behaviour and anticipated outcomes is dependent on effective exercise programmes at an appropriate intensity.
Number of groups and organisational levels involved	Programmes are delivered in a variety of settings with variation in organisational systems. There are practical considerations such as transport systems and programme leaders.

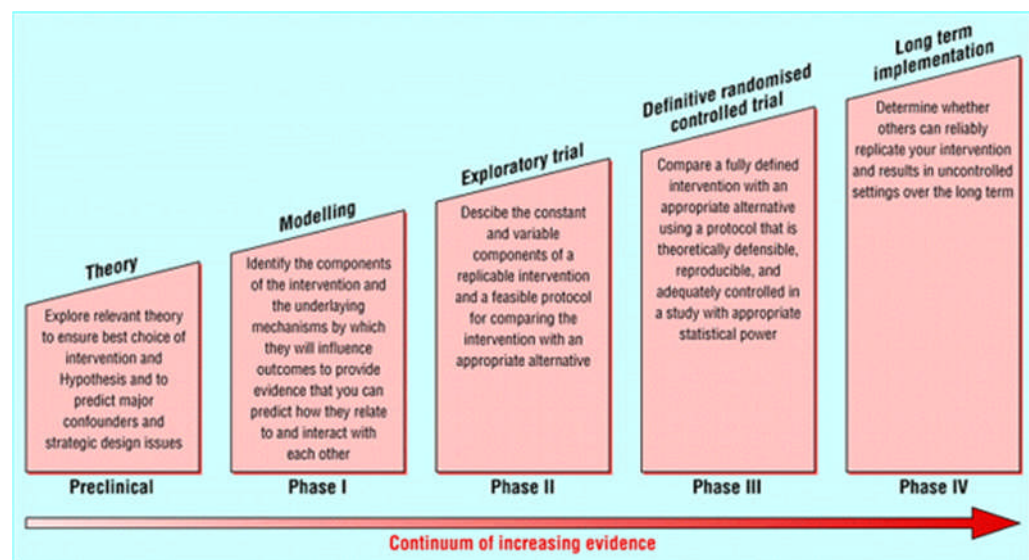
Modified from Craig et al [118]

## 2.2 Evaluating complex interventions

The need to develop a robust evidence base for complex healthcare interventions has led to an increased focus on developing and evaluating complex interventions. Very few healthcare interventions may be considered simple [118], however, it is acknowledged that evaluating interventions becomes more challenging as interventions become more complex [119]. As with all healthcare research, complex interventions require careful methodological consideration to ensure successful evaluation [120]. Complex interventions pose further challenges in their evaluation relating to standardising the intervention, accounting for issues of context and accounting for the interactions between components [120]. The understanding of complex interventions and why they work under

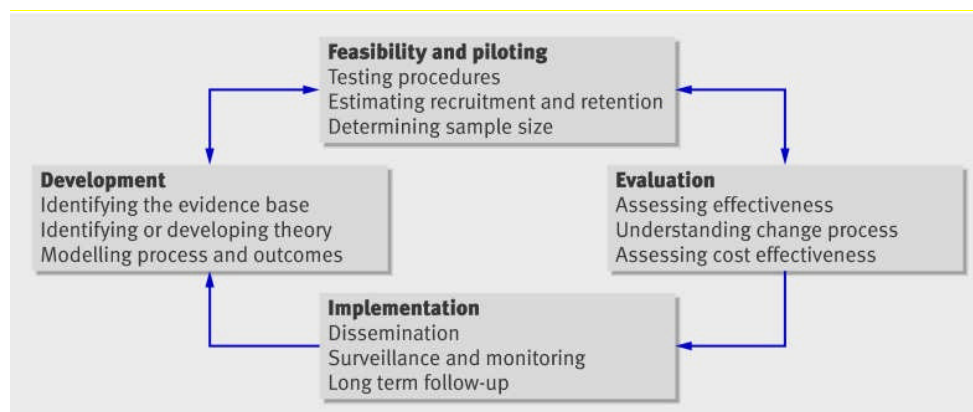
certain conditions is important to consider for successful implementation and replication. Effect sizes and significance levels may demonstrate if there has been a change after an intervention, but do not offer insight into how an intervention might work and which components are needed for which outcomes [121]. It is important to know not just whether the intervention has worked, but also when, why, how and in what context it might work in order to make the findings more widely applicable [119]. There is, therefore, a need to explore the causal mechanisms of interventions and establish how an intervention works as part of the evaluation process [118].

Given the challenges in evaluating complex interventions, the Medical Research Council (MRC) provided a framework to support healthcare researchers in the development and evaluation of complex interventions. The guidance which was first published in 2000 [122] is summarised in Figure 1. The framework was criticised for being too linear [3, 117] with disparate phases similar to drug development that did not reflect the complexity of applied healthcare interventions or real-world clinical settings. A lack of emphasis on the development phase of the process was considered a further limitation.



**Figure 1: MRC Framework (2000) for developing and evaluating complex interventions**

A revised version of the guidance was published in 2008 [3] drawing on further methodological and understanding and addressed some of the limitations outlined above. The revised guidance, outlined in Figure 2, focused on a cyclical model with the two-way directional arrows emphasising the iterative nature of the process. The guidance [3] suggests there are four main stages involved in the development and evaluation of a complex intervention; development, feasibility and piloting, evaluation, and implementation.



**Figure 2: MRC Framework (2008) for developing and evaluating complex interventions**

## 2.3 Developing complex interventions

The importance of rigorous intervention development was stressed in the revised MRC guidance [3] and the cyclical model described how the development of a complex intervention was not a disparate component but runs throughout all of the evaluation stages. There is also the need to consider all four components throughout anticipating the feasibility, evaluation and implementation of an intervention as part of the development process.

As outlined in Figure 2, the systematic development of a complex intervention requires several necessary conditions to be fulfilled:

**Identifying the evidence base-** an understanding of the existing literature that could inform the intervention needs to be established.

**Developing theory-** there should be a sound theoretical underpinning to support the mechanisms through which it is intended that the intervention will produce the desired outcome.

**Modelling processes and outcomes** - ensuring that the intervention can be delivered in practice, with outcomes that are compatible with the underlying theory and that it is acceptable to the intended participants.

If a complex intervention is sufficiently developed to ensure the underlying theories are robust and sufficiently modelled to demonstrate that the theories can be operationalised in practice formal evaluation is then justified. If there are inadequacies in the underlying theory, or the intervention is not coherently modelled, then further development work would be indicated prior to formal evaluation (as indicated by the two-way directional arrows in Figure 2).

## **2.4 Contribution of this thesis**

Chapter one outlined that chair based exercise may be an accessible form of exercise for older people with compromised health and mobility. As with other health care interventions chair based exercise had a limited theoretical basis, however, there was a belief that it was a possible solution to a clinical problem [121]. Chair based exercise interventions were poorly defined with little standardisation in practice and a lack of a clear rationale for their use. There was a lack of transparency regarding how interventions were expected to achieve the anticipated outcomes and identifying the existing evidence was difficult due to the lack of clarity over the parameters of the intervention. Formal evaluation through high-quality empirical research was limited by the lack of theoretically robust interventions. Further development of a chair based exercise intervention (PACE) was therefore indicated before progressing to rigorous high-quality evaluation.

This thesis focused on developing PACE as a complex intervention using the three key elements as outlined by MRC guidance [3]. Although the revised MRC framework emphasised the importance of rigorous intervention development there is little guidance on how to approach each of the elements [123]. Lakshman et al [124] suggest that the programme of development work should be informed by the current understanding of an

intervention and that not all stages may be necessary if there is existing robust evidence. The lack of understanding around chair based exercise as an intervention indicated that this needed to be the starting point for the development of PACE.

The programme of work is outlined below and the intervention development process summarised in Figure 3.

**1. Developing theory-** in view of the lack of understanding of chair based exercise the starting point to this work was to establish the underlying principles and define the parameters of the PACE intervention. This was done using a consensus development process (chapter three).

**2. Identifying existing evidence-** in view of the difficulty identifying chair based exercise literature a high-quality systematic review of existing evidence using the newly established theory was indicated (chapter four).

**3. Planning the PACE intervention-** to develop a transparent, theory-driven intervention a systems approach was used using the theories identified in chapter one, three and four. A logic model was applied to provide a visual representation of how the intervention was expected to work when delivered in a real-world community setting (chapter five).

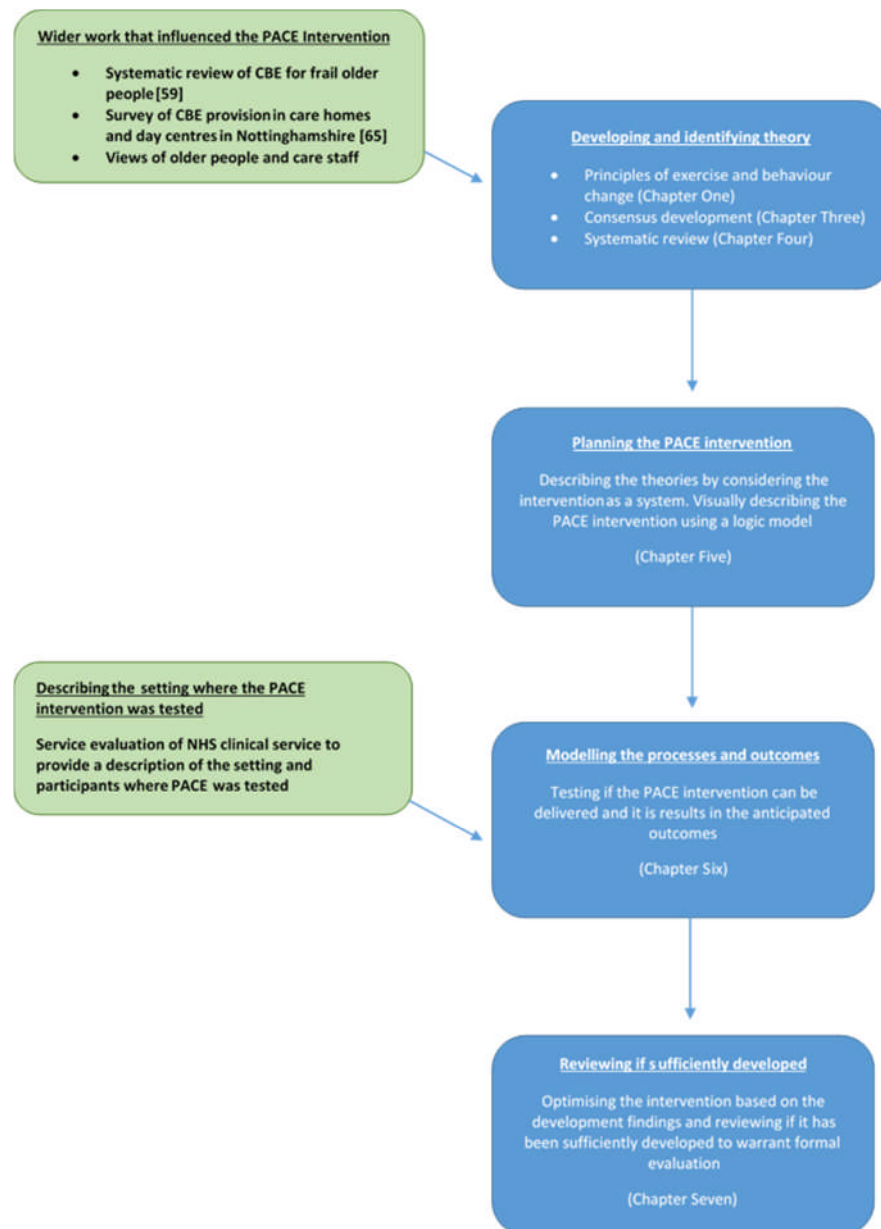
**4. Modelling processes and outcomes** –to determine if the PACE intervention was practicable and could be delivered in the way it had been planned and to determine if it resulted in the anticipated outcomes. This was done through a pre and post cohort study. The acceptability of the intervention was considered through focus groups with older people (chapter six).

Each component of the development process was conducted and analysed separately with appropriate methods chosen to address the specific research aims. It is however acknowledged that the process was iterative with findings from one component informing another.

The final chapter (chapter seven) reflects upon on whether the PACE intervention was theoretically sound and sufficiently modelled. An acceptable and feasible intervention would support progressing to formal evaluation and areas of this work would help to inform the design of a

definitive trial. Issues with acceptability and feasibility would indicate the direction for further developmental work.

In Figure 3 the development of the intervention which is presented in this thesis is detailed in the blue boxes. The peripheral green boxes represent the wider components of work which are discussed in chapter one (section 1.2.1) which will have influenced the development process.



**Figure 3: Summary of the PACE intervention development**

### **3 Chapter Three: Developing theory**

This chapter presents a consensus development process as the first stage in the development of the PACE intervention. This consensus development process has been published in BMC Geriatrics [125].

#### **3.1 Introduction**

As reported in chapter one, the only systematic review of chair based exercise in older people [59] found six studies [81-86] of poor methodological quality. The key findings from the review were; a lack of clarity over the definition, the purpose, and the expected benefits of chair based exercise, and a lack of understanding of when practitioners should use chair based exercise and what outcomes they should expect when they do so. In the absence of a strong evidence base, a consensus development technique was chosen to provide a basis for establishing the concept of the intervention [126]. Establishing a core set of principles which included a definition, purpose, delivery and expected outcomes was the starting point for developing the theory and parameters of the PACE intervention and to allow a subsequent review of the existing evidence.

#### **3.2 Aim**

This study aimed to use expert consensus to develop a core set of principles for the PACE intervention.

#### **3.3 Objectives**

The consensus development process was designed to meet the following objectives:

- Create a definition of chair based exercise
- Establish the purpose of chair based exercise
- Establish essential components of programmes and how it should be delivered
- Identify the anticipated benefits of chair based exercise programmes

## 3.4 Methods

### 3.4.1 Consensus methods

There is often ambiguity surrounding interventions within health and social care settings where there is a lack of high-quality research to guide practice [127]. The development of guidelines to support practice then has to rely on the views and experience of experts in the field [128]. Formal consensus methods can use the views and experiences of an expert group in a structured and planned way in order to develop practice [127].

It is recognised that consensus development methods are not a research methodology for creating new knowledge, instead, they draw on the best available knowledge and experience of experts [129]. Capturing this available knowledge does have its challenges with Murphy et al suggesting that although consensus development methods can '*capture collective knowledge*', they are also open to the risk of '*capturing collective ignorance*' [128] 1]. Despite the limitations, formal consensus developments have a role in drawing together the best available knowledge in the absence of clear evidence from high-quality primary research [130].

There are three main formal consensus development methods: the Delphi technique, the nominal group technique and the consensus development conference [128, 129]. These methods will be briefly discussed to justify the choice of method for this study.

A nominal group technique is a structured, face-to-face group interaction that is facilitated to generate individual ideas that are then discussed [131]. A consensus development conference is a face-to-face meeting with a group of experts that are presented evidence by a range of stakeholders [131]. The group of experts are often selected for their methodological expertise rather than their knowledge of the particular topic of interest. In contrast, a Delphi technique uses a structured survey to elicit the views of experts individually and the expert panel never meet face-to-face [128].

The differences and similarities of each of the methods are summarised in Table 6.

**Table 6: Overview of consensus development techniques**

	<b>Delphi technique</b>	<b>Nominal group technique</b>	<b>Consensus conference</b>
Structured questionnaires	Yes	No	No
Formal feedback to the group	Yes	Yes	No
Face-to-face	No	Yes	Yes
Open discussion amongst the panel	No	Yes	Yes
Anonymity between panel members	Yes	No	No
Criteria for determining consensus	Yes	No	No

Modified from Murphy 1998 [128]

There are advantages and disadvantages to each method. The practical issues of co-ordinating a busy group of experts to attend a nominal group or consensus development conference may limit the number and range of participants. This may be alleviated through a more flexible approach employed by a Delphi technique [128]. The nominal group method does however have the advantage of generating results more rapidly with all discussions held in one session [131]. It is recognised that effective nominal groups and consensus development conferences require a competent facilitator that can ensure all ideas are discussed in a balanced way [128].

The Delphi technique was chosen for this consensus development process as it allows for a broader research area to be explored which would have been limited in a one-off nominal group or consensus development conference. Co-ordinating a face-to-face group of busy experts that are not located in similar geographical locations may have impacted on the number of experts taking part and potentially excluded key stakeholders. In addition, a face-to-face meeting may have been influenced by the views of authoritative experts potentially minimising other views [132].

### **3.4.2 The Delphi technique**

The Delphi technique is a well-recognised consensus method used to determine the extent of agreement on an issue [133]. It is an iterative process and characterised by several aspects:

- Anonymity - participants are not aware of each other as they never meet face-to-face. This can reduce the potential risks of dominant experts influencing the opinions of other participants which may be an issue in face-to-face discussions [132].
- Multiple iterations of a similar survey tool - the survey tool is refined after each round in view of the responses to move towards a consensus [129].
- Feedback between rounds – participants are provided with feedback between each round to provide context in further rounds. Controlled feedback allows participants to make judgements within the context of previous rounds of the survey tool which may provide further understanding on the issue [132].
- Statistical assessment of consensus scoring – a pre-defined method for determining consensus to allow a transparent and objective approach [132].

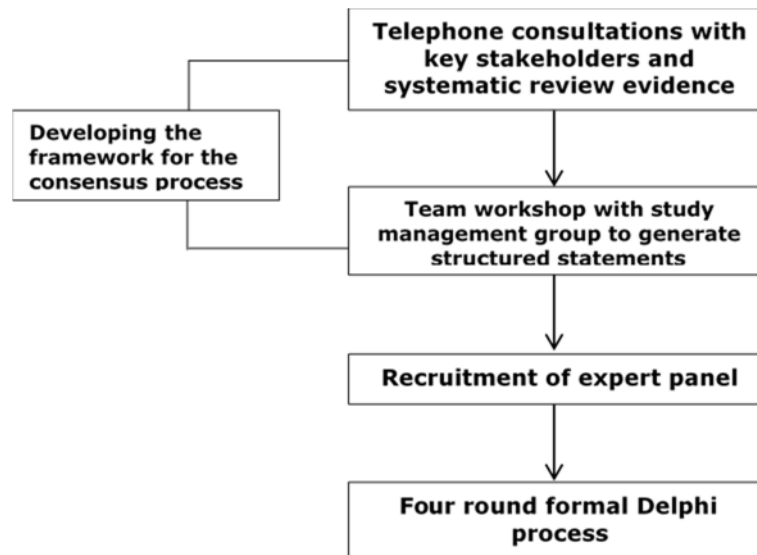
### **3.4.3 Ethical approval**

Ethical review and NHS permissions were not required for the stakeholder consultations which was confirmed by the relevant NHS organisation as this was not considered research and recruitment was not through the NHS. In line with good clinical practice, an information sheet (Appendix B) was provided before each consultation to ensure stakeholders were fully informed of the process and their involvement.

Ethical approval for the Delphi technique was obtained from the University of Nottingham Medical School ethics committee (Appendix C). NHS ethics was not required as participants were not recruited through their NHS roles.

### **3.4.4 Overview of the process**

Figure 4 provides an overview of the study process with each section then discussed in further detail.



**Figure 4: Overview of the study process**

### **3.4.5 Framework for the Delphi technique**

It is acknowledged that the first round of a traditional Delphi technique uses open questioning to identify the focus of the process [134]. Modifying the Delphi technique is, however, considered appropriate to ensure that the methodology is appropriate for the study aims rather than shaping the study aims to fit the methodology. In this study, a modified approach to developing the framework for the formal consensus was used. This approach was chosen to manage the breadth of open data anticipated in this consultation process and then allow formal consensus development in a manageable, pragmatic way.

The focus and scope of the consensus process was determined through a review of current literature [59] and consultation with eleven stakeholders (two academic geriatricians, four exercise physiologists/scientists, two physiotherapists representing AGILE (professional group of physiotherapists working with older people), two exercise instructors, one physiotherapist delivering chair based exercise). Consultations comprised of telephone discussions with open questioning about key areas around chair based exercise. The stakeholders were identified from a review of the current literature and professional networks. In addition, stakeholders were asked during the consultation about any experts or groups that also needed to be included.

Statements for round one of the Delphi technique were generated by the study management group in a team workshop held on the 27/03/13, which comprised seven clinical researchers (two physiotherapists, one occupational therapist and four geriatricians) with an interest in rehabilitation for older people. This approach has been used successfully in other Delphi techniques [135].

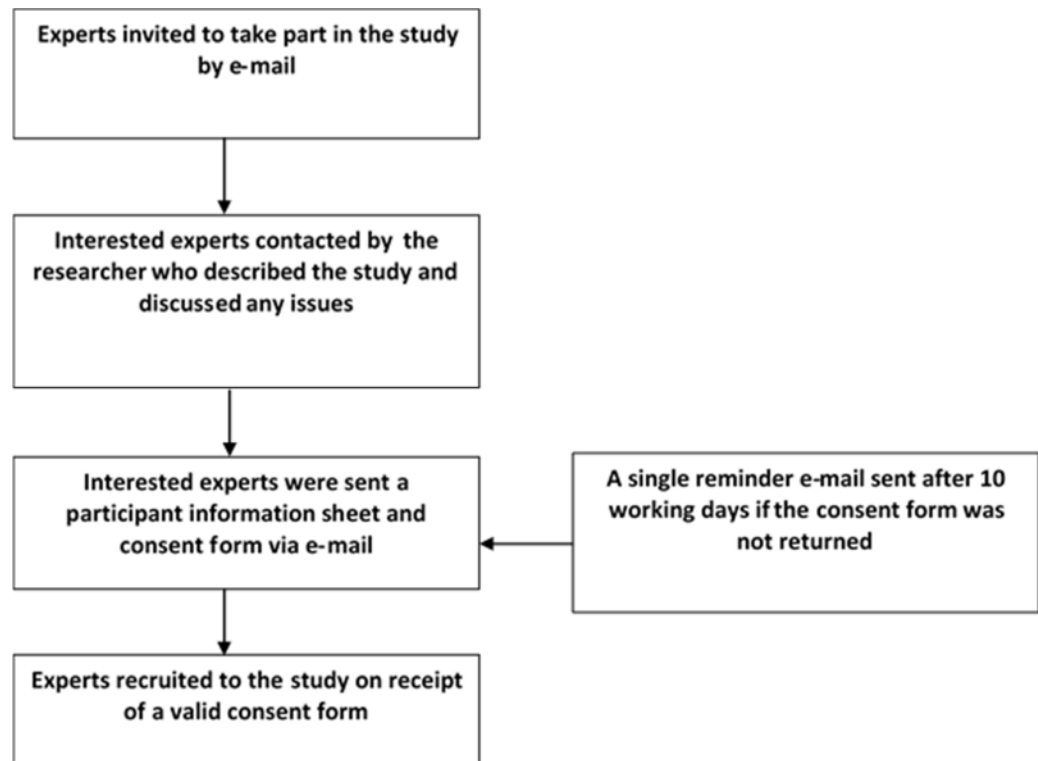
#### **3.4.6 Recruitment of the expert panel**

To reflect the complexity and variety of expertise involved in the delivery of chair based exercise for older people, a purposive sampling strategy was developed to recruit experts involved in chair based exercise from a variety of different clinical and professional settings. A mixed group of experts was used to ensure that all relevant aspects of a chair based exercise were explored [131] and to allow for different perspectives to be considered [134].

It is acknowledged that defining and selecting experts for a Delphi technique is a challenging process and may require a pragmatic approach that is appropriate to the study aims [136]. For this study, an expert was defined as anybody with knowledge and experience of chair based exercise programmes in an elderly population. However, this was not limited to a clinical setting and included experts with an academic background, exercise instructors and experts working in the voluntary and social care sectors. Experts were selected from specialist professional groups (e.g. Chartered Society of Physiotherapy Older People Network-AGILE, British Geriatrics Society, College of Occupational Therapists Older People Specialist Section), leading providers in chair based exercise training programmes (e.g. LaterLife Training Limited, EXTEND), charitable organisations involved in supporting older people (e.g. Age UK) and prominent clinicians and academics identified through a review of the literature.

In total, 25 UK based experts in the field of chair based exercise for older people were invited to take part by an individual e-mail and provided with a Participant Information Sheet (Appendix D). Experts were asked to provide a summary of their experience and expertise in the field prior to being included in the study by telephone or via e-mail. All willing experts returned a completed consent form either by post or e-mail prior to the consensus development process. This approach was considered more

appropriate than meeting the participants face-to-face, as the experts were in a wide range of geographical locations. Figure 5 provides an overview of the recruitment process.



**Figure 5: Overview of expert panel recruitment process**

### **3.4.7 Survey procedure**

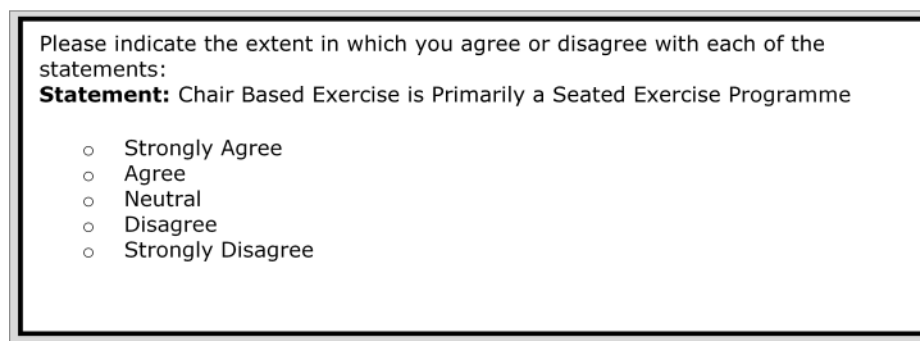
An electronic communication method (e-mail and the Survey Monkey web-service) was chosen as a practical way of allowing experts to complete each round at a convenient time within the specified deadline and has been used successfully in other studies [137, 138].

The electronic survey allowed participants to remain anonymous from each other. Anonymity supports the generation of responses which are free from the bias introduced by the issues of group dynamics, which can be problematic in face-to-face discussions [136].

Participants were given one week to complete each round with a reminder e-mail sent at one week and two weeks after this deadline. If a participant had not completed the round at this point, they were excluded from further rounds of the process to ensure that the remaining participants received the next questionnaire in a timely manner.

To ensure strong retention of expert involvement, an upper limit of four rounds of investigation was set [139]. It is also acknowledged that having a planned number of rounds is an indicator of good quality when facilitating a Delphi technique [140].

Each survey tool consisted of a series of structured statements constructed so that responders could rate their level of agreement using a five-point Likert scale. Open response questions were also used to allow participants to comment freely on each statement. Figure 6 presents an example statement and scoring.



Please indicate the extent in which you agree or disagree with each of the statements:

**Statement:** Chair Based Exercise is Primarily a Seated Exercise Programme

- ☐ Strongly Agree
- ☐ Agree
- ☐ Neutral
- ☐ Disagree
- ☐ Strongly Disagree

**Figure 6: An example of statement scoring**

### **3.4.8 Between rounds analysis**

As outlined the Delphi technique is an iterative process that uses repeated communication to refine expert opinion on a specific topic and move towards an accepted level of consensus. It was therefore, necessary to analyse and review the findings of each round and revise the survey instrument for the following round. Procedures used in this process were:

- A summary of the panel scoring was presented for each statement in the following round. This panel scoring included the level of agreement of each statement along with a text summary of the comments given in the previous round. This provided a context for participants to inform their rescoring to the revised survey instrument.
- Any statement which reached consensus (agreement or disagreement) was removed from rescoring in further rounds of the survey unless the free text comments indicated modifications.

- Statement that did not reach consensus and the free text comments supported the removal of a statement were removed from re-scoring in future rounds.
- Statements where consensus was reached, were modified where the free text comments indicated this was appropriate. This statement was then re-scored in the following round and participants were given the opportunity to provide open text comments. This was considered appropriate as even though consensus had been reached, further improvements to the statements may be achieved through the views of the expert panel.
- The wording of statements was modified where appropriate to reflect any comments from participants. This statement was then presented back to the panel in the following round for rescoring and comments.
- New statements were formulated based on comments and when further clarification was needed.

### **3.4.9 Determining consensus**

Determining consensus is '*one of the most contentious components*' [141], p. 1528] of the Delphi technique with measurements of consensus varying in published literature. Measurement includes establishing a certain percentage level of agreement, measures of central tendency (mean, median and mode) and dispersion (standard deviation) and inferential statistics. The criteria for determining consensus should be established by the research team relevant to the study aims [141]. The use of a pre-defined certain level of agreement was considered appropriate for this study as the aim was to develop a core set of principles for chair based exercise that was to be further developed and evaluated. It is acknowledged that this is a simple method for determining consensus but was sufficient for the scope of this study.

There is no universally accepted threshold for defining consensus as part of the Delphi process, with thresholds for consensus ranging from 55% to 100% in the published literature [133]. A predefined consensus level is an indicator of good quality Delphi techniques [133] and the consensus level is influenced by the study aims [142]. A 70% threshold was considered appropriate for this study and is consistent with other research using a

Delphi technique [143, 144]. Statements were considered to be principles to support the development of the PACE intervention when 70% of the expert group agreed. Agreement was established by the combined score of strongly agree and agree or strongly disagree and disagree. Further statistical analysis, such as the median, which is common in Delphi techniques [131] was not conducted. This was not considered appropriate to the aims of the study as the inclusion of principles was already established through the pre-defined agreement level. The level and extent of agreement for each principle were not the focus of the study.

### **3.5 Results**

#### **3.5.1 Formulation of Delphi statements**

Statements were constructed within seven key areas based on the current literature and the stakeholder consultation process (defining, potential benefits, intended users, components, safety, delivery, evaluation). Each statement was discussed at length by the study management group, all of whom agreed on the final set of 42 statements (Appendix E). An additional area of '*tailoring of exercises*' was identified in the workshop with some statements being moved into that category for the first round of the process. An example of the development of the statements relating to 'defining' is presented in Appendix F.

#### **3.5.2 Response rate**

Twenty-five experts were invited to take part and seventeen (68%) agreed to do so. A 100% response rate ( $n = 17$ ) was achieved in round one and a 94% response rate ( $n = 16$ ) for rounds two, three and four. Reasons for declining to participate or not completing the process included time constraints and a perceived lack of expertise. These reasons were obtained from asking potential participants via e-mail at the point of declining to take part.

#### **3.5.3 Participants**

Of the twenty-five experts invited, seventeen participants took part in the modified Delphi technique. They represented a range of health care professions including six physiotherapists, two occupational therapists, two chair based exercise leaders, one rehabilitation consultant, one clinical

exercise specialist, one older people's lead at the British Heart Foundation National Centre for Physical Activity and Health, three academics in the field of exercise for older people (one from a sport science, one from a physiology department and one from a nursing department) and one older persons' specialist nurse. The experts worked in a range of settings including NHS acute and community services, private exercise training providers, social care, academic institutions and The Care Inspectorate, Scotland. Experts represented a range of professional bodies including AGILE-the Chartered Society of Physiotherapy Older People's Network, the British Geriatrics Society, College of Occupational Therapists Older People's Specialist Section, and Admiral Nurses specialising in dementia care.

### 3.5.4 Summary of rounds

The results for each round are presented in Table 7. The four rounds of investigation took a total of five months.

A summary of analysis from each round was sent with the survey of the next round to provide context. An example of the summary between rounds two and three for one statement is provided in Appendix G.

**Table 7: Summary of rounds**

	<b>Round 1</b>	<b>Round 2</b>	<b>Round 3</b>	<b>Round 4</b>
<b>Total number of statements</b>	42	22	10	4
<b>Primary aim of round</b>	Exploratory	Exploratory and clarifying	Exploratory and clarifying	Confirmatory
<b>Reached consensus (&lt;70%) and accepted</b>	22 (52%)	16 (73%)	4 (40%)	4 (100%)
<b>Reached consensus and revised based on comment</b>	6	3	1	0
<b>Removed</b>	3	0	2	0
<b>Did not reach consensus and revised</b>	11	3	3	0
<b>New statement</b>	5	4	0	0

Table 7 presents a summary of the scoring for each round and outlines the following:

- Total number of statements that participants were asked to score and comment on.
- Statements that reached 70% agreement and were accepted in each round.
- Statements that reached the 70% consensus, however, comments indicated that wording changes would improve the clarity and were therefore revised and included in the following round to be re-scored. An example is presented in Figure 7.
- Statements that were removed as they did not reach consensus and the free text comments supported the removal of the statement. An example is presented in Figure 8.
- Statements that did not reach consensus and comments suggested changes to the statement were modified and included in the following round to be re-scored. An example is presented in Figure 9.
- New statements that were generated from the free text comments and suggestions from participants. An example is the generation of a statement regarding whether GP's should be consulted prior to an older person taking part in a chair based exercise programme. This statement was created as one participant suggested the study '*... ought to consider and gain consensus on whether a GP must be informed when people start a programme or not*'.

Round One Statement (Please do not rescore)

Chair Based Exercise is beneficial for improving muscle strength and mobility

- Strongly Agree (64.7%)
- Agree (23.5%)
- Neutral (11.8%)
- Disagree (0.0%)
- Strongly Disagree (0.0%)

*Although there is high level of agreement with this statement comments indicated there was agreement for chair based exercise improving strength however there were some concerns over the improvement in mobility. This statement has therefore been revised to differentiate between these two components.*

Please rate the extent to which you agree or disagree with the following two statements:

1. Chair based exercise is beneficial for improving muscle strength
  - Strongly Agree
  - Agree
  - Neutral
  - Disagree
  - Strongly Disagree
2. Chair based exercise is beneficial for improving mobility
  - Strongly Agree
  - Agree
  - Neutral
  - Disagree
  - Strongly Disagree

**Figure 7: Example of a revised statement that had reached consensus**

Round One Statement (Please do not rescore)

Chair Based Exercise is beneficial for reducing pain

- Strongly Agree (11.8%)
- Agree (41.2%)
- Neutral (41.2%)
- Disagree (5.9%)
- Strongly Disagree (0.0%)

*Scoring identified high level of neutral responses with comments suggesting that it is difficult to specify if chair based exercise is beneficial in reducing pain. Statement was considered too generic in relation to complexities of pain management.*

**Figure 8: Example of a removed statement**

Round One Statement (Please do not rescore)

Strength training should be done using resistance bands

- Strongly Agree (11.8%)
- Agree (23.5%)
- Neutral (52.9%)
- Disagree (11.8%)
- Strongly Disagree (0.0%)

*Feedback identified that there is no need to be so prescriptive about the equipment using for strength training as other methods (such as weights, body resistance) are just as valid if used appropriately. This statement has therefore been revised to include the additional methods for strength training.*

Please rate your level of agreement or disagreement with the following statement:

Strength training can include the use of resistance bands, weights and body weight resistance

- Strongly Agree
- Agree
- Neutral
- Disagree
- Strongly Disagree

**Figure 9: Example of a revised statement that had not reach consensus**

### **3.5.5 Summary of results**

Consensus was reached on forty-six statements relating to seven domains of chair based exercise: definition, intended users, potential benefits, structure, format, risk management and evaluation. These domains were identified by the initial telephone consultations and the team workshop of the study management group in the development of the framework for the process. The domains were reworded in some cases to reflect the full range of statements and for clarity. These changes included:

- Components changed to structure
- Delivery changed to format
- Instructors and safety changed to risk management
- Tailoring was integrated into each of the domains.

All statements that reached consensus are presented in Table 8 within the seven domains.

**Table 8: Summary of accepted statements**

	<b>Statement</b>	<b>% of agreement</b>	<b>Consensus reached</b>
<b>Definition</b>	CBE should be considered as part of a continuum of exercise for frail older people where progression is encouraged	100	Round 2
	CBE should be used flexibly to respond to the changing needs of frail older people	100	Round 2
	The purpose of using a chair is to promote stability in both sitting and standing	87.5	Round 2
	Where possible CBE should be used as starting point to progress to standing programmes	76.5	Round 1
	CBE is primarily a seated exercise programme	75.0	Round 2
<b>Intended users</b>	CBE can be considered as part of a progressive falls exercise pathway with the aim of progressing to evidence-based standing programmes	93.8	Round 2
	For use with older people who are unable to carry out standing exercises as a consequence of an acute medical problem from which they might improve and progress to weight bearing exercises	88.2	Round 1
	For use with older people with an activity limitation who cannot participate in other forms of exercise	76.5	Round 1
<b>Structure</b>	The delivery of sessions and exercises can be tailored to individual preference within a structured programme	93.8	Round 2
	All CBE programmes should include progressive resistance training that is tailored to the individual	93.8	Round 2
	Each session should begin with an appropriate warm up	88.2	Round 1
	Music can be beneficial as part of programmes if used appropriately and it is welcomed by participants	87.5	Round 2
	Strength training can include the use of resistance bands, weights and body weight resistance exercises	87.5	Round 2
	Cardiovascular interval training should be performed to prevent fatigue, if appropriate and tailored	87.5	Round 4
	Participants should be encouraged to work at an intensity which is appropriately challenging for them	86.0	Round 3
	Each session should include developmental stretches	82.3	Round 1
	Each session should end with an appropriate cool down	82.3	Round 1
	Each session should include a component of strength resistance training, endurance training and cardiovascular fitness	76.5	Round 1
	Strength training should be targeted to meet nominated programme aims	76.5	Round 1
	Cardiovascular training should be performed at a moderate intensity for all participants	76.5	Round 1

	Statement	% of agreement	Consensus reached
<b>Format</b>	Each session should be carried out at least once a week	94.1	Round 1
	Rolling programmes are appropriate with new participants joining at any point	94.1	Round 1
	Gradually building up the duration of sessions can be beneficial for frail older people with reduced exercise tolerance	93.8	Round 2
	Each session should last no longer than an hour	88.2	Round 1
	Programmes should be tailored to meet individual needs	88.2	Round 1
	The goal of CBE should be clearly defined for each individual participant	88.2	Round 1
	The number of CBE sessions should be tailored to the individual needs of the participants	81.3	Round 2
	Each CBE session should be a minimum of 10 minutes long with a view to increasing further	75	Round 4
<b>Risk management</b>	All programmes should be run by a suitably skilled and trained leader	100	Round 1
	Instructors should have knowledge and skills of working with frail older people	100	Round 1
	Programmes do not have to be delivered by healthcare professionals	94	Round 1
	An individual health assessment should be carried out prior to commencing a CBE programme	93.8	Round 4
	Instructors should be aware of medical conditions which could disqualify participation or which require careful monitoring throughout sessions on the grounds of safety	87.5	Round 2
	CBE training programmes need to be regulated to ensure that they meet the agreed training curriculum	86.0	Round 3
	All instructors should have completed a regulated CBE training programme	81.3	Round 4
<b>Evaluation</b>	Participants of CBE should be encouraged to actively feedback on each session	100	Round 3
	Participant-reported outcome measures are useful for evaluating the effectiveness of programmes	94.1	Round 1
	If CBE's are undertaken for health gains, a standardised outcome measure should be used routinely throughout programmes to evaluate effectiveness	70.6	Round 1
<b>Potential benefits</b>	If tailored appropriately CBE can be beneficial in improving the following:		
	- mood and well-being	100	Round 1
	- certain activities of daily living	93.8	Round 2
	- mobility around joints	93	Round 3
	- social interaction	88.2	Round 1
	- muscle strength	88.2	Round 2
	- certain personal activities of daily living	87.5	Round 2
	- co-ordination	78.3	Round 3
	- confidence with activities of daily living	70.6	Round 1

Five statements were removed throughout the process due to not reaching the threshold for consensus and the thematic analysis of the free text responses. One statement was removed from the definition domain in round three, one statement was removed in the intended users' domain in round 1, and two statements were removed in the potential benefits domain in rounds one and three and one statement was removed in the structure domain in round one. All statements that were removed are presented in Table 9.

**Table 9: Removed statements**

	Statement	Consensus	Selected comments
<b>Definition</b>	Chair based exercise can include static standing exercises Once dynamic standing exercises are included this is no longer considered chair based exercise	68.75	<i>'I wouldn't describe sit-stand as static' 'unsure whether static is the correct word to use'</i>
			<i>'unsure whether static is the correct word to use'</i>
			<i>'Do you mean by static that both feet remain in a fixed position' 'a chair was designed to sit in, and stand up from- beyond that we are stretching the purpose'</i>
<b>Intended users</b>	Encouraged for older people who are concerned about stability in movement	64.71	<i>'If we offer CBE to all people with concerns about stability it will become the default!'</i>
<b>Potential benefits</b>	Chair based exercise is beneficial for reducing pain	52.94	<i>'Depends on the source of the pain'</i> <i>'Is there any evidence relative to pain management?'</i>
	Chair based exercise is beneficial for improving ambulation	68.75	<i>'Think we have to be very careful, if CBE is CBE (i.e. seated) therefore is not going to improve standing activity'</i>
<b>Structure</b>	Chair based exercise programmes should ideally be carried out in a group environment	52.94	<i>'Neutral because some people will not want to be in a group and others will not be able to get to a group'</i>
			<i>'Group environments are best as the social interaction can be a vital component of adherence and motivation - however home exercises can be just as effective if carried out correctly and maybe with supervision'</i>

From the accepted statements at the end of the modified Delphi process, the study management group constructed a definition of chair based exercise which was emailed to the expert panel. This definition was modified following minor comments from the expert panel and the final definition was approved by fourteen of the sixteen Delphi panel experts (87.5%).

Chair based exercise has been defined by this process as:

*'a primarily seated, structured and progressive exercise programme that is part of a continuum of exercise for older people, which uses a chair to provide stability, and is delivered by instructors that are suitably skilled and trained to work with frail older people'.*

## **3.6 Discussion**

### **3.6.1 Summary of findings**

Consensus was reached on forty-six statements relating to seven domains of chair based exercise: defining, intended users, potential benefits, structure, format, risk management and evaluation. This provided the basis on which to develop the PACE intervention.

### **3.6.2 Strengths and limitations**

The consensus threshold of 70% achieved the desired effect of allowing the process to be completed, without participant drop-out, within four iterations. Agreement for most statements exceeded 70% by some degree. However, at this threshold, the findings must be taken as the best achievable consensus given the current lack of robust evidence in the field, rather than as evidence of absolute unanimity. A limitation is that the views of older people were not included in the consensus process, however, the focus of the work was influenced by the views of older people as outlined at the start of this thesis.

The focus and findings of this study were influenced by the perspectives of the author, the stakeholder group and the consulted experts, who were clinicians and experts in the delivery of chair based exercise. The framework for round one was developed by a study management group in consultation with experts which will have influenced the scope of the process. This modified Delphi technique may have introduced bias from experts when rating the structured statements in round one. Experts may have responded more favourably to the predefined statement rather than to iterate a statement of their own. In addition, experts in exercise for older people may not be entirely impartial in their appraisal of chair based exercise as they have already invested and engaged with the concept which may have led to more favourable responses. Nevertheless, only 52%

of statements were accepted in round one and opportunity was given for experts to freely comment on all statements and propose new themes and statements.

However, despite these limitations the Delphi technique appears to have provided a fair representation of the expert practitioner view of chair based exercise, as a mixed group of experts spanning health and social care, voluntary and private sector groups as well as academia were consulted. The established principles offered a framework on which develop the PACE intervention.

### **3.6.3 Principles of the PACE intervention**

The complexities of developing PACE as an intervention were highlighted with a clear agreed definition of chair based exercise proving challenging. Several rounds of consultation were required to reach a level of agreement regarding the scope of chair based exercise for older people. It is clear that many experts do not want chair based exercise to be regarded as the default exercise programme for all older people without appropriate justification and progression. These concerns are reflected by the expert discussions with a reluctance to commit to a predefined and prescriptive amount of seated activity within a programme. Instead, comments centred on the need to consider appropriate progression to more challenging and dynamic standing programmes to maximise health benefits. The definition established in this process does, however, offer a framework for the PACE intervention, outlining that it is primarily a seated programme that uses a chair to provide stability. This framework allows chair based exercise to be adapted to meet the changing needs of older people in the appropriate setting and perhaps a more prescriptive model would have limited applicability across community settings.

Chair based exercise has been used as a control in research studies testing exercise interventions and is often described as low-level exercise [145] suggesting that it may be viewed as a default option for older people with limited effectiveness. This consensus process suggests that chair based exercise is appropriate for older people who are unable to take part in other forms of exercise due to activity limitation, which may be acute or longer term. Experts predominantly working in the healthcare sector stressed the importance of progression for all users of chair based exercise

– whether it is to standing exercise programmes or a progressively challenging seated programme. Progressively challenging programmes are supported by evidence of effective exercise delivery for older people [82].

The results suggest that the duration of exercise sessions should be ten minutes or longer, and include progressive resistance (strength) training and moderate intensity cardiovascular exercise. This is broadly in line with the UK national exercise guidance for older people [13]. The consensus achieved here differs from the national guidance by stating that a minimum programme should be one session per week, lasting up to an hour, whilst national recommendations require programmes to achieve 150 minutes of moderate-intensity exercise per week, with daily activity recommended. However, these national guidelines are generic covering all types of exercise in a variety of patients, whilst chair based exercise, as defined in this study, is useful for those who cannot participate in other forms of exercise and therefore a less intensive approach in this context may be reasonable. Other advice, such as from the British Heart Foundation National Centre for Physical Activity and Health [15], supports lower intensity programmes in patients unable to tolerate higher intensity exercise with a view to progressing intensity and duration when able. It is important to consider that the expert views may not be based on up to date knowledge of the physiological principles of exercise for older people and may draw more on experiences. Further development of the principles of the PACE intervention is therefore needed to ensure it is compatible with the principles of exercise for older people.

People participating in the PACE intervention may well be sedentary for much of the time when they are not doing exercise and present with multiple health needs. Thus, although the consensus statements have defined a programme that might be expected to achieve worthwhile health benefits, consideration of how the programme can be implemented and how to support participation is needed.

Exercise has been shown to have wide-ranging health benefits for older people and the potential benefits offered by chair based exercise are broadly in line with this evidence [13, 34, 43]. It is, however, important to recognise that for some intended users of chair based exercise interventions, for example, those with a chronic long term condition, the

likely outcomes may be different. From a physiological perspective chair based exercise may offer a way of protecting against the progression of musculoskeletal frailty rather than having a restorative role. Comments relating to maintaining functions were identified by experts however, the agreed principles did not reflect this role of chair based exercise.

Managing the potential risks of chair based exercise programmes was considered important by the expert panel and ensuring appropriate training and regulation was commented on throughout, often being raised in domains outside risk management. Consensus was however not reached on a minimum qualification required for instructors as this impacted on the volunteers and support workers that are currently trained to deliver programmes. Instead, an agreement was reached on having regulated chair based exercise training programmes that follow an agreed curriculum to improve standardisation and quality. It is acknowledged that health professionals and instructors influence the attitudes and beliefs of older people to exercise [146] and there is evidence to imply that instructors have different attitudes depending on the setting in which they work and whether they predominantly deliver seated or standing programmes [147]. A greater focus on the training for instructors which encourages positive attitudes towards seated programmes is essential to ensure that older people are able to take part in programmes that are delivered by well-trained and motivated instructors and who have the appropriate skills to deliver programmes in line with the established principles.

### **3.7 Conclusions**

A definition for chair based exercise for older people has been suggested based on clinical expert opinion which has previously been lacking in the literature. Agreement was reached on a set of principles of chair based exercise for older people through a Delphi technique with a mixed group of experts. These principles provided the framework to develop the PACE intervention.

The next chapter will use this definition to identify the existing evidence based through a systematic review as part of the development of the PACE intervention.

## **4 Chapter Four: Identifying existing evidence**

This chapter presents a systematic review of the health benefits of chair based exercise for older people. The definition of chair based exercise developed in chapter three was used to identify eligible exercise interventions from the literature.

### **4.1 Introduction**

In line with the MRC guidance [3], the development of a complex intervention should be informed by the existing evidence base. Craig et al [118] recommend that if there is not already a high-quality systematic review available then this is something that should be carried out as part of the development of a complex intervention. A systematic review on the benefits and harms of chair based exercise was published in 2013 with a specific focus on frail older people [59] and identified six papers [81-86] evaluating chair based exercise interventions (outlined in chapter one). However, there were limitations in the search strategy, such as the use of an incomplete list of search terms, which may partly have arisen due to an incomplete definition of chair based exercise. Since the 2013 review, the consensus study in chapter 3 has established a definition and framework for chair based exercise programmes [125] which provided a definition to help identify the existing evidence. This was the next stage in developing the PACE intervention.

### **4.2 Aim**

The aim of this review was to collate what was already known about chair based exercise programmes for older people, to inform the development of the PACE intervention.

### **4.3 Objectives**

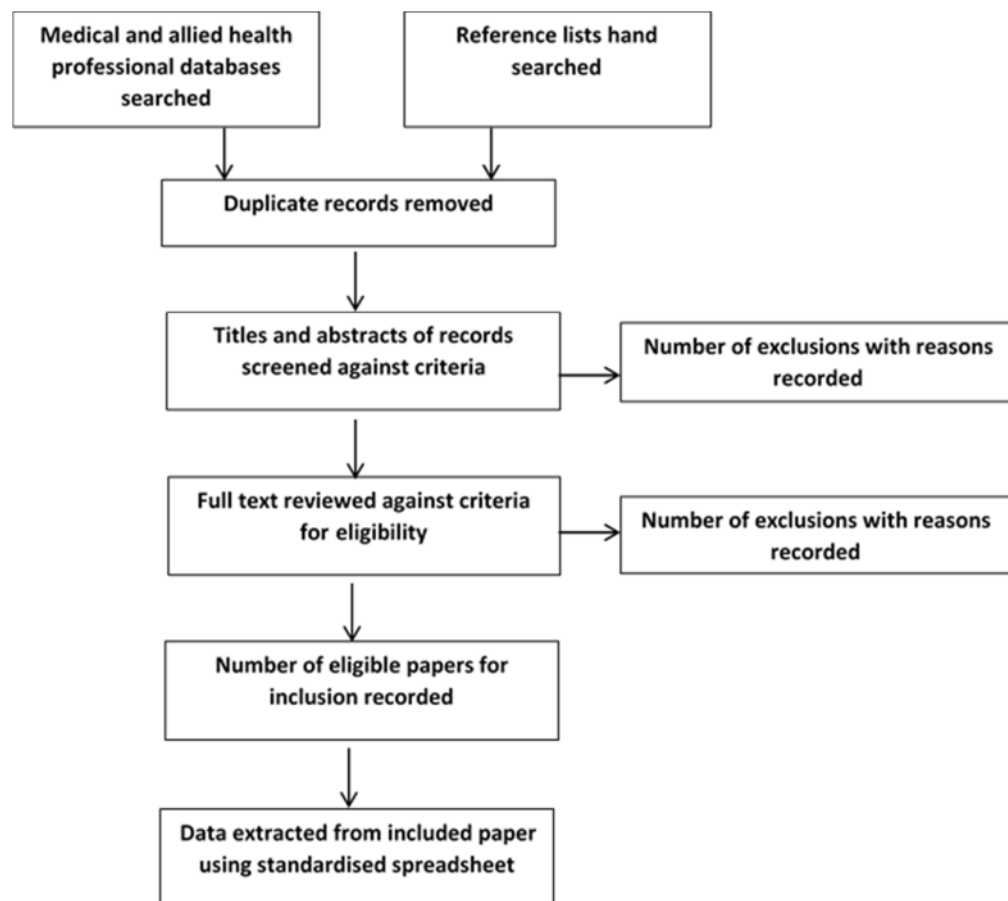
The objectives of this review were:

- To identify the quantity of literature on chair based exercise for older people
- To appraise the quality of literature on chair based exercise for older people

- To explore outcomes used to evaluate chair based exercise for older people
- To synthesise the available literature to determine the impact of chair based exercise on physical and mental health outcomes

## 4.4 Methods

The review followed the principles of conducting a systematic review as outlined by the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) checklist [148]. A protocol was developed in line with the PRISMA guidelines (Appendix H). A summary of the methods is provided in Figure 10 with further details provided under the headings below.



**Figure 10: Summary of methods**

#### 4.4.1 Eligibility criteria

Studies were considered to be eligible for inclusion using the following criteria:

- Types of studies: Randomised controlled trials. As outlined in the protocol in the absence of sufficient randomised controlled trials then other study designs would be considered.
- Types of participants: Adults aged 65 years and over are considered to be older people in physical activity guidelines [13]. Studies were, therefore, included where the mean and standard deviation indicated the majority of participants were 65 years and over. Studies of chair based exercise that were primarily applied to younger groups, such as wheelchair athletes and spinal rehabilitation, were not of interest in this review.
- Types of exercise programmes: Studies where the intervention was considered to be primarily seated using the following consensus definition from the Delphi technique (chapter three):

*'a primarily seated, structured and progressive exercise programme that is part of a continuum of exercise for older people, which uses a chair to provide stability, and is delivered by instructors that are suitably skilled and trained to work with frail older people'.*

Programmes that used a chair to promote stability in sitting and standing were considered chair based exercise based on the consensus understanding [125]. Programmes that included a significant component of walking, unsupported standing exercises or used resistance training machines were excluded.

- Types of outcome measures: Studies that included any of the following outcomes were eligible for inclusion as identified by experts in chapter three.
  - Physical health such as mobility, muscle strength and activities of daily living using a validated tool.
  - Mental health such as depression, anxiety and behaviour using a validated tool.

#### **4.4.2 Search strategy**

The search strategy was developed to answer the question:

*What are the physical and mental health benefits of chair based exercise for older people?*

The broad concepts of exercise, older people and chair based exercise were defined and searched separately and then combined. Limitations of a previous review identified the difficulties in searching for chair based exercise as a full phrase which was rarely cited in titles and abstracts [59]. Keywords of chair, seated and sitting were therefore selected to ensure a full search of the literature. Keywords from the papers identified in a previously published review [59] also shaped the search strategy with the inclusion of keywords such as rehabilitation. The search strategy was constructed to include all older people. The term frail elderly was included as a search term but was not a limiting factor to ensure that the search remained as broad as possible and was not limited to frailty, which is difficult to define and identify in the literature [149].

It was acknowledged that this strategy may reduce the specificity and result in a large proportion of literature not being relevant to the review question [150]. The search strategy was deliberately broad to ensure all relevant literature was identified and to reduce the limitations identified by the previously published review [59].

The search strategy for MEDLINE, CINAHL, AMED and PsychINFO is presented below:

1. Exercise/
2. Exercise.mp
3. Exercise therapy/
4. Exercise therapy.mp
5. Rehabilitation/
6. Rehabilitation.mp
7. Aged/
8. Frail Elderly/
9. Frail elderly.mp
10. Older people.mp
11. Elderly.mp
12. Chair.mp
13. Seated.mp
14. Sitting.mp
15. 1 or 2 or 3 or 4 or 5 or 6
16. 7 or 8 or 9 or 10 or 11

- 17. 12 or 13 or 14
- 18. 15 and 16 and 17
- 19. Limit 18 to 65 years and over

Other keywords relating to exercise such as aerobic, strength training and cardiovascular were not included in the search. This was to ensure the search was kept as broad as possible encompassing all types of exercise.

The reference lists of the included studies were searched to ensure all relevant literature was considered.

#### **4.4.3 Data sources**

The following databases were searched: MEDLINE, Cumulative Index to Nursing and Allied Health Literature (CINAHL), PsychINFO, Cochrane, DARE, Health Technology Assessment (HTA) reports, NHS Economic Evaluation Database, PEDro and the Allied and Complimentary Medicine Database (AMED). Databases were searched from the date of their inception to 24/09/2015. The reference lists of papers were hand searched and included where they met the inclusion criteria. The databases were chosen as subject specific databases relevant to therapeutic exercise and older people to ensure a comprehensive review of available literature and were discussed with a local information specialist prior to the review.

MEDLINE is a bibliographic database covering biomedicine and health which map to Medical Subject Headings. The database covers international research in the field of medicine and was relevant to this review.

CINAHL and AMED were selected as primary databases relating to nursing and allied health professional research journals, as chair based exercise can be considered a rehabilitation intervention and is predominantly therapy led.

PEDro is a database relating to all aspects of physiotherapy which was considered appropriate for the chair based exercise intervention in this review.

PsychINFO is the primary database for mental health and behaviour change and was selected to ensure articles relating to mental well-being were identified as an outcome of the review.

DARE, Health Technology Assessment (HTA) reports, NHS Economic Evaluation Database were searched to identify systematic reviews, systematic review protocols and on-going research. It was acknowledged that results from these databases may duplicate those from MEDLINE, AMED and the Cochrane library but this would ensure full coverage by the search and identify systematic reviews for the reference lists to be searched.

The Cochrane review library was included to identify any relevant systematic reviews of which the reference lists were searched for appropriate papers.

#### **4.4.4 Study selection**

The process of selecting studies was carried out independently by two reviewers (KR -author and VH -second supervisor). Titles and abstracts were screened by the two reviewers against the eligibility criteria to identify articles to retrieve in full.

Full articles were reviewed by the two reviewers against the inclusion criteria. Reasons for exclusion were recorded based on a pre-defined classification system (Appendix I). This was to ensure a standardised approach to study selection and reporting of exclusions.

Disagreements were resolved by the independent assessment of a third reviewer (TM- clinical supervisor).

#### **4.4.5 Data extraction**

Data was extracted systematically from the included studies independently by each reviewer using a standardised spreadsheet which included: setting, participant characteristics, detail on the structure and format of the intervention, detail on the control, reported health benefits, attendance rates and adverse events.

#### **4.4.6 Quality appraisal**

A numerical scale, such as the Jadad scale [151], was not considered appropriate to assess the quality of the studies based on recommendations from the Cochrane Systematic review handbook [152]. This handbook suggests that scales can lead the reviewer to look more at the reporting of the trial rather than whether it has been conducted properly. For example,

a scale may ask if the paper reports how participants have been allocated but does not allow for a judgement on the quality of this allocation and if it is appropriate for the study design.

Instead, a two-stage approach to assessing the quality of the studies was conducted:

1. Critical Appraisal Skills Programme (CASP) checklist
2. Categorisation of quality using the Cochrane risk of bias tool and the sample size

Firstly the Critical Appraisal Skills Programme (CASP) checklist for randomised controlled trials (Appendix J) was completed for each study. The CASP tool provided an approach for assessing the quality of the literature, considering the findings within the clinical context of the research [153]. It has been used in reviews of healthcare interventions [154] and practice guidelines [155] to explore the quality of the evidence.

With randomised controlled trial literature, it was important to consider how the risk of bias had been limited [152] as the reliability of the results is dependent on a rigorously conducted study [156]. The Cochrane review handbook identifies five areas where the risk of bias needs to be considered: selection, performance, attrition, detection and reporting bias [152]. The Cochrane Collaborations tool was used to assess the risk of bias [152], quality of the paper and confidence in the findings. It was conducted across each study. The CASP tool was used to provide evidence for the risk of bias judgements.

Assessing the risk of bias per outcome for each study was considered as certain domains of bias may be influenced by the type of outcome measures [152]. For example, outcomes that require active participation (such as muscle strength measures) may be more open to performance bias if participants are aware of the group allocation and the study outcomes [152]. The outcomes in this review were all potentially influenced by participants and researchers being aware of group allocation as they required active completion of test protocols or questionnaires. A risk of bias for each outcome for each study was therefore not conducted.

A quality statement based on the risk of bias summary and the sample size (of completed participants) was made independently by each reviewer in order to synthesise the quality assessment tools. The studies were categorised into good research quality, medium research quality and low research quality using the following pre-defined criteria:

Assumptions:

- An unclear risk of bias was considered the same as a high risk of bias as the reviewers were unable to assess the risk given the reporting in the paper and the judgements from the CASP tool
- Each type of bias was considered equal
- A small sample was considered 30 (or less) completed participants

Assessment criteria:

- Good – no or only one risk of bias, sample size > 30
- Medium – no or only one risk of bias and sample size <30 or two or three risks of bias, any sample size
- Low – four or more risks of bias, any sample size

#### **4.4.7 Data synthesis**

A meta-analysis was considered as a way of synthesising the data from the studies to draw conclusions about the evidence for chair based exercise [157]. However, it was not possible in this review as there was substantial variation across the studies. This variation occurred at a clinical level where there were differences between the participants, settings, outcome and interventions across the included studies [158]. In addition, there was methodological diversity with differences in study designs leading to variation in the study quality and robustness of the findings. Conducting a meta-analysis with these variations may have led to unreliable conclusions and a narrative synthesis of the data was reported. A narrative synthesis is a method of synthesising the results of multiple studies using words and text to summarise the findings, rather than using statistical pooling of data [159]. A narrative synthesis needs to go beyond description and provide an '*analysis of the relationships within and between the studies*' [158], p. 48]. As this type of synthesis is a more subjective process, a transparent and rigorous approach was required [158].

For the narrative synthesis in this review, the interventions were described to examine the range and pattern of use of the components of chair based exercise programmes. The reported effects for each outcome (e.g. strength, mobility, balance) were synthesised using a systematic process which is summarised in Table 10.

Where possible, the significance and size of the effect were extracted to allow for a transparent approach to synthesis. The robustness of the evidence for each outcome was assessed using the quality appraisal summary for each study (described in section 4.4.6). This allowed for an assessment of the effect of chair based exercise for each outcome based on the good quality evidence identified.

**Table 10: Example of narrative synthesis**

Author	Sample size	Quality	Statistical significance	Data reported	Effect size	Interpretation
Baum [81]	20	Medium quality	Significant difference (p=0.013)	Cohen's d effect size	Berg Balance Score= 0.32	Small effect on balance
Latham [160]	222	Good	No significant difference (p > 0.05)	Between group difference and 95% CI	<u>Berg balance score</u> = -1 (-4-2)	No clinically meaningful effect

Where the means and standard deviations were provided in the papers, the standardised mean difference, also known as the effect size, was calculated. A standardised mean difference allows comparison of the effects across studies where different methods are used to measure an outcome [161]. Cohen's d effect size was used as this is an appropriate method for calculating the standardised mean difference [162] where means and standard deviations of two groups are reported. Cohen's d is the difference between the two groups' mean divided by the pooled standard deviation [163].

Where the means and standard deviations were provided in the included papers, the data was assumed to be normally distributed unless otherwise stated.

The following standard formulae were used to calculate the Cohen's d effect sizes [161].

Where the mean and standard deviations were presented for the exercise and control group after the intervention had been delivered:

$$d = \frac{X_1 - X_2}{SD_{pooled}}$$

Where  $X_1$  is the mean post-intervention score for the exercise group and  $X_2$  is the mean post-intervention score for the control group.

The pooled standard deviation was calculated using the following formula:

$$S_{pooled} = \sqrt{\frac{s_1^2 (n_1 - 1) + s_2^2 (n_2 - 1)}{n_1 + n_2 - 2}}$$

Where the standard deviations and means of the pre and post-intervention scores of the exercise and control groups were presented, the following formula was used:

$$d = \frac{\Delta_1 - \Delta_2}{SD_{pooled}^{**}}$$

\*Where  $\Delta_1$  and  $\Delta_2$  are the pre-post mean differences for each group calculated as  $\Delta = X_{post} - X_{pre}$

\*\* The SD pooled used the raw standard deviations from the pre and post test data using the following equation to calculate  $s_1$  and  $s_2$  and then the pooled standard deviation equation above was used:

$$S_j = \sqrt{\frac{S_{pre}^2 + S_{post}^2}{2}}$$

Where the mean change and standard deviation for the change were presented, the effect size was not able to be calculated without knowing the correlation between the two time points. As this was not provided, the effect size was not calculated when this type of data was presented.

The size of the effects was considered against the following criteria [164]:

- 0.20= small effect
- 0.50= moderate effect
- 0.80= large effect

Where the means and standard deviations were not provided in the paper or the data was stated as not being normally distributed, appropriate data was extracted to identify the effect of the intervention. These included the median/mean change and 95% confidence intervals (CI) and the between-group differences.

## 4.5 Results

The search strategy resulted in 2618 papers being identified and these were reviewed for eligibility. A summary of the search results and screening is presented below in Figure 11. The 20 included studies are summarised in Table 11.



**Figure 11: Summary of results**

**Table 11: Characteristics of the included studies**

Author	Country	Setting	Participants	Intervention	Attendance	Control
Baum [81]	USA	Long-term care facility	Over 65, able to ambulate with/without device or assistance of one carer.  <u>Mean age</u> Exercise = 88 (75-96) Control = 88 (78-99)	Upper and lower body strengthening. 1 set of 5 increased to 2 sets of 10 as tolerated.  3/week for 12 weeks Delivered in a group	Exercise = 80%  Control = 56%	Recreational group run by art therapist or social worker
Boshuizen [165]	The Netherlands	Welfare centres	Community-dwelling older people experiencing difficulty rising from a chair. Excluded if maximum knee extension torque exceeded 87.5 newtons.  <u>Mean age</u> High guidance = 80 ±6.7 Medium guidance = 79.30±7.0 Control = 77.2±6.5	Strength training -concentric, eccentric and isometric knee extension exercises. 9 exercises (7 in a chair, 2 behind chair). Resistance progressed once 8 repetitions achieved. <b>High guidance group-</b> 2 supervised and one home based session. <b>Medium guidance group-</b> 1 supervised and 2 home based sessions.  3/week for 10 weeks Delivered in a group	High Guidance = 79%  Medium Guidance = 72%	Asked to remain habitually active

Author	Country	Setting	Participants	Intervention	Attendance	Control
Brittle [166]	England	Care homes	65 years and over, reduced mobility indicated by a Barthel Index score less than or equal to 16/20.  <u>Mean age</u> Exercise = 87 ±6.99 Control = 82 ±9.98	Warm up, cool down, flexibility, sitting balance, posture, co-ordination, strengthening of major muscle groups, cardiovascular exercises. Prescription and progression by a physiotherapist.  2/week for 5 weeks Delivered in a group	Participants attended a mean of 3.61 sessions out of 8 prescribed sessions. 18% of participants attended all sessions.	Usual Care
Bonura [167]	USA	Senior living community facility	Independent for personal care, assistance with transportation, cleaning and cooking  <u>Mean age</u> =77.04 ±7.28	<b>1. Chair Yoga</b> Hatha Yoga, meditation, asana (yoga physical exercises), pranayama (breathing exercises) <b>2. Chair Fitness</b> Paralleled physical movements of the asana's selected for chair yoga, gentle stretching, cool down, challenging strength and balance exercises. Considered CBE for this review  1/week for 6 weeks Delivered in a group	All participants attended at least 4 out of the 6 sessions.  Yoga participants attended a mean= 5.7 sessions and chair fitness a mean = 5.03	Waiting list and offered same classes after study

Author	Country	Setting	Participants	Intervention	Attendance	Control
Chen [168]	Taiwan	Nursing homes	65 years and over, using a wheelchair for mobility, resident for over 3 months, cognitively intact, heavily or moderately dependency on activities of daily living measured by the Barthel Index).  <u>Mean age</u> = 79.15 ±7.03	Elastic band. 2 Levels (3 months each level): <b>1. Basic-</b> 3 phases - Warm up, aerobic and harmonic stretching. 4 elastic band exercises in each phase. <b>2. Advanced-</b> basic with additional 2 elastic band exercises per phase.  3/week for 6 months Delivered in a group	94.51%	Usual care (no elastic band exercises)
Dechamps [169]	France	Long term care	65 and over, ability to get up alone or with technical or human help.  <u>Mean age</u> =82.3 ±9.1	<b>1. Adapted Tai Chi (AT)</b> Adapted standing yoga with multidirectional weight shifting. Not considered CBE for this review. <b>2. Cognition-action (CA)</b> - Seated warm up, lower limb and upper body movements. Back of chair used for any standing exercise. Seated passing of ball and deep breathing exercises. Considered CBE for this review.  2/week for 6 months Delivered in a group	AT= 38.8%  CA= 48.9%	Usual care with no restriction in any other healthcare support
Holliman [170]	USA	Geriatric psychiatry facility	Primary diagnosis of dementia, planned to be on unit for duration of study.  <u>Age range</u> = 65-89	Interactive physical activities included passing a bean bag, playing balloon volleyball. Activities designed to train gross and fine motor skills and also designed to be purposeful.  2/week for 3 weeks Delivered in a group	Not reported	Not detailed

Author	Country	Setting	Participants	Intervention	Attendance	Control
Karl [171]	USA	Intermediate Care Facility	Intermediate care patients, some deficit in self-care.  <u>Median Age</u> = 73 (62-95)	Range of movement exercises of arms and legs, ball throwing.  2/week for 4 weeks Delivered in a group	Not reported	Attended movies
Latham [160]	New Zealand and Australia	Hospital and at home	Over 65 admitted to geriatric rehabilitation units.  <u>Mean Age</u> = 79.1 ±6.9	Quadriceps resistance exercises with adjustable ankle cuff. 3 sets of 8 repetitions.  3/week for 10 weeks Individual home based	82%	Frequency matched telephone calls and home visits
McMurdo [172]	Scotland	Long term care home	Care home residents. Excluded only with severe communication difficulties.  <u>Mean Age</u> = 81 (range 63-91)	Seated exercise involving all major joints of upper and lower limbs through full range of movement.  2/week for 7 months Delivered in a group	Exercise= 91% Control= 86%	Reminiscence Therapy
McMurdo [109]	Scotland	Long term care homes	Care home residents able to toilet, dress and walk independently.  <u>Mean Age</u> = 83 (67-98)	All seated exercises. Isometric exercises designed to strengthen major muscle groups and improve flexibility and tone.  2/week for 6 months Delivered in a group	Exercise= 72% Control= 62%	Reminiscence Therapy

Author	Country	Setting	Participants	Intervention	Attendance	Control
Mills [173]	USA	Community facility	Convenience sample from two apartment complexes.  <u>Mean age</u> Exercise = 75.25±7.04 Control = 74.78±6.14	Seated flexibility exercises for the legs. Seated knee extension with no resistance. Standing heel raises and knee bends whilst holding the chair.  3/week for 12 weeks Delivered in a group	Not reported	Normal activity
Seynnes [174]	France	Nursing homes	Nursing home residents aged over 70 who were ambulatory and able to follow simple instructions.  <u>Mean age</u> = 81.5± 1	3 sets of 8 repetitions of knee extension exercises in sitting. High-intensity group trained at 80% of 1RM, low-intensity group at 40% of 1RM and placebo control had empty ankle cuffs.  3/week for 10 weeks Delivered in a group	High and low intensity exercise = 99%  Control = 89%	Placebo control with empty weight cuff
Skelton [75]	UK	Research setting-muscle function laboratory	Women aged 75 and over, medically fit to exercise.  <u>Mean age</u> = 79.5 (75-93 years)	All exercise was done seated included strengthening and stretching of main muscle groups.  1/week supervised for 12 weeks with an additional 2 unsupervised session a week. Supervised session delivered in a group.	Median number of sessions attended = 35.5	No active control but asked not to perform more or less activity than they did before

Author	Country	Setting	Participants	Intervention	Attendance	Control
Van de Winckel [84]	Belgium	Psychiatric hospital	<p>Dementia, Mini-Mental State Examination (MMSE) lower than 24/30, able to respond to verbal or visual commands, be able to mimic movements of the therapist and to hear music. Excluded if unable to remain in sitting position for 30 minutes.</p> <p><u>Mean age</u>  Exercise = <math>81.33 \pm 4.24</math>  Control = <math>81.90 \pm 4.18</math></p>	<p>Seated in a circle. One step verbal instructions. Music chosen with consideration to age. Exercises focused on upper and lower body strengthening, balance, trunk movements and flexibility training.</p> <p>Daily for 3 months  Delivered in a group</p>	Not reported	Conversations
Venturelli [175]	Italy	Nursing home	<p>Nursing home resident aged over 65. Dependent on assistance in more than one activity of daily living according to the Barthel Index and MMSE 15-25. Serious mobility limitation (maximal score of 5 on the Performance-Orientated Mobility Assessment index).</p> <p><u>Mean age</u>  Exercise group = <math>83.3 \pm 6.7</math>  Control group = <math>84.1 \pm 5.8</math></p>	<p>Upper limb exercise class seated in a wheelchair. Warm up exercises using sticks and ball for flexibility, strength circuit training using weights and elastic resistance band, static stretching. Exercised progressed when able.</p> <p>3/week for 12 weeks  Delivered in a group</p>	74.8%	Standard care

Author	Country	Setting	Participants	Intervention	Attendance	Control
Vogler [176]	Australia	Home based	Adults over 65, discharged from hospital within 3 months. No cognitive impairments and medically fit to exercise.  <u>Mean age</u> = 80 ±7	<b>1. Seated strength training:</b> Individualised resistance exercise with cuff weights and exercise bands to target hip flexion, abduction, knee flexion and extension and ankle plantar and dorsiflexion. Considered CBE for this review. <b>2.Weight-bearing exercises:</b> Individualised programme of weighted exercise belt heel raises, partial squats, sit to stands and stepping forwards and sideways onto blocks 10-12 reps. Additional WB exercises were reaching and leaning in standing, step taps, pelvic hitches, tandem stance and getting up from the floor. Not considered CBE for this review.  3/week for 12 weeks Individual home based	Seated group = 70%  Weight-bearing group = 62%	Social group
Webber [177]	Canada	Community facility	Women aged over 70 with self-reported mobility limitation.  <u>Mean age</u> = 75.0 (70-88)	<b>1. Weights group:</b> 3 sets of 8-10 repetitions of 80% 1RM concentric dorsi flexion and plantar flexion. Loads progressed every 2-3 weeks. <b>2. Bands groups:</b> 3 sets of 8 to 10 reps concentric DF and PF using a resistance band. Concentric phase performed as fast as possible and eccentric slowly controlled. Resistance progressed every 2-3 weeks.  2/week for 12 weeks Delivered in a group	63%	Neck stretches (not considered CBE for this review)

Author	Country	Setting	Participants	Intervention	Attendance	Control
Witham [83]	UK	Community facility then home based	<p>Adults <math>\geq 70</math> with chronic heart failure (New York Heart Association Class 2 or 3), able to walk without human assistance.</p> <p><u>Mean age</u>  Exercise = <math>80 \pm 6</math>  Control = <math>81 \pm 4</math></p>	<p>Seated exercise programme: warm-up movements, upper limb exercises, lower limb exercises, slow whole body aerobic exercises and quicker whole body aerobic exercises, set to music. Supervised exercise for 3 months then home exercise programme with telephone support for 3 months.</p> <p>2/week for 15 weeks  Delivered in a group</p>	82.7%	Normal activity
Yamada [178]	Japan	Community facility	<p>Community dwelling, 65 and over. Able to walk independently and have access to transportation. No severe cognitive impairments or significant hearing and vision problems.</p> <p><u>Mean age</u>  Exercise = <math>83.0 \pm 6.7</math>  Control = <math>82.9 \pm 5.5</math></p>	<p>Exercise class using a DVD. 15 minutes of basic seated exercise including stretching, strengthening and agility training. 5 minutes of dual task seated stepping using a verbal fluency task whilst repeatedly stepping.</p> <p>2/week for 24 weeks  Delivered in a group</p>	87.5%	Normal activity

### 4.5.1 Quality appraisal

The Cochrane risk of bias summary for each paper is presented in Figure 12. Variation in the quality of both the conduct and reporting was evident in this review. Areas of concern included blinding of outcome assessors, allocation concealment and unclear reporting of methods and results. The quality appraisal for each study is presented in Table 12 along with a justification based on the quality assessment process.

	Random sequence generation (selection bias)	Allocation concealment (selection bias)	Blinding of participants and personnel (performance bias)	Blinding of outcome assessment (detection bias)	Incomplete outcome data (attrition bias)	Selective reporting (reporting bias)	Other bias
Baum 2003	+	+	-	+	?	+	
Bonura 2014	?	?	-	-	?	?	
Boshuizen 2005	?	?	-	+	-	+	
Brittle 2009	+	+	-	+	+	+	
Chen 2015	+	+	-	?	+	+	
Dechamps 2010	+	+	-	+	+	+	
Holliman 2001	?	?	-	?	-	+	
Karl 1982	?	?	-	?	?	-	
Latham 2003	+	+	-	+	+	+	
McMurdo 1993	+	+	-	-	?	+	
McMurdo 1994	+	+	-	?	+	+	
Mills 1994	?	-	-	?	-	+	
Seynnes 2004	?	?	-	-	-	+	
Skelton 1995	+	?	-	-	+	+	
van de winckel 2004	+	?	-	+	+	+	
Venturelli 2010	?	?	-	+	+	+	
Vogler 2009	+	+	-	+	+	+	
Webber 2010	+	+	-	+	+	+	
Witham 2005	+	+	-	+	+	+	
Yamada 2011	+	+	-	+	+	+	

**Figure 12: Risk of bias summaries**

**Table 12: Summary of quality appraisal of included studies**

<b>Paper</b>	<b>Quality statement</b>	<b>Justification</b>
Boshuizen [165]	Low quality	Unclear risk of selection bias from a lack of detail regarding randomisation and allocation concealment, high risk of performance bias with participants aware of group allocation, low risk of detection bias with therapist guiding the training not acting as outcome assessor. High dropout rate with 23 drop outs from 73 consented. 18 drop-outs from exercise groups and a lack of detail about the analysis of dropouts. High risk of attrition bias as 6 month follow up not reported due to confounding of study with participants at one centre starting another exercise programme. Larger sample (n= 49).
Bonura [167]	Low quality	Unclear risk of selection and detection bias with a lack of detail regarding randomisation, allocation concealment and blinding of assessors. Participants self-completed questionnaires and were not blinded to group allocation. The same instructor delivered the chair yoga and exercise group. No reporting on the numbers and drop outs in each group. Large sample (n= 114).
Holliman [170]	Low quality	Unclear risk of selection and detection bias with a lack of detail regarding randomisation, allocation concealment and blinding of assessors. Unclear reporting of numbers and drop outs in each group. Small sample (n= 14).
Karl [171]	Low quality	Unclear or high risk across all domains due to a lack of clear reporting and detail and unable to make judgements. No raw data provided. Small sample (n= 19).
Mills [173]	Low quality	Unclear risk of bias as lack of detail regarding block randomisation and concealment from allocation, high risk of performance bias as participants aware of allocation and unclear risk of detection bias from a lack of detail on the blinding of the assessor. Larger sample size (n= 47).
Seynnes [174]	Low quality	Unclear risk of selection bias from lack of detail on sequence generation and allocation concealment, high risk of performance and detection bias with outcome assessor's not blinded, high risk of attrition bias as not stated how drop outs analysed and which group they dropped out from. Small sample (n= 22).
Baum [81]	Medium quality	High risk of performance bias with participants aware of allocation and exercise and control delivered in same setting. Semi-cross over design with control participants receiving exercise group after 6 months. No control for 9 and 12 month follow up data. Unclear risk of attritions bias with 13% of repeated measures missing due to participant inability to perform due to illness however unclear at which time point this occurred and if across all measures. Small sample size (n= 20).
Chen [168]	Medium quality	High risk of performance and detection bias from a lack of blinding of outcome assessors. Low risk of bias in other domains. Large sample size (n= 127).

<b>Paper</b>	<b>Quality Statement</b>	<b>Justification</b>
McMurdo 1993 [172]	Medium quality	Low risk of selection bias with computer generated random numbers of randomisation and sealed envelopes supplied by study co-ordinator. High risk of detection and performance bias with the same physiotherapist delivering both intervention and control and completing the outcome assessments. Unclear risk of attrition bias with differences in the reporting on the numbers and dropouts in each group. Larger sample size (n= 41).
McMurdo 1994 [109]	Medium quality	High risk of detection and performance bias with the same physiotherapist delivering both intervention and control and completing the pre-study assessments. Unclear on whether the pre-assessments were before randomisation or whether the researcher was aware of the allocation and then delivered the intervention. Low risk of bias in other domains with blinded outcome assessors at follow up. Larger sample size (n= 55).
Skelton [75]	Medium quality	Unclear risk of selection bias with no detail on allocation concealment. High risk of performance and detection bias with participants and assessors not blinded to group allocation. Low risk of bias in other domains. Larger sample (n= 40).
van de Winckel [84]	Medium quality	Low risk of bias across most domains apart from unclear risk of allocation concealment and blinding of participants which is not possible with the intervention. Small sample size (n= 25).
Venturelli [175]	Medium quality	Unclear risk of selection bias, high risk of performance bias which was not possible due to intervention. Low risk of bias in all other domains Small sample size (n= 30).
Brittle [166]	Good quality	Low risk of bias across most domains apart from blinding of participants which is not possible with the intervention. Large sample size (n= 56).
Dechamps [169]	Good quality	Low risk of bias across most domains apart from blinding of participants which is not possible with the intervention. Large sample size (n= 161).
Latham [160]	Good quality	Low risk of bias across most domains apart from blinding of participants which is not possible with the intervention. Large sample size (n= 222).
Witham [83]	Good quality	Low risk of bias across most domains apart from blinding of participants which is not possible with the intervention. Large sample size (n= 75).
Webber [177]	Good quality	Low risk of bias across most domains apart from blinding of participants which is not possible with the intervention. Large sample size (n= 50).
Yamada [178]	Good quality	Low risk of bias across most domains apart from blinding of participants which is not possible with the intervention Large sample size (n= 84).
Vogler [176]	Good quality	Low risk of bias across most domains apart from blinding of participants which is not possible with the intervention. Large sample size (n= 171).

Examples of well-conducted trials with a low risk of bias and larger sample sizes included Latham et al [160], Webber et al [177], Vogler et al [176], Witham et al [83], Yamada et al [178], Brittle et al [166] and Dechamps et al [169]. Issues with reporting were identified in several papers [167, 171, 173, 174] limiting the confidence in the findings due to a lack of transparency and an unclear risk of bias. Karl [171] provided little detail on the randomisation technique, sequence allocation, level of blinding, and outcome measure data and no p values or raw data were reported. This lack of detail makes it difficult to judge the benefits of the intervention and whether these can be applied to a clinical context. As identified by the Cochrane Collaboration [152] there is a difference between the quality of the reporting and the quality of the conduct. However, a lack of detail on many study aspects means the reviewer is unclear of the potential risk, limiting the judgement of the findings.

Blinding at all levels within the studies may have been difficult as participants would be aware if they were undertaking an exercise intervention. Performance bias may, therefore, be difficult to limit. However, Baum et al [81] carried out a cross over design to try to reduce this bias and to try to improve recruitment by not withholding treatment from participants. Following the cross-over all participants in the study were carrying out the exercise programme and as such there was no control group in which to compare findings for the final 6 months of the study. Seynnes et al [174] attempted to reduce the risk of bias from participants by using empty ankle cuffs in the control training group. There was, however, still a risk of the research team being aware of the treatment allocation when fitting the empty ankle cuffs and participants being aware that no weight was used.

Randomisation was at the level of two residences in the paper by Mills et al [173], with a lack of detail over the generation sequence and allocation concealment. With only two residences randomised, there was the potential for a high risk of selection bias and it was likely the allocation was known to researchers.

The good quality evidence as identified by the quality assessment process was used to synthesise the most reliable and robust findings.

### 4.5.2 Settings

The range of settings is summarised in Table 13. Care homes (n=8) and community facilities (n=7) were the most common settings for programmes to be delivered. Seynnes et al [174] did not clearly report the setting where the exercises were conducted, however, recruitment was from nursing homes and this study has therefore been categorised as being completed in a care home.

**Table 13: Settings of included studies**

Setting	Number	Studies
Care homes	8	[81, 109, 166, 168, 169, 172, 174, 175]
Community facility	6	[83, 165, 167, 173, 177, 178]
Healthcare facility	3	[84, 170, 171]
Home based	2	[160, 176]
Research setting	1	[75]

### 4.5.3 Participants

The number of participants recruited ranged from 14 [170] to 243 [160], with a total of 1478 across all twenty randomised controlled trials and a mean of 74 participants recruited.

All included studies, with the exception of Karl [171], used 65 years of age as the lowest threshold for inclusion (see Table 11). Participants ranged from 62 [171] to 102 [160] years across the included studies. Twelve studies [81, 83, 84, 109, 165, 166, 169, 172, 174-176, 178] reported a mean age (across the sample or in a control or exercise group) of 80 years and over, with the highest mean of 88 years reported by Baum et al [81].

The mobility and function of participants, and the methods for assessing these varied across the included studies (see table 11). The Barthel Index was used in three studies [166, 168, 175] as a method for determining the study population. Other criteria included using a wheelchair for mobility [168] or having difficulty rising from a chair [165]. In contrast, some authors identified more able participants such as Yamada et al [178], where participants had to be able to walk independently and have access to their own transport to be eligible for inclusion.

#### **4.5.4 Risk management**

The exercise programmes were delivered by a range of instructors, however, the type of instructor or level of qualification was not always clearly stated. Where reported, instructors included physiotherapists/physical therapists (n=9) [83, 84, 109, 160, 165, 166, 172, 176, 177], exercise physiologists (n=2) [81, 175], volunteers or care staff (n=1) [168] and exercise instructors (n=2) [167, 169]. One study used a DVD to demonstrate the exercise programme [178].

Eight studies [75, 83, 160, 168, 174, 175, 177, 178] reported excluding participants based on contraindications to exercise, or conditions that would be adversely affected by the exercise intervention. Although excluding participants on medical grounds was common in the included papers, there was very little detail on how this was performed. Where detail was provided, methods for obtaining medical history included self-reporting by participants [165, 178] and assessment by a physician [160, 175]. Common contraindications included unstable or severe cardiovascular disease, and symptomatic rheumatoid and osteoarthritis.

In contrast, a health screening was not used by Bonura et al [167] to exclude participants but to allow the programme to be tailored to individuals based on their medical history. McMurdo and Rennie [109] also reported that participants were not excluded based on their medical history as all older care home residents should have access to appropriate exercise programmes.

#### **4.5.5 Adverse events**

Adverse events were reported on in twelve [75, 83, 109, 160, 168, 169, 172, 174-178] of the twenty studies. Of these, seven authors stated there were no adverse events with the exercise intervention [83, 109, 168, 169, 172, 174, 175]. Eight studies [81, 84, 165-167, 170, 171, 173] did not clearly report on adverse events.

Latham et al [160] reported an increased risk of musculoskeletal injury as an adverse event with progressive resistance training in the frail elderly (n= 18 in the exercise group, n= 5 in control; risk ratio= 3.6, 95% confidence interval- 1.5-8.0) suggesting potential risks in this population. As only 25% of the participants were reported by Latham et al [160] to

have reached high intensity training the risk of musculoskeletal injury may also be prevalent at lower intensities. Muscle stiffness and soreness were reported by three authors [75, 176, 178] that resolved throughout the programme. Two participants (out of 120 in the exercise groups) withdrew in the study by Vogler et al [176] due to musculoskeletal pain. Vogler et al [176] also reported an increase in muscle soreness in the seated exercise programme compared to the weight bearing programme, suggesting an increased risk with seated exercise. Three participants (out of 50) withdrew in the study by Webber et al [177], due to the aggravation of pre-existing musculoskeletal conditions.

#### **4.5.6 Structure of interventions**

Nine studies [81, 109, 160, 165, 172, 174-177] employed only progressive strength training protocols. Ten studies [75, 83, 84, 166-169, 171, 173, 178] examined multi-component exercise interventions which included a combination of strength, flexibility, aerobic and balance exercises. One study [170] reported using purposeful activities which were designed to train the gross fine and motor skills and included coordination activities such as the passing of a bean bag.

A lack of detail in the reporting of interventions limited the ability to compare key components of the interventions. Where detailed, resistance exercise protocols varied from two sets of ten repetitions [81] to three sets of eight repetitions [75, 160, 176]. Progression was achieved through increasing repetitions and sets [75, 81, 83, 160, 165, 173, 175, 176] when good technique was observed [81] or as the exercise instructor felt appropriate [175]. There was little detail on the progression to supported standing and unsupported standing programmes across the papers.

Where detailed, the intensity of programmes ranged from low [173], low-moderate [175] and moderate [83, 166]. High intensity programmes were reported in three studies [160, 174, 177]. 80% of the one repetition maximum was used by Webber et al [177] to determine a high intensity strength training protocol for participants. Seynnes et al [174] compared a high intensity programme (80% of the one repetition maximum) with a low intensity programme (40% of the one repetition maximum). Latham et al [160] intended for participants to be working at a high intensity (60-80%

of one repetition maximum) by mid-way through the programme, however, this was only achieved by 25% of participants.

#### **4.5.7 Format of interventions**

The duration, frequency and length of programmes varied amongst the included studies. The longest programme ran for twelve months [81] and the shortest for two weeks [170]. Programmes ran from ten minutes long [174] up to an hour [75, 81, 165, 166]. The most common frequencies were twice a week (n= 9) [83, 109, 166, 169-172, 177, 178] and three times a week (n= 9) [75, 81, 160, 165, 168, 173-176] with one programme delivered once a week [167] and one delivered daily [84]. Programmes were primarily run in a group setting (n= 18), with two delivered individually at home [160, 176].

#### **4.5.8 Attendance**

Attendance rates to the chair based exercise programmes were commonly reported (see Table 11) however were missing in four papers [84, 170, 171, 173]. Attendance rates varied from 48.9% attendance reported by Dechamps et al [169] to 99% reported by Seynnes et al [174].

#### **4.5.9 Health outcomes**

Different outcomes were reported in the studies including; functions and their impairments (muscle strength, endurance, mobility, falls, balance, mood, depression, anxiety and cognition); activity limitations (activities of daily living, activity levels); and participation restriction (quality of life).

Meta-analysis was not appropriate for any of the outcomes due to variation in outcome measures and exercise protocols with differences in the exercise delivery, settings, participants and the structure of programmes. A narrative synthesis was therefore completed and an overview of the synthesis for each outcome is presented, allowing for a summary of the good research evidence to be provided for each outcome. For each outcome, a table is used to summarise the effects with green representing the good evidence, amber representing the medium quality evidence and red representing the low-quality evidence.

## **Strength**

Muscle strength (summarised in Table 14) was reported in thirteen studies, three of low quality [165, 173, 174], five of medium quality [75, 109, 168, 172, 175] and five of good quality [160, 169, 176-178].

Quadriceps strength, measured by a dynamometer or strain gauge, was the most commonly reported strength measure [75, 109, 160, 165, 173, 176], with a significant improvement reported in three studies [75, 109, 165]. The quality of the trials reporting significant improvements in muscle strength was limited by potential selection bias [165], performance and detection bias where the intervention and control were delivered by the same therapist [109] and smaller sample sizes compared with studies reporting non-significant findings [160, 176].

Lower limb muscle strength was also measured using sit to stand tests in six papers [75, 168, 169, 172, 174, 178]. Treatment effects varied from no effect in a larger higher quality study [178] to a moderate effect in a low quality study [174]. One good quality study [169] reported a greater improvement in chair rising time however the significance and size of the effect for the chair based exercise were unable to be calculated from the data. The lack of treatment effect on quadriceps strength reported in the larger, good quality trial by Latham et al [160] may be due to the fact that only 25% of participants were reported to have reached a high intensity of exercise training. This may suggest the training stimulus was not sufficient to elicit improvements in strength. Seynnes et al [174] reported a significant improvement in muscle strength (using the repetition maximum) in a high-intensity group (n=8) compared to a low-intensity group (n=6) with the size of the effect increasing with the higher intensity exercise, suggesting a dose-response relationship between training intensity and strength gains.

In summary, although some studies provide some support to the notion that chair based exercise improves lower limb muscle strength, this could be an artefact of trial design and the good quality evidence showed that as delivered here it does not greatly improve lower limb muscle strength.

Grip strength was measured in four studies, three of medium [75, 168, 172] and one good quality study [169]. The medium quality studies

reported significant and small improvements in grip strength [75, 168, 172]. The largest, best quality study [169] reported a slower decline in hand grip strength relative to a significant decline in the control group, however, the significance and size of the effect between the groups was unable to be calculated from the data. In summary there was insufficient good quality on hand grip strength with only one good quality study [169] reporting this outcome, however, only small effects were reported in the medium quality studies [75, 168] suggesting a large effect is unlikely.

**Table 14: Strength narrative synthesis**

Author	Sample	Quality	Statistical significance	Data reported	Effect	Interpretation
Dechamps [169]	154	Good	Unable to determine due to data provided, however, significant effect between three groups and no difference between intervention groups indicating significant effect	Adjusted mean difference and 95% CI	<u>Hand grip strength (kg)</u> <b>3 months</b> CBE group= -1.0 (-2.5 to 0.6) and control= -3.8 (-4.9 to -2.7) <b>6 months</b> CBE group= -0.2 (-3.2 to 2.7) and control= -6.4 (-7.8 to -5.0) <b>12 months</b> CBE group= -3.0(-6.5 to 0.4) and control= -6.5 (-8.2 to -4.8)	Declined in CBE and control across all time points, however, slower rate of decline than control, unclear size of effect
			Unable to determine due to data provided, however, significant effect between three groups and no difference between intervention groups indicating significant effect	Adjusted mean difference and 95% CI	<u>Chair rising (seconds)</u> <b>3 months</b> CBE group = -1.2 (-2.8 to 0.5) and control=3.3 (2.1 to 4.4) <b>6 months</b> CBE group = -1.1 (-3.8 to -1.6) and control=2.9 (0.7 to 5.1) <b>12 months</b> CBE group= -1.3 (-5.1 to 2.6) and control= -0.4 (-3.0 to 2.3)	Significant decline in control group at 6 months and no change in CBE group, unclear size of effect
Latham [160]	222	Good	No significant difference (p >0.05)	Median between group difference and 95% CI	<u>Quadriceps strength(kg)</u> = 0 (-2-1) Mean increase of 2kg in exercise group and 1kg in control	No clinically meaningful effect
Webber [177]	50	Good	Improvement in each group but no significant differences between groups (p=0.98)	Cohen's d effect size	<u>Dorsi flexion strength (N-m)</u> Weights group compared to control group= 0.03 Bands group compared to control group= -0.02 Weights group compared to bands group= 0.05	No effect
			Improvement in each group but no significant differences between groups (p=0.75)	Cohen's d effect size	<u>Plantar flexion strength (N-m)</u> Weights group compared to control group= 0.16 Bands group compared to control group= 0.10 Weights group compared to bands group= 0.04	No effect
Vogler [176]	171	Good	No significant difference (p=0.730)	Cohen's d effect size	<u>Quadriceps strength (kg)</u> Weaker leg= 0.01 Stronger leg= 0.03	No effect
Yamada [178]	84	Good	No significant difference (p=0.83)	Cohen's d effect size	<u>Five time chair stand (seconds)</u> = 0.03	No effect

Author	Sample	Quality	Statistical significance	Data reported	Effect	Interpretation
Chen [168]	114	Medium	Significant difference ( $p < 0.05$ )	Cohen's d effect size	<u>Hand grip strength (kg)</u> = 0.25	Small effect
			Significant difference ( $p < 0.05$ )	Cohen's d effect size	<u>30 second chair stand</u> = 0.38	Small effect
McMurdo [172]	41	Medium	Significant difference ( $p < 0.02$ )	Mean change $\pm$ SD	<u>Hand grip strength (kg)</u> Exercise= increased $2.2 \pm 4.2$ Control= declined by $1.0 \pm 3.6$	Small improvement relative to decline in control group, however, concern over whether considered clinically meaningful against minimum clinically important difference (MCID)
			Significant difference ( $p < 0.001$ )	Mean change $\pm$ SD	<u>Chair rising time (seconds)</u> Exercise= improved by $0.7 \pm 0.8$ Control= slower by $0.3 \pm 0.8$	Small improvement relative to decline in control group, however, concern over whether clinically meaningful as MCID for single chair rise time not well established
McMurdo [109]	55	Medium	Significant difference ( $p = 0.009$ )	Median change and 95% CI	<u>Quadriceps strength (N)</u> Intervention: 18 (-123-432) Control: -20 (-231-59)	Concern of whether 18N is clinically meaningful against MCID, however, decline in control group so potential maintenance effect
Skelton [75]	40	Medium	Significant difference ( $p = 0.03$ )	Cohen's d effect size	<u>Quadriceps strength (N)</u> = 0.61	Moderate treatment effect
			No significant difference ( $p = 0.348$ )	Percentage change	<u>Five time chair stand (seconds)</u> Exercise group= 2% improvement Control group= 2% deterioration	Small improvement compared to control, however, size of improvement not considered clinically meaningful
			Significant difference ( $p = 0.050$ )	Cohen's d effect size	<u>Hand grip strength (kg)</u> = 0.27	Small effect
Venturelli [175]	23	Medium	Significant difference ( $p < 0.05$ )	Cohen's d effect size	<u>Upper limb strength (one repetition max)</u> = 1.1	Large effect

Author	Sample	Quality	Statistical significance	Data reported	Effect	Interpretation
Boshuizen [165]	49	Low	Significant difference for high guidance group compared to control (p=0.03)	Cohen's d effect size	<u>Quadriceps strength (N):</u> High Guidance compared to control = 0.32 Medium Guidance compared to control = 0.11	Small effect high therapy guidance
Mills [173]	47	Low	No significant differences for knee strength (p=0.55) and ankle strength (p=0.12)	Cohen's d effect size	<u>Lower limb strength (N)</u> Left knee= 0.24 Right knee= 0.02 Left ankle= -0.40 (control better) Right ankle= -0.39 (control better)	Small treatment effect for left knee strength, small negative effect on ankle strength
Seynnes [174]	22	Low	Significant differences between high intensity exercise and control and low intensity exercise and control (p<0.0001) Significantly better in high-intensity group compared to low intensity (p=0.001)	Cohen's d effect size	<u>Quadriceps strength (one repetition max)</u> High intensity compared to control= 1.8 Low intensity compared to control= 1.5	Large effect of high-intensity strength training and low-intensity training; increased effect with increasing intensity
			Significant differences between high intensity exercise and control and low intensity exercise and control (p<0.01)	Cohen's d effect size	<u>Chair rising time (seconds)</u> High intensity group compared to control= 0.70 Low intensity group compared to control = 0.61	Moderate effect with high-intensity exercise and low intensity

### ***Aerobic endurance***

Aerobic endurance was measured in two studies using the six-minute walk test, one of low quality [174] and one of good quality [83]. The effects are summarised in Table 15. Significant differences were reported in the low quality study following a high-intensity exercise programme of ten weeks with a large treatment effect [174]. There was no significant difference with the low-intensity exercise programme in the same study [174]. No effect was reported in the good quality study [83] where the programme was delivered for fifteen weeks. With only two studies, and only one considered good quality, addressing this outcome there was insufficient evidence to determine the effect.

**Table 15: Aerobic endurance narrative synthesis**

Author	Sample	Quality	Statistical significance	Data reported	Effect	Interpretation
Witham [83]	75	Good	No significant difference (p=0.84)	Cohen's d effect size	<u>6 minute walk test (metres)</u> <b>3 months</b> = 0.05 <b>6 months</b> = -0.05	No effect
Seynnes [174]	22	Low	Significant improvement in high-intensity group compared to low intensity (p=0.01) and control (p<0.001). No significant differences between low intensity and control group	Cohen's d effect size	<u>6-minute walk test (metres)</u>  High intensity vs control = 0.99  Low intensity vs control = 0.38	Large effect with high-intensity exercise and small effect with low intensity exercise, size of effect increases with intensity of exercise

### ***Muscular endurance***

Upper limb muscular endurance was measured in two studies using the number of repetitions of a fixed load [174] or in a set time period [168]. The effects are summarised in Table 16. A significant improvement was reported in both studies. The medium quality study reported a moderate treatment effect [168]. Large effects were reported in the one low-quality study [174] with an increase in the size of the effect observed with an increase in the intensity of the programme. From the available evidence,

chair based exercise may improve muscular endurance however these conclusions are limited by the quality of the available evidence with no good quality studies addressing this outcome.

**Table 16: Muscular endurance narrative synthesis**

Author	Sample	Quality	Statistical significance	Data reported	Effect	Interpretation
Chen [168]	114	Medium	Significant difference (p<0.05)	Cohen's d effect size	<u>Upper limb (number in fixed time)</u> = 0.58	Moderate effect
Seynnes [174]	22	Low	Significant improvement in high-intensity exercise compared to low intensity exercise (p=0.008) and in low intensity exercise compared with control (p=0.048)	Mean increase	<u>Upper limb (number of repetitions)</u> High intensity= 13  Low intensity= 7  Control= no change	Large effect for high intensity and low intensity exercise, size of change increases with intensity of exercise

### **Power**

Muscle power was considered an outcome in one medium quality study [75] and one good quality study [177], with one study measuring leg extensor power [75] and one measuring ankle power comparing the use of weights, band and a control group [177]. The effects are summarised in Table 17. Although improvements in muscle power in all groups were observed no significant differences between groups were reported by the good quality study [177]. The medium quality study reported a significant and small effect for leg extensor power when standardised for body weight, however, the effect was not significant for leg extensor power alone, although a moderate effect was observed [75]. There were limited studies addressing this outcome and only one of good quality to draw reliable conclusions.

**Table 17: Power narrative synthesis**

Author	Sample	Quality	Statistical significance	Data reported	Effect	Interpretation
Webber [177]	50	Good	Improvement in each group but no significant differences between groups (p=0.88)	Cohen's d effect size	<u>Dorsi-flexion power (Watts)</u> Weights group compared to control group= 0.07 Bands group compared to control group= 0.07 Weights group compared to bands group= 0	No effect
			Improvement in each group but no significant differences between groups (p=0.38)	Cohen's d effect size	<u>Plantar flexion power (Watts)</u> Weights group compared to control group= 0.26 Bands group compared to control group= 0.23 Weights group compared to bands group= 0	Small effect with both bands and weights
Skelton [75]	40	Medium	No significant difference between groups (p=0.11)	Cohen's d effect size	<u>Leg extensor power (Watts)</u> =0.60	Moderate effect
			Significant difference between groups (p=0.049)	Cohen's d effect size	<u>Leg extensor power/body weight (watts/kg)</u> =0.21	Small effect

**Falls related outcomes**

Two good quality studies reported falls outcomes [160, 176]. The effects are summarised in Table 18. One reported falls rates and the Falls Efficacy Scale [160] and the other risk of falls using a profile score [176]. Vogler et al [176] reported significant differences between the intervention and control group with a small effect size. Latham et al [160] reported no effect on falls rates.

Therefore in summary chair based exercise may have a small effect on falls risk, however, there is conflicting evidence and a small number of studies addressing this outcome.

**Table 18: Falls narrative synthesis**

Author	Sample	Quality	Statistical significance	Data reported	Effect	Interpretation
Latham [160]	222	Good	No significant difference (p > 0.05)	Falls rates	164 falls in exercise compared to 149 in control.  Falls rate in exercise= 1.02 and 1.07 in control	No effect
			No significant difference (p > 0.05)	Median between group difference and 95% CI	<u>Falls efficacy scale (Total score 100)</u> -5 (13-0)	No effect
Vogler [176]	171	Good	Significant difference (p=0.019)	Cohen's d effect size	<u>Physiological profile assessment</u> = 0.21	Small effect

**Mobility**

Mobility outcomes were reported in seven studies one of low quality [165], one of medium quality [81] and five of good quality [160, 166, 169, 176, 178]. The effects are summarised in Table 19. Mobility outcomes were measured in different ways: four studies reported single task gait speed [160, 169, 176, 178], one reported dual task gait speed [20], five reported Timed Up and Go Test scores [81, 160, 165, 169, 178], and one study used the Rivermead Mobility Index [21]. Significant differences between intervention and control groups were reported in two studies, a moderate effect in one of medium quality [81] and a small effect on dual task walking in one of good quality [178]. One good quality study [169] reported a significant decline in gait speed in the control group with no change in the CBE group which may suggest a maintenance effect; however the significance and size of the effects between the groups could not be determined from the data.

In summary, chair based exercise may have a very limited effect on mobility with only one good quality study [178] demonstrating a small effect and one good quality study [169] demonstrating a potential maintenance effect.

**Table 19: Mobility narrative synthesis**

Author	Sample	Quality	Statistical significance	Data reported	Effect	Interpretation
Brittle [166]	56	Good	No significant differences (p > 0.05)	Cohen's d effect size	<u>Rivermead mobility index (Total score 15)</u> = 0.11	No effect
Dechamps [169]	154	Good	Unable to calculate the differences between the CBE and control group due to the data given however significant difference between all three groups and no difference between CBE and standing exercise	Adjusted mean differences and 95% CI	<u>Gait speed (meters/second)</u> <b>3 months</b> CBE group= 0.01 (-0.06 to 0.09) and control = -0.06 (-0.12 to 0.01) <b>6 months</b> CBE= -0.00 (-0.1 to 0.12) and control= - 0.16 (-0.25 to -0.08) <b>12 months</b> CBE group= -0.11 (-0.25-0.03) and control= -0.12 (-0.22 to 0.02)	Significant decline in gait speed in control group at 3 and 6 months and no effect in CBE group suggesting a potential maintenance effect, significant and similar rate of decline in both groups at 12 months
			Unable to calculate the differences between the CBE and control group due to the data given however no significant effect across all three groups and reported no differences between intervention groups	Adjusted mean differences and 95% CI	<u>TUGT (seconds)</u> <b>3 months</b> CBE group=0.3 (-1.2 to 1.7) and control group= 1.0 (-0.2 to 2.2) <b>6 months</b> CBE group= 0.5 (-1.7 to 2.8) and control group= 2.5 (0.8 to 4.2) <b>12 months</b> CBE group= 2.3 (-0.2 to 4.7) and control group =2.3 (0.2 to 4.3)	No effect at 3 months, decline in control at 6 months and no effect in CBE group suggesting a maintenance effect, similar decline in intervention and control at 12 months
Latham [160]	222	Good	No significant difference (p > 0.05)	Median between group differences and 95% CI	<u>TUGT (seconds)</u> -2 (-4-1)	No clinically meaningful effect between groups
			No significant difference (p > 0.05)	Median between group differences and 95% CI	<u>Timed walking test (seconds)</u> - 0.4 (-1 to 0.3)	No clinically meaningful effect between groups

Author	Sample	Quality	Statistical significance	Data reported	Effect	Interpretation
Vogler [176]	171	Good	No significant difference ( $p > 0.05$ )	Cohen's d effect size	<u>Gait speed (meters/seconds)</u> =0	No effect
			No significant difference ( $p > 0.05$ )	Mean change	<u>Physical performance and mobility</u> (12 point scale) No change in score in CBE group and an increase of 1 in control	No effect
Yamada [178]	84	Good	No significant difference ( $p = 0.31$ )	Cohen's d effect size	<u>TUGT (seconds)</u> = -0.13	No effect
			No significant difference ( $p = 0.18$ )	Cohen's d effect size	<u>Single task walking speed (seconds)</u> = -0.13	No effect
			Significant difference ( $p < 0.05$ )	Cohen's d effect size	<u>Dual task walking speed (seconds)</u> =0.30	Small effect
Baum [81]	20	Medium	Significant difference ( $p = 0.013$ )	Cohen's d effect size	<u>TUGT (seconds)</u> =0.54	Moderate effect
Boshuizen [165]	49	Low	No significant difference (p value not given)	Cohen's d effect size	<u>TUGT (seconds)</u> High guidance compared to control= 0.16 Medium guidance compared to control =0.07	No effect for medium guidance, approaching threshold for small effect for high guidance and size of effect increased with increased level of guidance

### Activity levels

Measures of activity were reported in two studies [83, 173] using two different measures. The findings are summarised in Table 20. Activity was measured using accelerometry [83] and a self-complete journal [173]. The low-quality study [173] reported an increase in activity levels in the comparison group although the differences were not significant.

The good quality study [83], demonstrated an 18.7% improvement in the activity levels in the exercise group compared to a 7.0% improvement in the control group. The good quality study [83] did include walking goals, however, little detail was given on how this was conducted and how much was achieved.

In summary, there is insufficient good quality evidence to determine the effect on this outcome.

**Table 20: Activity levels narrative synthesis**

Author	Sample	Quality	Statistical significance	Data reported	Effect	Interpretation
Witham [83]	75	Good	Significant difference (p=0.036)	Median percentage change and 95% CI	<u>Accelerometry</u> <b>3 months</b> Exercise=18.7 (-28.5 to 51.8) Control= 7.0 (-29.1 to 36.8) <b>6 months</b> Exercise= 2.3 (-11.1 to 46.6) Control=-14.0 (37.7 to 25.4)	Larger improvement in exercise group compared to control
Mills [173]	47	Low	No significant difference (p=0.39)	Cohen's d effect size	<u>Activity journals</u> = -0.26	Small effect to indicate that the control group was more active

### Balance

Eight studies reported balance outcomes, one of low quality [173], four of medium quality [75, 81, 109, 172] and three of good quality [160, 176, 177]. The effects are summarised in Table 21. A range of balance

measures were used: the Berg Balance Scale [81, 160], postural sway [172], Roberts Balance Scale [173], reaction times [109], functional reach test [75], Hill Step Test [176], movement time [177] and maximal balance range [176]. Significant differences between the intervention and control group were reported in one medium quality study [81], demonstrating a small treatment effect and one good quality study [177] demonstrated a small effect when using resistance bands. No large or moderate effects were observed by any of the studies. In summary, there is inconsistent evidence from the good quality studies to draw reliable conclusions, however, as only small effects were reported the evidence suggests there is unlikely to be a large effect on balance outcomes.

**Table 21: Balance narrative synthesis**

Author	Sample	Quality	Statistical significance	Data reported	Effect	Interpretation
Latham [160]	222	Good	No significant difference ( $p > 0.05$ )	Between group difference and 95% CI	<u>Berg balance score</u> = -1 (-4-2)	No clinically meaningful effect
Vogler [176]	171	Good	No significant difference between seated exercise group and control ( $p=0.151$ )	Cohen's d effect size	<u>Foot press reaction time (m/s)</u> = 0.09	No effect
			No significant difference between seated exercise group and control ( $p=0.104$ )	Cohen's d effect size	<u>Co-ordinated stability (error score)</u> = 0.22	Small effect
			No significant difference between seated exercise group and control ( $p=0.473$ )	Cohen's d effect size	<u>Postural sway (eyes open) (mm)</u> Effect size= 0.09	No effect
			No significant difference between seated exercise group and control ( $p= 0.107$ )	Cohen's d effect size	<u>Postural sway (eyes closed) (mm)</u> = 0.16	No effect as below threshold
			No significant difference between seated exercise group and control ( $p= 0.107$ )	Cohen's d effect size	<u>Finger press reaction time (m/s)</u> = 0.02	No effect
			No significant difference between seated exercise group and control ( $p=0.679$ )	Cohen's d effect size	<u>Maximal balance range (mm)</u> = 0.06	No effect
			No significant difference between seated exercise and control ( $p=0.708$ )	Cohen's d effect size	<u>Hill step test (steps/15 seconds)</u> Stronger leg= 0.19 Weaker leg= 0	Approaching threshold for small effect with stronger leg
Webber [177]	50	Good	Significant difference when using band ( $p=0.003$ )	Cohen's d effect size	<u>Movement time (m/s)</u> Bands compared to control= 0.45 Weights compared to control= 0.18	Significant and small effect using band
			No significant difference ( $p=0.51$ )	Cohen's d effect size	<u>Reaction time (m/s)</u> Weights compared to control= 0.26 Bands compared to control= -0.02	Small effect with weights, no effect with band

Author	Sample	Quality	Statistical significance	Data reported	Effect	Interpretation
Baum [81]	20	Medium	Significant difference (p=0.013)	Cohen's d effect size	<u>Berg balance score</u> =0.32	Small effect
McMurdo [172]	41	Medium	No significant difference (p values not given)	Mean change $\pm$ SD	<u>Postural sway (eyes open)</u> Exercise= -9.6 $\pm$ 17.7 Control= -2.9 $\pm$ 16.1  <u>Postural sway (eyes closed)</u> Exercise= -16.6 $\pm$ 32.3 Control= -10.9 $\pm$ 34.8	Larger improvement in intervention compared to control, however, not statistically significant and clinical relevance unclear
McMurdo [109]	55	Medium	No significant difference (p value not given)	Median change and range	<u>Reaction Time</u> Exercise= 0.03 (-0.38 to 2.75) Control= 0.15 (-0.43 to 1.72)	No effect
Skelton [75]	40	Medium	No significant difference (p=0.169)	Cohen's d effect size	<u>Functional reach (cm)</u> = 0.31 Exercise= 1% improvement Control= 0% improvement	Small effect
Mills [173]	47	Low	No significant difference (p=0.39)	Cohen's d effect size	<u>Roberts balance score</u> = 0.29	Small effect

***Activities of daily living***

Activities of daily living were reported in nine studies (summarised in Table 22), three of low quality [165, 171, 174], four of medium quality [81, 168, 172, 175] and two of good quality [160, 169]. All four medium quality studies [81, 168, 172, 175] reported significant differences between the intervention and control groups. Effect sizes from the medium and low-quality studies ranged from below the threshold (0.18) of a small effect in one study [168], a small effect in one study [81] and a large effect in one study [175]. A significant difference between the control and intervention group was reported at 6 months in one good quality study due to a decline in the control group, however, significant differences were not sustained at 12 months [169]. There are inconsistent findings from the medium and low quality studies and evidence from the two good quality studies [160, 169] demonstrates that chair based exercise does not improve performance in activities of daily living.

**Table 22: Activities of daily living narrative synthesis**

Author	Sample	Quality	Statistical significance	Data reported	Effect	Interpretation
Dechamps [169]	154	Good	No significant differences at 12 months (p=0.15)	Adjusted mean change and 95% CI	<u>Index of activities of daily living (Total score 12)</u> CBE group = 0.71 (-0.36 to 1.07) Control= 1.56 (1.02 to 2.10)	No effect
Latham [160]	222	Good	No significant difference (p > 0.05)	Between group difference and 95% CI	<u>Barthel Index (Total score 20)</u> = 0 (0-0)	No effect
			No significant difference (p > 0.05)	Between group difference and 95% CI	<u>Adelaide activities profile</u> Domestic (Total score 24)= 0 (-2-2) Household maintenance (Total score 24)= 0 (-2-1) Service to others (Total score 21)= 0 (-1-1) Social (Total score 12)= 0 (-1-1)	No effect
Baum [81]	20	Medium	Significant difference (p= 0.013)	Cohen's d effect size	<u>Physical performance test (Total score 24)</u> = 0.40	Small effect
Chen [168]	114	Medium	Significant differences (p < 0.05)	Cohen's d effect size	<u>Barthel Index (Total score 100)</u> = 0.18	Approaching threshold for small effect

Author	Sample	Quality	Statistical significance	Data reported	Effect	Interpretation
McMurdo [172]	49	Medium	Significant difference (p < 0.05)	Mean change $\pm$ SD	<u>Barthel Index (Total score 100)</u> Exercise= 1.0 $\pm$ 2.8 Control= -1.0 $\pm$ 2.8	Small improvement compared to decline in control group, however, concern whether clinically meaningful against MCID
Venturelli [175]	22	Medium	Significant difference (p < 0.05)	Cohen's d effect size	<u>Barthel Index (Total score 100)</u> = 1.16	Large effect
Boshuizen [165]	49	Low	No statistically significant differences (p value not stated)	Cohen's d effect size	<u>GARS Questionnaire (Total score 72)</u> High guidance vs control= -0.02 Medium guidance vs control= 0.21	Small effect with medium guidance intervention
Karl [171]	19	Low	No significant difference (p > 0.05)	No data given	<u>Performance test of activities of daily living</u> Unable to assess as no data given	Unable to determine
Seynnes [174]	22	Low	No significant differences (p=0.73)	Cohen's d effect size	<u>Disability index (8 item scale)</u> High intensity =0.47 Low intensity =0.84	Large effect with low intensity and small effect with high intensity

### ***Flexibility***

Four studies reported flexibility outcomes three of medium quality [168, 172, 175] and one of low quality [173]. The effects are summarised in Table 23. A range of flexibility measures were used: goniometry of the knees and ankles [172, 173], the back scratch test [168, 175], spinal flexion [172] and the sit and reach test [168]. All four studies reported significant differences between the intervention and the control with effect sizes ranging from small in one study [168] to large in three studies [172, 173, 175]. Evidence from the medium quality studies demonstrates inconsistent findings with no significant effects reported for knee flexion [172] in one study and a moderate effect on lower limb flexibility in another study [168], and treatment effects for upper limb flexibility ranged from small [168] to large [175]. There were larger improvements in spinal flexion reported in one medium quality study with a mean improvement of 12.7 cm for the exercise group compared to 2.3 cm in the control [172].

Although there were inconsistencies in the reported effects, evidence from the medium quality studies [168, 172, 175] demonstrates that chair based exercise may improve flexibility, however, the size of the effect is unclear. None of the studies measuring flexibility were considered good quality trials, therefore, the findings are limited by the quality of available evidence.

**Table 23: Flexibility narrative synthesis**

Author	Sample	Quality	Statistical significance	Data reported	Effect	Interpretation
Chen [168]	127	Medium	No significant differences at 3 months (p=0.081) Significant differences at 6 months (p<0.05)	Cohen's d effect size	<u>Upper limb flexibility (cm)</u> = 0.22 at 6 months	Small effect
			No significant differences at 3 months (p=0.081) Significant differences at 6 months (p<0.05)	Cohen's d effect size	<u>Lower limb flexibility (cm)</u> = 0.55 at 6 months	Moderate effect
McMurdo [172]	49	Medium	Significant differences (p <0.00001)	Mean change ± SD	<u>Spinal flexion (cm)</u> Exercise= 12.7 ± 8.9 Control= 2.2 ± 8.8	Large improvement compared to control
			No significant differences in knee flexion or right knee (p value not given)	Median change and range	<u>Knee flexion (degrees)</u> <b>Right</b> Exercise= 0 (-5 to 35), Reminiscence = -5 (-15 to 20) <b>Left</b> Exercise = 0 (-30 to 25), Reminiscence= -5 (-20 to 10)	No effect
			Left knee extension significant improvement (p <0.05) No significant differences for right knee extension (p value not given)	Median change and range	<u>Knee extension (degrees)</u> <b>Right:</b> Exercise= 0 (0 to 0), Reminiscence 0 (-10 to 10) <b>Left:</b> Exercise= 0 (-10 to 10), Reminiscence 0 (-10 to 10)	No effect (authors report spurious result for left knee extension due to concentration of negative values in control)
Venturelli [175]	22	Medium	Significant difference (p<0.05)	Cohen's d effect size	<u>Back scratch (cm)</u> = 1.25	Large effect
Mills [173]	47	Low	Significant differences for right knee flexibility (p<0.05) and ankles (p<0.001)	Cohen's d effect size	<u>Goniometry (degrees)</u> Left knee= 0 Right knee= 0.52 Left ankle= 1.73 Right ankle= 1.52	Large effect on ankle flexibility, moderate effect on right knee and no effect on left knee flexibility

### **Health-related quality of life**

Health-related quality of life was considered in three studies, two of good quality [83, 160] and one of medium quality [172]. The effects are summarised in Table 24. No significant differences between intervention and control groups were reported in any of the three studies. A small improvement relative to the control group on life satisfaction was reported in one medium quality study [172], however, the clinical relevance of this improvement was unclear with a lack of a well-established minimum clinically important difference for this scale. A small effect was reported in the good quality study by heart failure patients immediately post the intervention, however, this was not sustained at follow up [83].

Therefore evidence from the good quality studies demonstrates that chair based exercise does not greatly improve quality of life.

**Table 24: Health-related quality of life narrative synthesis**

Author	Sample	Quality	Statistical significance	Data reported	Effect	Interpretation
Latham [160]	222	Good	No significance difference (p>0.05)	Between group difference and 95% CI	<u>Physical component of SF36</u> -1 (-4 to -1)	No clinically meaningful effect
Witham [83]	75	Good	No significance difference (p=0.48)	Cohen's d effect size	<u>Chronic heart failure questionnaire (20 item scale)</u> = 0.2 at 3 months =-0.1 at 6 months	Small effect post intervention, no effect at 6 months
McMurdo [172]	47	Medium	No significant difference (p value not stated)	Mean change $\pm$ SD	<u>Life satisfaction index (20 item scale)</u> Exercise= 1.5 $\pm$ 1.6 Control= 0.7 $\pm$ 1.4	Small improvement that is greater than control, however, not significant and clinical relevance of satisfaction index unclear

### **Cognition**

Cognition using the Mini-Mental State Examination (MMSE) was reported in six papers, five of medium quality [84, 109, 170, 175] and one of low quality [170]. Three medium quality studies reported significant group differences. The effect on cognition is summarised in Table 25. Effect sizes ranged from moderate [81, 84] to a large effect [175]. Although there

were inconsistencies in the findings the medium quality evidence demonstrated that chair based exercise has the potential to have a moderate to large effect on cognition. These moderate and large effects were, however, from medium quality studies with smaller sample sizes [81, 84, 175]. None of the studies measuring cognition were considered good quality trials, therefore, the findings are limited by the quality of available evidence.

**Table 25: Cognition narrative synthesis**

Author	Sample	Quality	Statistical significance	Data reported	Effect	Interpretation
Baum [81]	20	Medium	Significant difference (p=0.013)	Cohen's d effect size	MMSE (Total score 30) = 0.54	Moderate effect
McMurdo [172]	49	Medium	No significant difference (p values not stated)	Mean change $\pm$ SD	MMSE (Total score 30) Exercise= 1.4 $\pm$ 1.4 Control= 0.2 2.4 $\pm$	Small improvement relative to control, not statistically significant but may be clinically meaningful
McMurdo [109]	55	Medium	No significant difference (p=0.06)	Mean change $\pm$ SD	MMSE (Total score 30) Exercise= -0.4 $\pm$ 2.0 Control= -1.6 $\pm$ 2.6	Small slowing of decline compared to control group, however ,not statistically significant and concern over clinical relevance against MCID
Van de Winckel [84]	25	Medium	Significant difference (p=0.02)	Cohen's d effect size	MMSE (Total score 30) = 0.50	Moderate effect
Venturelli [175]	22	Medium	Significant difference (p=0.04)	Cohen's d effect size	MMSE (Total score 30) =2.9	Large effect
Holliman [170]	14	Low	No data given	No data given	MMSE (Total score 30) no data given	Unable to assess

### ***Depression***

Four studies reported outcomes relating to depression, two of good quality [83, 166], one of medium quality [172] and one of low quality [167] using a range of measures. The Hospital Anxiety and Depression Scale was used by two authors [167, 172] and the Geriatric Depression Scale used in two papers [83, 166]. There were no significant differences reported in one

good quality [166] study. A small significant effect was reported in one good quality study [83] post intervention, however, the effects were not maintained at follow-up. As summarised in Table 26, the good quality evidence suggests that chair based exercise may have only a small effect on depression, however, there is conflicting evidence and a small number of good quality studies addressing this outcome.

**Table 26: Depression narrative synthesis**

Author	Sample	Quality	Statistical significance	Data reported	Effect	Interpretation
Brittle [166]	56	Good	No significant difference (p >0.05)	Cohen's d effect size	<u>Hospital anxiety and depression scale (Total score 42)</u> =0.19	Approaching threshold for small effect
			No significant difference (p >0.05)	Cohen's d effect size	<u>Stroke aphasic depression questionnaire (Total score 30)</u> = 0.40	Small effect
Witham [83]	75	Good	No significant difference (p= 0.10)	Mean percentage change and 95% CI	<u>Hospital anxiety and depression scale(depression subscale, total 21)</u> Exercise= 17.7 (-3.5 to 38.9) Control= -3.4 (-18.3 to 11.5)	No effect between groups, positive percentage change indicates increased levels of depression in exercise group compared to control
McMurdo [172]	49	Medium	Significant difference (p <0.01)	Mean change ± SD	<u>Geriatric depression scale (30 item scale)</u> Exercise= -1.8 ±1.6 Control = -0.5 ±1.5	Larger mean change in exercise compared to control, clinical relevance unclear as MCID not well established for this population
Bonura [167]	104	Low	Significance difference for all three groups (p <0.001)	Cohen's d effect size	<u>Geriatric depression scale (30 item scale)</u> Chair yoga compared chair fitness = 0.47 Chair fitness compared to control= 0.02	No effect with chair fitness

## **Anxiety**

Anxiety was measured in one good quality study [83] using the Hospital Depression and Anxiety Scale and one low-quality study [167] using the State Anxiety Inventory. The effects are summarised in Table 27. A small effect was reported for a chair yoga programme in the low-quality study when compared with a chair fitness programme, with no effect reported for the chair fitness programme in comparison to the non-exercise control [167]. No significant differences were reported in the good quality study [83]. Due to the lack of good quality studies addressing this outcome there is insufficient evidence to determine the effects.

**Table 27: Anxiety narrative synthesis**

Author	Sample	Quality	Statistical significance	Data reported	Effect	Interpretation
Witham [83]	75	Good	No significant difference (p=0.77)	Mean percentage change and 95% CI	<u>Hospital depression and anxiety scale (anxiety subscale, total 21)</u>  Exercise= -3.1 (-30.0 to 23.7)  Control= 1.5 (-16.1 to 19.2)	No effect
Bonura [167]	106	Low	Significance difference between all three groups (p<0.002)	Cohen's d effect size	<u>State anxiety inventory (40 item scale)</u> Yoga group compared to chair fitness group= 0.27 Chair fitness group compared to control= 0.13	No effect with chair fitness

## **Behaviour**

Behaviour was measured in three studies [84, 169, 170] using the Neuropsychiatric Inventory Score [169], the adapted Stockton Geriatric Rating Scale [84] and the Psychogeriatric Dependency Rating Scale [170]. Dechamps et al [169] was considered the only good research quality study measuring behaviour and reported that the Neuropsychiatric Inventory score was maintained in the exercise group compared to a significant decline in the control group. As presented in Table 28, effect sizes could not be calculated in any of the papers due to a lack of data or the type of

data presented. With only one good quality study addressing this outcome there was insufficient evidence to determine the effects.

**Table 28: Behaviour narrative synthesis**

Author	Sample	Quality	Statistical significance	Data reported	Effect	Interpretation
Dechamps [169]	154	Good	Significant difference between CBE and control group (p >0.01)	Adjusted mean difference and 95% CI	<u>Neuropsychiatric inventory score (Total 144)</u> <b>6 months</b> CBE group = -4.8 (11.6 to 2.0) Control group = 9.9 (2.0 to 17.6) <b>12 months</b> CBE group = -6.6 (-11.4 to 1.8) Control Group = 14.2 (5.4 to 23.0)	Maintenance effect
Van de Winckel [84]	25	Medium	No significant difference (p>0.05)	Mean change	<u>Adapted Stockton geriatric rating scale</u> No change in any domain	No effect in any domain
Holliman [170]	14	Low	No significant difference (p= 0.252)	No data given	<u>Psychogeriatric dependency Rating Scale</u> unable to calculate	No significant difference and unable to calculate effect size, therefore, unclear

## 4.6 Discussion

### 4.6.1 Summary of findings

There was a small number of good quality studies on chair based exercise (n=7), covering a range of physical health domains and a small number, (n=4) covering a range of mental health domains. A range of physical and mental health outcomes were measured across the studies with strength, balance, activities of daily living and mobility the most commonly reported outcomes.

The highest quality evidence from the good quality studies only demonstrated that chair based exercise, as tested in these studies, does not improve lower limb muscle strength or performance in activities of daily living. There was limited, inconsistent good quality evidence to determine the effect on the other health outcomes. An increased risk of

musculoskeletal injury with seated resistance exercise was identified in two good quality trials [160, 176], however, no adverse events were reported in two good quality studies [83, 169] where multicomponent interventions were used.

The available evidence indicated that chair based exercise can improve flexibility, muscular endurance and maintain cognitive impairment in older people, but this evidence was from poorer quality studies and there were no high-quality studies addressing these outcomes. Larger benefits in health domains were noted in the medium and low-quality research, which may be due to biases in trial design.

The evidence for the effectiveness of chair based exercise was limited in some domains (power, activity levels, aerobic endurance, flexibility, muscular endurance, behaviour, cognition and anxiety) by the small number or lack of high-quality studies addressing these outcomes.

#### **4.6.2 Strengths and limitations**

This review had a broad search strategy with a view to identifying all available literature and identified twenty papers instead of a previous review's [59] six [81-86]. Only randomised controlled trials as the highest level of research quality were synthesised in this review. Although this will have excluded findings from other study designs, given the propensity for bias in this field, the most robust information about effectiveness will come from high-quality randomised controlled trials. Due to the diversity of study methods and outcomes, a meta-analysis was not possible and so the review was limited to a narrative synthesis. Collating the findings of all these studies was challenging given the different populations, settings, exercise protocols, and outcomes studied. The robustness of the conclusions about the apparent health benefits of chair based exercise are limited by the fact that only seven of the twenty RCTs identified were considered to be of good methodological quality. The evidence for the effectiveness of chair based exercise in certain health domains is limited by the small number of studies addressing this outcome.

#### **4.6.3 Participants of programmes**

Identifying the target population for the PACE intervention was challenging given the varied use of chair based exercise. Experts suggested

programmes should focus on older people who have an activity limitation, which may be acute or longer term. Activity limitations were identified using a range of measures in this review such as self-reported [177], difficulty rising from a chair [165] and Barthel Index scores [175]. In contrast, some participants were independently ambulant [178], and had access to their own transport [178]. The variation in mobility across the studies may account for the inconclusive results and further work is needed to establish clinical markers for whom the PACE intervention may be appropriate.

#### **4.6.4 Exercise protocols**

The range of outcomes identified in this review reflects the variety in the delivery of chair based exercise. The outcomes addressed the need to reflect the content and focus of programmes ensuring there is a logical relationship between what is being done and what is being achieved. For example, lower limb strength improvements cannot logically be expected with a programme that only includes upper limb training. Further work on chair based exercise and the development of the PACE intervention needs to ensure that interventions are matched to the desired outcomes.

This review supports the findings of the earlier systematic review [59] that chair based exercise has been delivered in a variety of settings with variation in the duration, frequency and intensity of programmes. Systematic reviews on all exercise types for older people [18, 179] have highlighted the difficulty in identifying the optimal exercise type, duration, frequency and intensity to maximise health outcomes. The variations noted in this review could, however, be due to the broad scope without a specific focus on frailty, setting or a health condition.

Progressive resistance strength training has been shown to improve muscle strength and functional limitations in older people [25]. The higher quality evidence from this review, however, reported limited effects of chair based exercise on muscle strength, which may be due to a lack of sufficient dosage or progression of exercise training. Given that chair based exercise is likely to be prescribed for older people with functional limitations, this may make it difficult for participants to undertake resistance exercise of sufficient intensity or progression, or it may be that investigators (or participants) have not appreciated the need for exercise to be more intense

than is often used. This balance between the sufficient intensity and potential risks needs to be considered in the development of the PACE intervention.

The increased risk of musculoskeletal injury observed in one study [160], which aimed for high-intensity progressive resistance exercise, has implications for the adoption of the intervention. More intensive and frequent interventions may produce the most health benefits but may also hold the most risk. These types of interventions may also be less acceptable to participants [180] and services. Therefore the reality may be that many chair based exercise interventions that are currently delivered are safe but ineffective. More work is needed to develop acceptable and safe, and appropriately progressive interventions that can achieve effectiveness. To allow for an assessment of the potential risks of exercise training, there is also a need for studies to provide greater detail on any adverse events.

Four out of the twenty studies in this review [165, 169, 173, 176] described exercise interventions which included both seated and supported standing exercises. This view of chair based exercise reflects the definitions and principles agreed by experts in chapter three [125] where progression is encouraged to maximise benefits. In addition, weight bearing exercise programmes have demonstrated greater improvement in health outcomes compared to seated programmes [176, 180]. Although the studies included both seated and supported standing exercises there was no indication that participants progressed to the supported standing programmes suggesting they were able to complete both seated and supported standing programmes at the beginning of the programme. Progressing older people from chair based exercise to unsupported standing programmes was not specifically detailed in any of the studies in this review and is an area that warrants more exploration.

## **4.7 Conclusions**

This systematic review has identified the broad use of chair based exercise for older people and provides some implications for practice and the development of the PACE intervention.

#### **4.7.1 Implications for clinical practice**

- Chair based exercise has the potential to provide physical health benefits however the evidence for benefit is from lower quality research.
- Chair based exercise programmes can be delivered in a range of settings.
- People completing chair based exercise that include progressive resistance strength training should be monitored for any adverse events such as musculoskeletal injury.

#### **4.7.2 Implications for the PACE intervention**

- Current interventions are not always underpinned by the principles of exercise for older people and there is variation in the frequency and duration of interventions. Up-to-date physiological knowledge needs to be considered in the development of the PACE intervention.
- The potential for negative consequences of pain and musculoskeletal injury need to be considered in the PACE intervention.
- There is a range of participants of chair based exercise and the target population needs to be carefully considered by the PACE intervention.
- The PACE intervention needs to be clearly described to allow an understanding of how it is expected to work.

Having established the existing evidence for chair based exercise the next chapter uses this evidence and evidence from the expert consensus in chapter three to describe the theory of the PACE intervention.

## 5 Chapter Five: Planning the PACE intervention

This chapter outlines how the theories of the PACE intervention were identified using the consensus development process (chapter three), review of the existing evidence (chapter four) and the physiological and behaviour change principles of exercise for older people (chapter one). A systems approach was used to ensure that all the key components of a coherent intervention were considered. A logic model is presented at the end of the chapter as a visual description of how the PACE intervention was intended to be implemented in a community setting.

### 5.1 Introduction

As outlined in Figure 2 (chapter two), the MRC framework [3] describes the stages of developing a complex intervention to ensure there is a sound theoretical basis for how the intervention is expected to achieve the intended outcomes. Identifying and generating the '*theory*' can be viewed as the planning of an intervention outlining what in theory should work. The '*modelling*' stage can be viewed as testing whether the theory can actually be put into practice and result in the anticipated outcomes.

As the PACE intervention was considered a complex intervention with multiple underlying theories it needed to draw upon the following:

- Best current understanding of chair based exercise (chapter three)
- Existing evidence for chair based exercise (chapter four)
- Physiological principles of exercise for older people (chapter one)
- Strategies to support participation to exercise interventions for older people (chapter one)

There is a lack of methodological guidance given by the MRC framework [3] on how to synthesise the underlying theories of a complex intervention. Guidance such as the TIDieR framework [181] support the clear reporting of complex interventions in trial literature; however such frameworks offer little guidance on the development phase of an intervention.

Guidance for developing the underlying theory of the PACE intervention was therefore sought from wider healthcare literature. The methods used to outline the theory of the PACE intervention are discussed below.

## **5.2 Methods for outlining the underlying theory**

System thinking was used as an approach to describe the underlying theories of the PACE intervention. Systems thinking refers to explicitly considering a system as a whole with clear assumptions of how each element interacts rather than relying on implicit models where these interactions are not transparent [182]. For a system to work there needs to be a number of essential components that interact with each other to reach the desired outcome [182]. The PACE intervention was therefore considered in terms of a system with a need to establish the essential components, interactions and outcomes.

Closed systems are ones where the structure, process and outcomes are not influenced by external factors. In contrast a healthcare intervention, such as PACE, can be considered an open system in that it is influenced by external and contextual factors. There was then a need to consider how the contextual factors influenced the components of the system when outlining the theories for the PACE intervention to anticipate its use in a real-world setting.

Describing the underlying theories of an effective open system involves identifying what the system does, how it does it, the purpose of the system and how the contextual factors influence the system. These core components in a functioning system can be described as the root definition [183]. The CATWOE model, presented in Figure 13, identifies six elements that need to be outlined in order to describe the root definition of a system [183]. The CATWOE model, which underpins systems thinking, has been used in helping to understand other healthcare systems such as nurse practitioners working in care homes [184] and vocational rehabilitation for stroke survivors [185].

The CATWOE model aims to describe the contextual influences over a system by separating context into world view, owners and the environmental factors. In outlining the underlying theories of the PACE intervention the CATWOE model was used to ensure a coherent and

detailed description of the intervention was achieved. For each element of the CATWOE principle results from the consensus development process, systematic review literature, and physiology and behaviour change literature are discussed to identify appropriate theories. A summary statement of the theories for each CATWOE element is presented at the end of each section.

<b>C (Customers)</b>	- who will benefit from the PACE intervention?
<b>A (Actors)</b>	- who should deliver the PACE intervention?
<b>T (Transformation)</b>	- what is it expected to achieve and how will it do this?
<b>W (World View)</b>	- what is the wider policy view and context?
<b>O (Owners)</b>	- what are the societal and political influencers?
<b>E (Environment)</b>	- what are the environmental consideration?

**Figure 13: The CATWOE principle**

### **5.3 Who will benefit from the intervention (Customers)**

Experts identified chair based exercise as appropriate for older people with activity limitations who cannot take part in other forms of standing exercise programmes. Activity limitation is defined by the World Health Organisation International classification of disability as '*difficulty in executing a task or action*' and may be caused by upper or lower limb impairments [186]. Activity limitation can refer to limitations in mobility and self-care [187] and may reflect some of the reasons why chair based exercise would be recommended. Participants in some of the randomised controlled trials in the systematic review were however independently ambulant [172], lived independently [75] and had no support for daily tasks [75], contradicting the views of experts that participants should have an activity limitation. Table 29 presents the reported activity limitations of the participants in the randomised controlled trials and how these align to the expert views derived from chapter three.

**Table 29: Activity limitations of participants in the systematic review literature**

Level of agreement with expert view	Examples of participant characteristics	Studies
Full	Activity limitation e.g. difficulty rising from a chair, wheelchair bound. The level of dependency measured using tools such as the Barthel Index.	[160, 165, 166, 168, 171, 175]
Partial	Potential activity limitation, however, could be independent based on the criteria e.g. independently ambulant or with the assistance of a carer, self-reported mobility limitation using criteria of inability to walk one mile at a moderate pace.	[81, 167, 169, 177]
None	Lack of detail on reporting, independence with daily activity and walking, lived independently.	[75, 83, 84, 109, 170, 172-174, 176, 178]

The principles of chair based exercise agreed by experts used the term frailty in some of the principles and the agreed definition. The British Geriatrics Society [188]p.2] refers to frailty as a health state in which *'multiple body systems gradually lose their inbuilt reserves'* and increasingly frailty is viewed as a condition [188]. Frailty is differentiated from disability and older adults with physical disabilities may not also have frailty. Due to the difficulties in defining and identifying frailty in a clinical setting [149] and the fact that participants of chair based exercise may have physical disabilities but not be considered frail, frailty was not used to determine participants of the PACE intervention. People who were unable to complete standing exercise programmes were instead considered the target population for the PACE intervention.

The systematic review identified that chair based exercise was delivered to a range of specific groups such as patients with heart failure [83], older people with dementia [84], and older people recently discharged from hospital [160] reflecting that activity limitations may not be the sole use of chair based exercise. Other reasons for the use of chair based exercise as a starting point to exercise may include reduced confidence, fear of injury with exercise [60] and reduced exercise tolerance which may be due to a sedentary lifestyle or existing health conditions.

Identifying older people who are appropriate for chair based exercise programmes across community settings was challenging given the broad

reasons for its use. Clegg [189] used the Timed Up and Go Test to stratify older people taking part in a home-based exercise programme with those scoring thirty seconds or more allocated to a lower level of exercise programme which consisted of chair based exercises. Across the wider literature, however, a broad range of older people have taken part in chair based exercise programmes from those scoring six seconds on the Timed Up and Go Test [190] to older people who were unable to complete the test due to impaired mobility [189]. Clinical decisions made by General Practitioners (GP) [190] and physiotherapists [191] has been used in other research studies to identify older people suitable for chair based exercise. Such methods may be better than using standardised criteria (such as the Timed Up and Go Test) as they allow for the different reasons why chair based exercise interventions are used. This approach was used in an NHS community service where a physiotherapy assessment and clinical reasoning were used to determine older people who could participate in unsupported standing programmes and older people more appropriate for chair based exercise (Appendix A).

The systematic review literature identified that older people who took part in chair based exercise interventions had multiple health conditions and this may have increased their risk of adverse events when taking part in physical activity [192]. Given the evidence for the deterioration in health with reduced levels of physical activity, there was a need to consider the benefits of activity in the context of the risks of inactivity. Fiatarone Singh [193] supports this view suggesting that the effects of a sedentary lifestyle are more harmful than the potential risks of physical activity for older people. Consideration of how to facilitate exercise programmes whilst minimising the risks was therefore warranted. Experts agreed that an individual health assessment should be carried out prior to commencing a chair based exercise programme to ensure the safety of participants. A health screening assessment may identify conditions that need to be monitored during participation or where the intervention needs to be tailored but does not warrant complete exclusion from the programme. From the systematic review (in chapter four), eight studies [75, 83, 160, 168, 174, 175, 177, 178] reported excluding participants with contraindications to exercise or conditions that may be adversely affected by the programme. Two studies [109, 167] reported that health screening

was not used to exclude participation but to allow modification of the programme in order to ensure access to appropriate exercise programmes. This was supported by Bean et al [194] who suggest health screening should serve three purposes 1) ensure safety 2) allow modifications of the programme and 3) design the programme to meet the impairments and limitations identified.

A variety of methods for health screening exist in clinical practice and the delivery of community exercise programmes. Exercise instructors are recommended to screen participants prior to commencing a programme through the use of existing questionnaires such as the Physical Activity Readiness Questionnaire (PAR-Q) [195]. These tools often require self-reporting from participants and older people are asked to consult their GP before starting an exercise programme. It was likely that health conditions listed on questionnaires such as the PAR-Q which include arthritis, high blood pressure and poor levels of current exercise will be reported by older people suitable for chair based exercise and would, therefore, require GP approval before starting a programme. In addition, there was evidence that the PAR-Q was not accurate in identifying conditions that would preclude exercise for older people when compared with clinical examinations [196]. Modifications of the PAR-Q to meet the needs of older people have been suggested [197] due to the high number of older people excluded by the original version. These modifications have been shown to be promising in helping to reduce the number of older people excluded from participating in physical activity [195], however, where the modifications were evaluated in older people between 60-69 years of age which may not be representative of all chair based exercise participants. Such tools may, therefore, need to be approached with caution as the only method of identifying contraindications to exercise in this older population. Consulting the participants GP was debated by experts throughout the consensus process with the general view that informing GP's was a courtesy but not a necessity.

**Summary statement of the target population:** The PACE intervention was developed for older people who were unable to take part in standing exercise programmes, as assessed by a healthcare professional, which

could be due to an activity limitation, lack of confidence or reduced exercise tolerance.

The PACE intervention was developed in order to allow a greater number of appropriate older people who might benefit to attend and therefore to maximise acceptability and participation.

A health questionnaire completed by a health professional was chosen as an appropriate way to identify conditions where the programme may need to be modified. Absolute contraindications based on the American College of Sports Medicine Guidelines [39] were used to exclude participation to ensure safety.

## **5.4 Who should deliver the PACE intervention (Actors)**

Instructors' attitudes and behaviours towards older peoples' participation in exercise classes have been shown to be influenced by the instructors' qualifications and training [147] and therefore the role of the exercise instructor or leader was important to consider in the development of the PACE intervention. The range of professionals delivering the programmes in the systematic review supports the Delphi derived principles that chair based exercise does not have to be delivered by healthcare professionals. Experts did, however, agree that instructors should be suitably skilled and trained with knowledge and skills of working with older people. This is supported by NICE guidance on physical activity programmes for older people which describe a range of potential instructors (such as physiotherapists, fitness instructors and voluntary sector staff) who have the '*qualifications, skills and experiences*' needed to deliver programmes' [198], p. 8].

Although experts agreed that leaders did not have to be health professionals there was no consensus reached on the level of qualification needed to ensure the appropriate level of skills required. In the absence of a clear understanding on the level of qualification, the PACE intervention, in its development phase, was delivered by a qualified therapist with experience of working with older adults in a community setting.

**Summary statement of leader skills:** The PACE intervention, during the development phase, was led by a qualified therapist with the knowledge and skills to adapt the intervention to meet the different and changing needs of older people. This would help to minimise the risks and ensure that the intervention could be appropriately tailored.

## **5.5 What is the PACE intervention expected to achieve and how will it do this (Transformation)**

Experts in chapter three used the terms structure to refer to the content of the intervention and format to refer to the delivery. These terms are used in describing the PACE intervention.

### **5.5.1 Structure**

Table 30 compares the Delphi derived principles on the structure of programmes with the evidence from the systematic review. The areas of exercise content, the use of music and behaviour change strategies are then discussed.

In comparing the findings from the systematic review and the Delphi derived principles it is important to consider that randomised controlled trials do not always represent a real world setting and so there may be disparities between what experts consider important for chair based exercise and how interventions are implemented in controlled trial settings.

**Table 30: Comparing the expert views with the systematic review evidence on the structure of the PACE intervention**

	<b>Delphi derived principle</b>	<b>Evidence from systematic review</b>
<b>Exercise Content</b>	Each session should begin with an appropriate warm-up and end with an appropriate cool down	Stated in 10 papers [75, 81, 83, 109, 160, 165, 166, 168, 175, 177]. Where duration was specified it ranged from 5-10 minutes.
	Each session should include a component of strength resistance training, endurance training and cardiovascular fitness training	Ten studies [75, 83, 84, 166-169, 171, 173, 178] reported multi-component programmes however only one study [166] specified all exercise types.
	Each session should include developmental stretches	Developmental stretches not reported in any papers. Flexibility exercises and stretching programmes were specified in 10 studies [75, 84, 166-169, 171, 173, 175, 178].
	Strength training should be targeted to meet nominated programme aims	Not clearly stated in any of the included papers. Four studies employed joint specific strength training programmes with related outcomes.
	All chair based exercise programmes should include progressive resistance training that is tailored to the individual	Progressive strength training reported in 12 studies [75, 81, 83, 109, 160, 165, 166, 172, 174-177]. Progression included increasing the number of repetitions, the level of resistance or weight.
	Cardiovascular training should be performed at a moderate intensity.	The level of cardiovascular intensity reported in 3 studies [83, 166, 175] with low to moderate intensities reported.
	The delivery of sessions and exercises can be tailored to individual preference within a structured programme	Not clearly stated in any of the included papers.
	Strength training can include the use of resistance bands, weights and body weight resistance exercises	Webber et al [177] compared the use of weights and band reporting improved power with the use of bands. Studies used both weights [160, 176] and resistance bands [75, 168, 175].
	Participants should be encouraged to work at an intensity which is appropriately challenging for them	High intensity and low-intensity exercise compared by Seynnes et al [174] however not based on participant abilities. High intensity improved outcomes. Difficulty achieving high intensity identified by Latham et al [160].
	Cardiovascular interval training should be performed to prevent fatigue if appropriate and tailored	Not clearly stated in any of the papers where cardiovascular training was performed.
<b>Use of music</b>	Music can be beneficial as part of programmes if used appropriately and it is welcomed by participants	Music was used in two studies [84, 172].
<b>Behaviour change strategies</b>	The goal of chair based exercise should be clearly defined for each individual participant	Not stated in any included papers.

### **Exercise content**

Experts agreed that chair based exercise programmes should include an appropriate warm up and cool down which was reported in ten of the studies in the systematic review and was supported by exercise guidelines

for older people which state the use of a warm up and cool down as a way of reducing muscle stiffness and injury [35].

Evidence from randomised controlled trials and expert opinion identified similarities in the types of exercise needed for a successful chair based exercise intervention. Multi-component programmes were recommended by experts, were delivered in the systematic review literature and were in line with the principles of exercise for older people [13]. The PACE intervention, therefore, included progressive resistance training (strength and endurance), flexibility training and cardiovascular fitness training.

The importance of a progressively challenging programme was emphasised in the expert consensus views and the systematic review findings. This was in line with the principles of exercise for older people with progression considered necessary for improvements in physical outcomes [13, 24, 35, 40, 199]. The agreed expert definition stated that the purpose of the chair was to promote stability in both sitting and standing and that progression to supported standing should be encouraged. Progression of the exercise protocol in the PACE intervention, therefore, included supported standing exercises in line with this view and the principles of exercise for older people.

Evidence supporting exercise for older people is included in a range of documents that provided guidance on the type, intensity, and frequency of exercise required to achieve health benefits [13, 24, 35, 40, 199]. The evidence presented contradictory findings and perhaps there is an over-reliance on guidelines without appraisal of the quality as well as consideration of individual need. Guidelines and systematic reviews on the number of repetitions, sets and intensity of strength training for older people report a variety of delivery models and optimal progression models. The American College of Sports Medicine guidelines [35] suggests higher repetitions (such as 10-20) are appropriate for older people beginning to exercise however the evidence cited to support this actually states 8-12 repetitions as optimal [200]. The American College of Sports Medicine progression guidelines has been strongly criticised by Carpinelli et al [201] for using selective reporting as well as misinterpreting the evidence that underpins the recommendations for progressive resistance training.

Consistent messages from the evidence did, however, recommend a gradual approach that was progressively challenging and therefore these principles may be more important than the specific progression model. The progressive resistance training protocol for PACE was developed to improve muscle strength and adhered to current evidence and other exercise programmes with progressing the repetitions, sets and resistance as appropriate to the individual [166]. Muscular endurance exercises were included as part of the protocol in recognition of their functional relevance [24]. Sessions were delivered 48 hours apart to allow appropriate recovery in line with the principles of strength training [24]. The PACE exercise protocol was developed in line with the primary focus of improving lower limb muscle strength to allow progression to supported standing exercise.

One repetition maximum (maximum amount of weight that can be lifted once with good technique [202]) is considered the gold standard [202] for determining the appropriate starting resistance; however there are difficulties using this approach with this population due to the number of co-morbidities [191] and potential risks of delayed muscle soreness and injury [203]. The OPERA trial [191] conducted with care home residents suggested chair based exercise participants should begin with 0.5kg or 1kg ankle weights reflective of participant's functional ability. This approach was chosen for the PACE intervention due to difficulties using the one repetition maximum and the success of this approach in other studies.

Flexibility training was considered by experts in chapter three who agreed that programmes should include stretches and this was supported by the components of programmes in the systematic review. Although there were no good quality studies in the systematic review addressing flexibility outcomes, evidence from medium quality studies suggested the potential for improvement in this domain [168, 172, 175]. The underlying theory of flexibility exercises was to improve range of movement which would support function, mobility and activities of daily living [199]. Although flexibility exercises were not one of the recommendations of the national guidelines on physical activity [13], a systematic review confirmed there was little risk with their inclusion [51] with some evidence of potential benefit [53]. Flexibility exercises were therefore included in the PACE intervention but range of movement and flexibility measures were not

considered primary outcomes. The American College of Sports Medicine Guidelines on flexibility exercises [39, 199] were used in the PACE intervention due to the lack of good quality research to determine the optimum prescription [51]. Upper and lower limb stretches involving the major muscles and tendons were included that were held for 10-20 seconds [199] and built up to a period of 30-60 seconds [39].

Moderate intensity cardiovascular exercise was defined by the American College of Sports Medicine as a 5-6 out of 10 effort with '*noticeable changes in breathing and heart rates*' [199] p. 1439]. Intensity was measured using the BORG scale of perceived exertion [204] and heart rate monitors [85] in the systematic review. The use of heart rate monitors in a community setting and with unsupervised sessions was not considered appropriate due to individual differences between participants. The BORG scale of-perceived exertion has been used in published exercise studies [204] and is routinely used in clinical practice. The scale indicates the level of intensity through words such as '*light*', '*somewhat hard*' and '*hard*' alongside a numerical scale of 6-20. Moderate intensity exercise was suggested to fall within 12-14 and be considered '*somewhat hard*'. Working at a '*somewhat hard*' level may be interpreted differently between individuals and may not provide a tangible way for older people to understand moderate intensity. A simple way for older people to identify the relative intensity that they were working was using the talk test which is a valid measure for exercise prescription [205]. This provided an understandable way for older people to determine the level of intensity that they are working. During moderate intensity exercise you can talk but not sing [206] and this was differentiated between vigorous activity where you are unable to say more than a few words without resting. By being able to talk during activity it provides an '*indication that there is adequate oxygen supply to meet the demands of the respiratory systems and the muscle*' [207], p.37]. This simple practical approach [205] was chosen to allow participants to determine if they were working at a level that was too demanding [208] to ensure participants were working at a safe level during both the supervised and unsupervised sessions.

## ***Music***

The use of music to accompany chair based exercise was debated throughout the expert consensus process with the agreement that it can be beneficial if used appropriately and was welcomed by participants. It was only reportedly used in two of the studies in the systematic review. Previous research exploring the use of music identified it can increase participation. Both Matthews et al [209] and Johnson et al [210] looked at the use of music to improve exercise participation in older people with dementia living in nursing homes and attending day centres. Matthews et al [209] suggested that the mean percentage of participation in exercise per session increased with the use of music. Johnson et al [210] suggested that participation significantly increased during the exercise intervention with music (67.8% on task participation) in comparison to without music (61.95% on task participation,  $p=0.028$ ). In line with the expert views and the evidence that music can enhance participation, music was used in the PACE intervention if welcomed by participants.

## ***Behaviour change strategies***

The adoption of exercise behaviours may be influenced by a number of factors which include socioeconomic status, physical health and cognition [211]. Behaviour change strategies were highlighted as an important component to include in PACE in chapter one to support participation. Due to a lack of evidence to support which behaviour change theory or strategies were most effective, a practical approach was taken. The PACE intervention did not use one behaviour change theory but instead used practical behaviour change techniques derived from a number of models and the taxonomy outlined in chapter one. LaterLife training offer training on practical behaviour change strategies that is designed for professionals involved in the delivery of exercise programmes for older people [212]. Based on this training package the following components were considered as part of the PACE intervention [212] with wider behaviour change literature used to determine the content of each component.

### **Initial contact**

Older people need to feel supported and ready to engage in exercise programmes. Personal invitations to programmes can enhance participation particularly if done by a health professional [213]. Although this

recommendation by Yardley et al [213] is for falls prevention interventions the findings are also relevant for PACE as a complex exercise intervention for older people where support is needed to maximise participation. Older people were therefore invited to take part in the PACE intervention by a health professional.

#### Supporting early participation

Creating a positive start to the programme can encourage re-attendance and continued participation. The fear of participating in an exercise programme and the potential for injury or harm could limit participation and a health screening assessment may provide reassurance. Providing information on what participants can expect from the session and safety precautions can overcome potential concerns. Emphasising that the intervention is tailored to individual needs and the importance of working within individual capabilities is recommended [213]. A health screening assessment by a health professional was used in the PACE intervention to provide reassurance and information on the exercise programme was provided. The benefits of exercise were discussed at the start of the programme and reinforced throughout to provide information on the purpose of the programme.

#### Building self-efficacy

Self-efficacy can be considered an individual's belief that they can carry out a specific behaviour to reach a goal [214] and continuing participation in exercise is underpinned by self-efficacy [215]. The health professional facilitating the PACE intervention used strategies to build self-efficacy such as positive reinforcement and trying to develop positive support between participants in the group.

#### Goal setting and self-monitoring

Goal setting was considered one of the most promising behaviour change techniques for older people by experts in a consensus development process [216]. Goal setting should be meaningful to participants to support participation [217] and a self-selected goal was used at the start of the PACE intervention.

In a meta-analysis of physical activity interventions for all adults self-monitoring techniques were demonstrated to facilitate behaviour change and were most effective if used with other components of control theory such as goal setting and feedback on performance [218]. Physical activity diaries may, therefore, be useful for some individuals as a way of monitoring and maximising participation and were offered to participants in the PACE intervention.

#### Acknowledging challenges

Acknowledging and recognising the difficulties of participation in exercise programmes for older people with complex health needs can help to support longer term participation. Strategies such as contacting participants if they missed a session were used in the PACE intervention to support re-attendance. The health professional facilitated discussions over how the programme could be modified to meet individual participant to encourage participation.

#### Support strategies

Yardley et al [213] recommend encouraging self-management by older people and reducing the dependency on professionals for long-term exercise participation. Support was however considered important for PACE as a short-term intervention. Support strategies such as social support in a group, home visits and telephone calls if a participant had not attended or there were any difficulties in the session were used due to the complex needs of the PACE participants. Supervision was provided for two sessions a week to demonstrate the tasks and provide feedback and progression.

**Summary statement on structure:** The content of the PACE intervention included multicomponent training (progressive resistance strength and endurance training, flexibility training and cardiovascular training), delivered at a moderate intensity and using music if appropriate. The content was designed to improve muscle strength and cardiovascular endurance based on the physiological responses to exercise and to support progression to supported standing. Practical behaviour change strategies were chosen to maximise participation.

### 5.5.2 Format

Table 31 compares the principles in the domain of format derived from the Delphi technique (chapter three) and the format of published programmes from the systematic review (chapter four). The delivery of the PACE intervention is then discussed in relation to the duration and frequency, the degree of tailoring and whether group or individual sessions were used.

**Table 31: Comparing the expert views with the systematic review evidence on the format of the PACE intervention**

	Delphi derived principle	Evidence from the systematic review
<b>Duration and frequency</b>	Each session should last no longer than an hour	All studies reported sessions that ran for less than an hour.
	Each session should be carried out at least once a week	All studies reported sessions at least once a week. Sessions were most commonly delivered twice a week [83, 109, 166, 169-172, 177, 178] and three times a week [75, 81, 160, 165, 168, 173-176].
	Gradually building up the duration of sessions can be beneficial for older people with reduced exercise tolerance	Reported in one study [169] where sessions were increased from 30 minutes to 40 minutes.
	Each CBE session should be a minimum of 10 minutes long with a view to increasing further	Duration of 10 minutes reported by one author [140] others were all over 10 minutes.
<b>Degree of tailoring</b>	Rolling programmes are appropriate with new participants joining at any point	Not stated in any included papers.
	Programmes should be tailored to meet individual needs	Not clearly stated in any papers. One paper [176] reported individualising strength training.
	The number of chair based exercise sessions should be tailored to the individual needs of the participants	Not stated in any included papers.
<b>Group or one-to-one delivery</b>	No consensus on group or home based	Primarily delivered in a group setting (n=18), two programmes [160, 176] delivered individually at home.

### *Frequency and duration*

There was a lack of clear guidance on the optimal duration and frequency of exercise programmes for older people with multiple health conditions. The technical report which supports the Chief Medical Officers' recommendations acknowledged the lack of research on exercise programmes for older people with physical disabilities [219]. The American College of Sports Medicine and the American Heart Association [199] compared existing guidance for specific conditions such as osteoarthritis as well as healthy older people. Strength training was recommended on two-three days across the guidance and as a minimum for cardiovascular

training. Three sessions a week was the most commonly reported intervention and the optimum frequency for achieving health benefits identified in a systematic review [18]. NICE recommendations on the provision of physical activity programmes to promote well-being propose that older people should be encouraged to attend class based programmes once or twice a week [198]. From the available evidence frequencies of 2-3 times a week was suggested. Two supervised sessions and one unsupervised session a week was selected to allow the PACE intervention to be delivered flexibly to individual needs and in line with the evidence base.

The most beneficial duration of each session in a systematic review by Theou et al [179] was identified as 30-45 minutes duration however, this review focused specifically on frail older adults. Reviewing all the guidance the American College of Sports Medicine and the American Heart Association [199] concluded that for older people who are not currently active, a gradual cautious approach is recommended. This was in agreement with the experts who agreed that chair based exercise programmes should be gradually built up in duration with an hour being the maximum length of each session. A gradual approach was therefore chosen for the PACE intervention with the session duration increased to a maximum of an hour as appropriate to each individual.

The length of therapeutic exercise programmes for older people was debated throughout the literature. There appeared to be tension between published guidelines that focus on a public health perspective of long-term participation in physical activity and therapeutic time-limited interventions. Issues of dropouts due to severe health problems and death have however been identified in longer term programmes [179]. The therapeutic use of chair based exercise with a focus on progressing to standing programmes may require a different approach and a shorter duration. Due to the primary focus of increasing muscle strength to allow progression a shorter duration was considered appropriate. Twelve weeks was chosen to maximise adherence throughout the programme and in accordance with evidence on the duration needed to elicit changes in muscle strength as outlined in Table 32.

**Table 32: Effect of strength training with duration**

Objectives	Possible effects of training	Dosage
Increase in muscle strength	Increase in muscle mass Training of intramuscular coordination	At least 8-12 weeks Several weeks
Reduction of sarcopenia	Increase in muscle mass	At least 8-12 weeks
Adaptation of tendons and bones	Increase in net synthesis of collagen; reduction in bone density loss	Weeks to months

Adapted from Mayer et al [220]

### ***Degree of tailoring***

The importance of tailoring chair based exercise programmes to meet the individual needs of participants and services was highlighted through expert opinion with the agreement that the number of sessions should be targeted at participant need, sessions should be gradually increased and rolling programmes may be appropriate. Complex interventions are described as requiring a degree of tailoring at an individual level and within the context they are delivered [3]. Hoffman et al [181] suggest that the degree of tailoring needs to be explicit when reporting complex interventions to allow replication and determine which active ingredients are needed and under what conditions. A high degree of flexibility was considered appropriate to meet the needs of the older participants and encourage participation in the programme [213]. The PACE intervention was able to be modified in terms of the location of delivery (home or community venue), the format of delivery (group or one-to-one), choice of exercise equipment (free weights, resistance bands), and the duration, frequency and rate of progression.

### ***Group or one-to-one delivery***

Experts could not determine between groups and one-to-one delivery for chair based exercise suggesting that the most appropriate format was dependent on participant preference. Group exercise programmes may provide a more cost-effective approach as well as providing additional social benefits. A Cochrane systematic review [221] comparing centre based and home based exercise programmes for older people (with cardiovascular risk factors or osteoarthritis) reported limited evidence for the most appropriate setting (n=6 studies), however, health improvements were reported across both settings. Longer term adherence was suggested to be improved by home-based programmes, however, facility based training was reported to be more beneficial in the short term [221]. This

review focused specifically on cardiovascular risk factors, as no evidence was found for osteoarthritis, and the training at the centres involved the use of a treadmill. The findings may therefore be less appropriate to the characteristics of the PACE intervention and the target population.

Literature from the systematic review in chapter four demonstrated that chair based exercise programmes were predominantly group delivered in community facilities, although individual home-based programmes were also delivered. There was evidence across the wider literature to support the feasible delivery of both home [189] and group-based exercise programmes [190] in an older population. Due to a lack of clear evidence between group and home-based programmes and the acknowledgement of individual preferences the PACE intervention allowed participants to select between home and group-based sessions. It was recommended that the PACE intervention was tailored to the needs of older people and their preference with regards to where they are delivered in order to maximise participation

**Summary statement on the format:** The format allowed group or one-to-one home-based delivery with two supervised sessions a week for twelve weeks with each session lasting up to an hour. Participants were encouraged to carry out one session independently a week. A degree of tailoring to meet the needs of the older participants and maximise participation and delivery was permitted.

## **5.6 Context (Worldview and Owners)**

The context for the PACE intervention has been outlined in chapter one where the research gaps and the need for the intervention was described. In summary, there is an ageing population with an increased number of older people with compromised health and mobility. Political and societal drivers influenced the PACE intervention as society wants to keep older people in good physical and mental health living in the community for as long as possible. There are however a group of older people who are unable to exercise in standing and therefore have reduced mobility, function and quality of life. For this group of older people, the PACE intervention may be an appropriate form of exercise to sustain health and maximise participation in society.

## **5.7 What are the environmental considerations (Environment)**

Chair based exercise can be delivered in a range of community settings including NHS day rehabilitation services, care homes, day centres and participants homes. As PACE was a community-based programme issues of access and resources needed to be considered.

The successful delivery of an intervention may be limited due to a lack of appropriate resources. Strength training equipment was debated amongst experts with the use of body weight resistance, weights and resistance bands identified. Muscle strength and power gains have been demonstrated to be similar with the use of weight and resistance bands [177] and therefore their use can be based on participant preference which was likely to improve acceptability with the intervention. Both methods were therefore included in the PACE intervention.

Programme barriers can influence whether older people participate in exercise programmes and these barriers can include location and timing of sessions [222]. The provision of transport has been identified as a facilitator in the delivery of community exercise programmes for older people [212] and has been used in existing NHS services to support participation. In addition, there is evidence that older people do not wish to travel long distances [222]. Transport was therefore offered as part of the PACE intervention when delivered in a group setting.

The type of community venue for group-based programmes can influence participation. In focus groups with older people, Bethancourt et al [222] reported that uneven footpaths were a barrier to participation in exercise programmes and King et al [223] reported decreased attendance with inconvenient locations. The PACE intervention was therefore delivered in an NHS primary care centre which had flat even surfaces, good lighting and delivered other healthcare services that older people may have accessed.

**Summary statement of environmental conditions:** Group and individual home-based sessions offered based on participant preferences. Group sessions were delivered locally at an accessible venue with transport provided. These inputs would lead to an acceptable and accessible intervention and maximise participation.

## 5.8 Modelling processes and outcomes

Having identified the theories of the PACE intervention, using the CATWOE model, the next stage was to '*model*' the intervention and describe how the interactions between components would lead to the anticipated outcomes. The MRC framework [3] suggests three frameworks which may be useful in the modelling phase. MOST [224] uses a randomised approach to optimise behaviour change interventions and their subsequent evaluation. The other two are the RE-AIM framework [225] and guidance from the National Institute for Clinical Excellence on the behaviour change interventions [226]. These frameworks and guidance focus on the public health impact of behavioural interventions. Whilst offering guidance on the key considerations none of the frameworks provided a procedure that could be followed to model the PACE intervention and focus more on the long-term evaluation rather than the development and early testing.

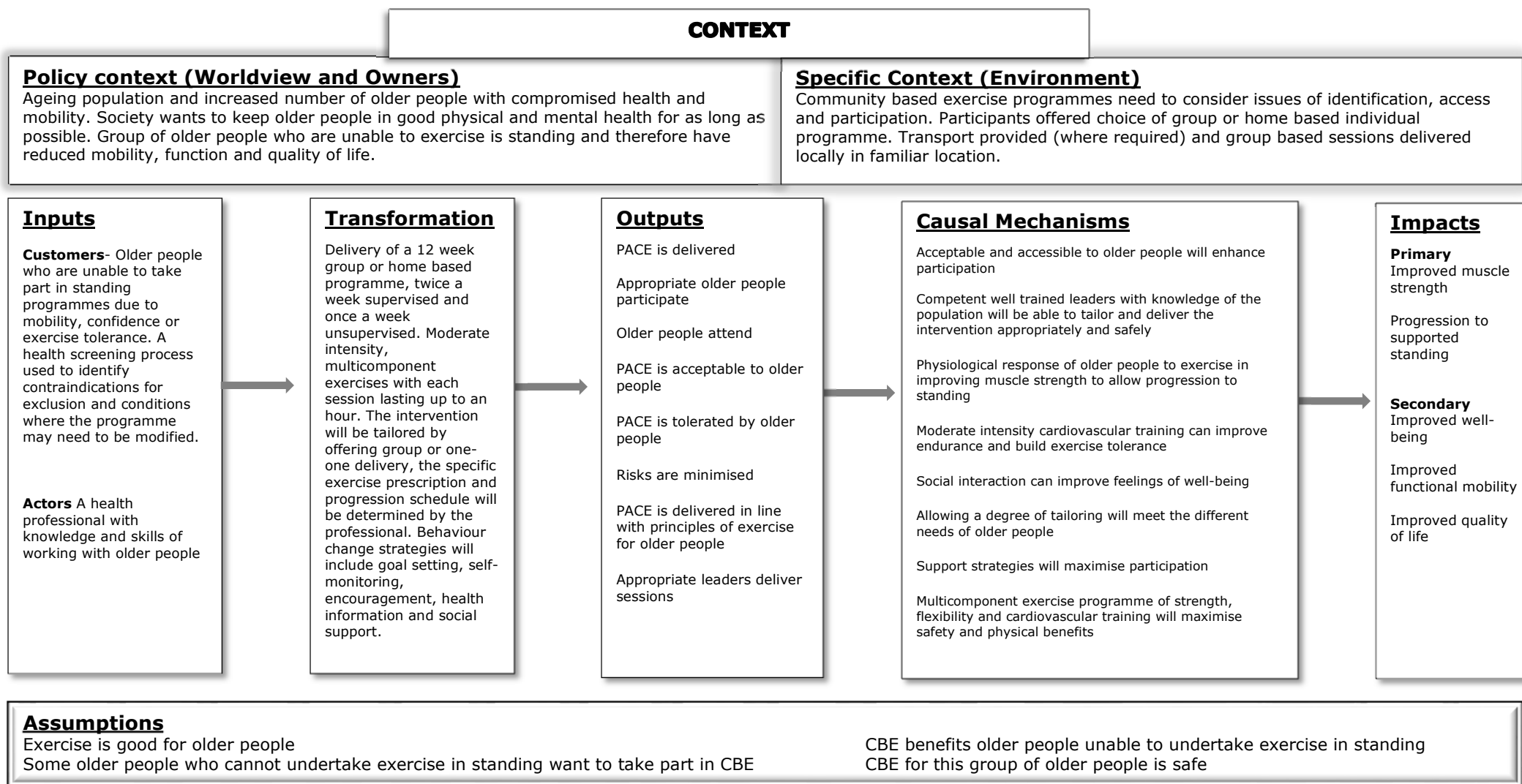
The modelling phase for the PACE intervention needed to consider whether the theories outlined by the CATWOE principle could be operationalised. It was, therefore, important to understand how these theories were intended to be delivered in practice. In order to do this, a logic model was used. A logic model can be considered a visual representation of describing how a system can be implemented and under what conditions [227], offering a way of sharing this understanding [228]. It displays the underlying theory of an intervention and how the anticipated outcomes are achieved [229] and is recommended in MRC guidance on process evaluations as a way of clearly defining and identifying causal mechanisms [121]. Logic models have been used in other healthcare intervention research such as midwifery [230] and improving patient safety [231]. They have also been used to present the findings of systematic reviews of complex interventions [229].

The logic model, presented in Figure 14, describes the PACE intervention and how it was expected to work. The theories identified using the CATWOE model have been visually displayed by using a logic model. The outputs and subsequent impacts describe what is expected to happen in practice if the PACE intervention remains compatible with the underlying theories. The assumptions that have been made about the PACE intervention are clearly stated. The logic model provides an implementation

plan that can be tested to see whether PACE has a robust theoretical underpinning and has been sufficiently modelled.

## **5.9 Conclusions**

This chapter outlined the underlying theories of the PACE intervention using a systems approach to ensure a coherent intervention had been developed. The theories were visually represented using a logic model which provided an implementation plan. Exploration of whether the underlying theories of the PACE intervention result in the anticipated outputs and primary outcomes will be explored in chapter six as the final stage of development of a complex intervention.



**Figure 14: Logic model of the PACE intervention**

## **6 Chapter Six: Modelling processes and outcomes**

This chapter presents a pre and post cohort study where the PACE intervention was delivered in a primary care community setting to explore whether the programme could be delivered as described in the logic model in chapter five and if it was acceptable to older people.

### **6.1 Introduction**

The final stage in the development of the PACE intervention was to '*model the process and outcomes*'. This stage was seen as testing whether the intervention could be delivered as outlined by the logic model in chapter five and testing if the underlying theories were demonstrated in practice.

The MRC framework [3] emphasises the importance of considering the implementation of a complex intervention throughout its development. The guidance suggests asking the question '*would it be possible to use*' [3], p.9] the intervention and advises that this is considered at an early stage before undertaking costly process evaluations and definitive trials. The feasibility and acceptability of the PACE intervention, therefore, needed to be explored to ensure that it was '*possible to use*' the intervention. This included considering if it could be delivered in the way it was modelled in chapter five, identifying any potential barriers to implementation as well as whether it was acceptable to the participants. The logic model described how the intervention would be implemented and what outputs would then be expected. By reviewing if the outputs have been achieved this would identify if the intervention had been delivered as intended, test whether the intervention had a robust theoretical underpinning and determine if it was a feasible and acceptable intervention package.

### **6.2 Aim**

To determine if the PACE intervention could be delivered successfully, if it was acceptable to participants and to assess if it elicited the anticipated outputs.

## 6.3 Objectives

1. Evaluate if the PACE intervention could be delivered as intended in an appropriate community setting.
2. Determine if the PACE intervention was safe, acceptable and tolerated by participants.
3. Assess if the PACE intervention resulted in the primary outcomes of success (improvements in lower limb muscle strength and progression to supported standing exercises) and secondary outcomes (improvements in quality of life, functional mobility and cardiovascular exercise tolerance)
4. Explore the most suitable outcome measures to evaluate the PACE intervention.
5. Evaluate if appropriate older people were participating in the PACE intervention.

## 6.4 Methods

A single site pre and post cohort study was completed, with a pragmatic design to reflect real patients who present to the NHS in the community. It consisted of two components. The first was a pre and post PACE intervention cohort study that collected delivery data and used standardised assessments to collect quantitative outcome data. The second component was a focus group with older people to collect qualitative data.

The study methods used to answer each of the objectives are outlined below.

**Objective One:** Evaluate if the PACE intervention could be delivered in an appropriate community setting.

Answered by:

- Number of participants recruited and the proportion recruited from those eligible
- Reasons older people decided not to take part in the study and the PACE intervention from field notes and a recruitment log
- Proportion of older people participating in the PACE intervention

- Barriers and facilitators identified in fields notes maintained by the researcher
- Fidelity to the PACE intervention and progression to supported standing exercises recorded in field notes and exercise spreadsheet

**Objective Two:** Determine if the PACE intervention was safe, acceptable and tolerated by participants.

Answered by:

- Qualitative data from participant focus groups
- Field notes maintained by the researcher on the barriers and facilitators to delivery
- Adverse events recorded in the case report form
- Attendance rates to the PACE intervention and reasons for non-attendance
- Fidelity to the exercise protocol and progression schedule

**Objective Three:** Assess if the PACE intervention resulted in the primary outcomes of success (improvements in lower limb muscle strength and progression to supported standing exercises) and secondary outcomes (improvements in quality of life, functional mobility and cardiovascular exercise tolerance).

Answered by:

- Pre and post measures of quadriceps strength, grip strength, walking endurance, Timed Up and Go Test and the EQ-5D-5L questionnaire
- Progression to include supported standing exercises in exercise completion spreadsheet
- Qualitative data on perceived benefits through participant focus groups

**Objective Four:** Explore the most suitable outcome measures for a future definitive trial to evaluate the PACE intervention.

Answered by:

- Researcher field notes on the completion of the outcome measures
- Number of older people completing pre and post assessments

**Objective Five:** Evaluate if appropriate older people were participating in the PACE intervention.

Answered by:

- Description of the sample in relation to mobility, strength, self-reported health status and medical history
- Qualitative data from the perspective of older people through participant focus groups

#### **6.4.1 Setting**

This was a single centre study completed in the Day Rehabilitation Service, Bassetlaw Health Partnership, of Nottinghamshire Healthcare NHS Foundation Trust. The Day Rehabilitation service provides group-based rehabilitation for older people with mobility limitations.

#### **6.4.2 Ethics and governance**

The study was given a favourable ethics opinion from North West Lancaster Committee (Appendix K) and local NHS Trust approval from Nottinghamshire Healthcare NHS Foundation Trust (Appendix K). As the researcher was a physiotherapist employed within the service no further governance procedures were required. The study was conducted in line with Good Clinical Practice (GCP) guidelines and the researcher had up-to-date GCP training (Appendix K) and informed consent training. A record was made in the electronic patient record after each consultation with a participant to ensure participation in the study was clearly documented for the usual care team.

#### **6.4.3 Sample**

A real world clinical setting (The Day Rehabilitation Service) was used as a recruitment source to identify older people with compromised health and activity limitations. At the time of this study, two exercise based therapy groups were delivered by the Day Rehabilitation service both with the aim of reducing falls and improving physical ability. A service evaluation was conducted in order to establish the current delivery of chair based exercise and the characteristics of older people attending programmes. A summary of the service evaluation of the Day Rehabilitation service is in Appendix A.

'Age Well' was a rehabilitation programme that combined chair based exercise and supported standing exercises with lifestyle education sessions (including diet and nutrition and falls prevention strategies). Participants assigned to the 'Age Well' programme were considered not able to take part in free standing dynamic balance exercise programmes. 'Age Well' was considered a chair based exercise programme based on the definition agreed by experts in chapter three. The second therapy programme, 'Staying Steady' provided free standing strength exercises, walking and dynamic balance exercises. Physiotherapy assessment and clinical reasoning was used to determine which group was most appropriate for the patients based on levels of mobility, functional abilities and exercise tolerance. The patient group attending 'Age Well' demonstrated poorer mobility and balance than those attending the 'Staying Steady' programme (Appendix A).

'Age Well' was delivered in a group twice a week for eight weeks for two hours each session (one hour of exercise and one hour of education sessions), in a primary care centre. Transport was provided by the service using a volunteer car scheme and private taxis where patients were not able to provide their own transport. The intervention was delivered by a physiotherapist and a generic rehabilitation support worker. The content of the programme is shown in Table 33.

**Table 33: Summary of the 'Age Well' therapy programme**

<b>Duration</b>	2 hours
<b>Frequency</b>	Twice weekly
<b>Length</b>	8 weeks
<b>Equipment</b>	Tea/Coffee Hand weights/Leg weights Resistance bands (varying levels of resistance) Parallel bars Educational leaflets Chair based exercise booklet
<b>Exercise component</b>	Seated warm up and cool down Seated strength and endurance training using resistance band and weights with no progression schedule Seated co-ordination Supported standing using parallel bars (if able)
<b>Educational component</b>	16 topics covering healthy eating, what to do in the event of a fall, footwear, benefits of exercise, support from Adult Health and Social Care
<b>Staffing</b>	1 physiotherapist 1 generic rehabilitation support worker
<b>Home exercise</b>	Chair based exercise booklet and visits from support worker to complete

As there were fundamental differences between the PACE intervention and the '*Age Well*' programme in terms of the exercise content, duration, frequency and progression it was not considered appropriate to evaluate the '*Age Well*' intervention to answer the objectives of this study. As the feasibility of the PACE intervention had not been established it was not considered appropriate to implement the PACE intervention over the existing '*Age Well*' programme.

It was not considered appropriate to offer participation in the PACE intervention whilst patients were receiving routine rehabilitation from the Day Rehabilitation due to the potential burden. Patients needed to complete the routine rehabilitation in order to access a multifactorial falls assessment, follow-up visits at home and input from other healthcare professionals but this may have had an effect on recruitment and engagement with the research project.

All patients who completed the '*Age Well*' rehabilitation programme were eligible for inclusion into the pre and post cohort study of the PACE intervention.

A formal sample size was not required for the study design as this study was addressing the feasibility of delivering the intervention and outcomes were considered on a case by case basis. A sample size calculation was therefore not conducted. A sample of up to twenty participants was considered acceptable to collect informative data within the constraints of the study.

#### **6.4.4 Recruitment methods**

Participants were recruited from the Day Rehabilitation service by a member of the patient's usual care team. Potential participants were screened by the clinical team to ensure they met the inclusion criteria. An invitation letter (Appendix L) accompanied by the Participant Information Sheet (Appendix L) was posted to potential participants and then followed up by telephone call approximately one week later. Potential participants who were interested were visited at home to discuss the study and answer any questions. Strategies to improve recruitment [232] included visiting potential participants in their home to reduce any inconvenience for the participants, ensuring the times of appointments were at the preference of the participant, offering for family members to be present at any visits and

providing free transport for any study visits when participant chose to attend the Day Rehabilitation service.

The approach of a letter followed by a telephone call and a home visit was implemented in response to recommendations made by the Division of Rehabilitation and Ageing patient and public involvement group. This group felt a letter would give potential participants prior information before the telephone call. A home visit would then allow further discussion and questions in a comfortable familiar environment.

Written informed consent was provided by all participants for the pre and post cohort study and separately for the focus group as it was recognised that some participants may have only wanted to take part in the exercise component. In line with good clinical practice, a copy of the consent form was retained by the participant, a copy was scanned onto the electronic patient record and the original was kept in the trial master file.

#### **6.4.5 Eligibility criteria**

The inclusion criteria outlined below were designed to be broad to ensure that a range of older people were identified. Absolute contraindications to exercise and recent injurious falls were exclusion criteria to ensure safe participation and reflected current clinical provision in the Day Rehabilitation service. In line with good clinical practice and ethical frameworks, older people without mental capacity were not included as the objectives of this study could be addressed by those with mental capacity.

##### ***Inclusion criteria***

- 65 years old and over
- Previously attended 'Age Well' programme within the last 16 months
- At least a month's break from completion of the 'Age Well' programme
- Able to understand and speak English
- No serious injurious falls in the last month (serious injurious fall defined as fracture, head injury, or internal injury [233])

##### ***Exclusion criteria***

- Completed the 'Age Well' programme within the last month

- Lack of capacity to provide informed consent
- Absolute contraindications to exercise according to the ACSM [39] guidelines as assessed by a physiotherapist. These include unstable angina, uncontrolled cardiac dysrhythmias, symptomatic severe aortic stenosis, uncontrolled symptomatic heart failure, acute pulmonary embolus, acute myocarditis, acute systemic infection.

#### **6.4.6 Intervention summary**

The PACE intervention was delivered as described in chapter five and a summary is provided below:

- Group or one-to-one dependent on participant preference
- Maximum of 10 participants when delivered in a group format to comply with health and safety procedures of NHS setting
- Led by one physiotherapist
- Delivered twice a week for up to an hour supervised by the physiotherapist
- Each participant was encouraged to complete one exercise session at home per week on their own (home exercise booklet provided)
- Up to 12 weeks
- Progressive exercise protocol as described in chapter five

Each session included a warm up phase, progressive strength and endurance resistance training, cardiovascular fitness training, stretches and a cool down phase. Music was used if welcomed by the participants. The exercise protocol was individually tailored based on the physiotherapy assessment to account for the differences in participant's health. Rolling programmes were used to allow participants to join at different times. A description of each exercise is presented in Appendix M.

Each participant's health was assessed by the researcher prior to commencing the exercise programme (Appendix N) to allow the programme to be tailored appropriately. Participants were asked about their past medical history and where information was lacking or there were areas of concern these were verified by their general practitioner (GP) to ensure safe participation. Informing GP's about participation in chair based exercise was contested by experts through the Delphi technique (chapter three) without consensus being reached. This was supported by the ethical

review of the study which stipulated that a letter informing the GP about participation in the study be removed from the study process.

#### **6.4.7 Data collection and storage**

A paper case report form was used to capture the study process for each participant. This included assessment of eligibility, consent, pre and post intervention data, attendance data, a summary of exercise completion, focus group participation, adverse events, study completion and withdrawal. A running record was used to document researcher observations and communication with the participant in line with routine clinical procedures. The case report form was completed by the researcher as soon as possible after the study process had been undertaken. The principles of good clinical practice were followed in the completion of the case report form.

Quantitative outcome data were recorded on paper case report forms for each participant and then transferred to an excel spreadsheet. The database was checked by an independent researcher using a standardised spreadsheet against the paper case report forms to ensure the accuracy of the data transferred and completion of the case report form (Appendix O). The type of exercise completed in each session was summarised in the case report form and details on the dosage and intensity stored in an excel spreadsheet for each individual participant. Free text comments on the reasons for modifying the exercises were recorded on the excel spreadsheet.

All quantitative data was stored and managed using the SPSS (Version 2.0) computer software programme.

Focus group data and field note data were managed using NVIVO (Version 10.0) data management software.

#### **6.4.8 Outcomes**

##### ***Recruitment data***

Data on the number of potential participants identified, the number invited to the study along with reasons for not being invited, the number visited to discuss the research study and the number providing informed consent was recorded using a recruitment log. Reasons for deciding not to take part in

the study were recorded where possible. Observations about the recruitment process were recorded by the researcher using field notes.

### ***Participant characteristics***

Data including gender, age, preferred mobility aid and health conditions were recorded for participants. The level of mobility was categorised depending on the walking aids used based on the following scale:

- 1: Independent with no aids
- 2: 1 Walking stick
- 3: 1 Elbow crutch
- 4: 2 Walking sticks
- 5: 2 Elbow crutches
- 6: Quad based walking stick
- 7: Wheeled walkers
- 8: Wheelchair

### ***Pre and post-intervention outcomes***

Each participant was assessed with the following measures before and after completing the PACE intervention and these were undertaken in the Day Rehabilitation service at Retford Primary Care Centre or in the participant's home (depending on the participant's preference). Participants were not made aware of their pre-test scores and the researcher did not have the pre-test scores available for the post-test data collection to reduce the potential for bias. The measures were chosen based on the underlying rationale of the PACE intervention and the programme content as described in chapter five.

#### Lower limb muscle strength

Isometric quadriceps strength was measured using a hand held dynamometer which was calibrated according to manufacturer's instructions. A hand held dynamometer was chosen as it was appropriate for use in a community therapy setting with older people [234]. Due to the mobility limitations of the participants measuring muscle strength whilst sitting was considered most appropriate and allowed the test to be completed in participants own homes. Hand held dynamometers have been shown to be valid and reliable in measuring quadriceps strength in a sitting

position in older people [235]. The test protocol for measuring quadriceps strength is outlined in Figure 15.

- Seated (due to mobility limitations of participants)
- High backed chair (to allow completion at home)
- Arms resting on arms of the chair
- Test device positioned 2 inches above lateral malleolus
- 5 seconds of muscle contraction
- Repeat 3 times with highest value recorded
- Test device positioned perpendicular to the limb
- Make Test (held in fixed position and participant asked to push against it maximally)
- Instruction: Push against device as hard as you can
- Record absolute value in kg

**Figure 15: Quadriceps strength test protocol**

A make test protocol, where the tester aims to keep the dynamometer still with the participant pushing out against the tester, was chosen as the most appropriate test protocol. The make test was chosen over a break test protocol as it has been shown to be more reliable [236, 237]. In addition, the break test requires the tester to push against the participant to the point of fatigue of the muscle which was not appropriate for the older participants in this study. The value from the hand held dynamometer was recorded in kilograms for each leg.

#### Upper limb strength

Grip strength was measured as the exercise programme included upper limb strength training. This was measured using a hand held JAMAR dynamometer which was calibrated according to manufacturer's instructions. This is an appropriate measure to use in a community setting [238] and is used as an objective measure in clinical practice. It has been demonstrated to be acceptable to older people in a range of healthcare settings [239]. The Southampton grip strength protocol [240] was used as it provides support for the forearm on the arm of a chair and has been used in an older population. The test protocol for grip strength is outlined in Figure 16. The highest of three test scores was recorded for each arm

and the participants were instructed to squeeze the dynamometer as hard as they could.

- Seated
- Elbow at 90
- Forearm in neutral
- Forearm supported on arm of chair
- Shoulder adducted

**Figure 16: Grip strength test protocol**

#### Functional exercise capacity using the 6-minute walk test

The 6-minute walk test was carried out as a measure of functional exercise capacity [241] as cardiovascular training was included in the intervention. It is a test of sub-maximal aerobic capacity. Participants were asked to walk for 6 minutes and the distance recorded. This is a reliable and valid outcome for community-dwelling older people [242]. Due to the nature of the participants in this study, the test was only carried out once at each time point. A standardised protocol based on the American College of Rheumatology Protocol was used [243].

#### Mobility using the Timed Up and Go Test (TUGT)

The Timed Up and Go Test is a measure of functional mobility and was developed using community-dwelling older people and contains balance and walking components that are used for daily functional activities [21]. It was chosen as an outcome to determine if the changes in lower limb muscle strength translated to improvements in functional mobility. The standardised protocol outlined in Figure 17 was used. Due to the mobility limitations of the participants the test was only carried out once at each time point without any practice test.

- Seat 44-47 cm with arms
- Usual walking aid used
- Start sitting, walk to a line 3 meters away turn around and walk back to the chair and sit down
- Instructed to walk at comfortable speed
- Timed from when moving away from back of chair to standing to when fully returned to sitting

**Figure 17: Timed Up and Go Test protocol**

#### Quality of life using the EuroQuol-5 Dimension-5L (EQ-5D-5L)

Participants self-completed the EQ-5D-5L. The EQ-5D-5L is a standardised measure of health status that is short and easy to complete [244]. It has been used in other studies with this participant group [245] and in other studies exploring exercise for community-dwelling older people [189]. The EQ-5D-5L provides a summary profile of a participant's self-rated quality of life and a measure out of 100 of how they would describe their current health. A copy of the EQ-5D-5L questionnaire and sample scoring is provided in Appendix P.

#### ***Delivery, fidelity and tolerability of the intervention***

Field notes were kept for each exercise session detailing the number of attendees, participant comments, what worked well in the session and any barriers to completion of the session. Attendance to the programme was recorded along with any reasons for non-attendance. The exercises completed in each session were recorded along with any reasons for non-completion. The progression to supported standing exercises was recorded. Therapist observations and reasons for a lack of progression against the exercise progression schedule were recorded in the running records and in the case report form.

#### ***Acceptability of the intervention***

All participants who consented to the intervention component were invited to take part in a one-off focus group to explore the acceptability and tolerability of the programme. A focus group can be described as research that *'involves a number of people-often with common experiences or*

*characteristics- who are interviewed by a researcher for the purposes of eliciting ideas, thoughts and perceptions about a specific topic' [246], p. 125].*

A focus group was chosen as it was considered useful in gaining insight into participants' experiences and views of a particular service [247], and in this case the PACE intervention. A focus group design allowed the views of older people, as participants in PACE as a complex intervention with multiple components, to be explored through facilitated discussion [248]. It was considered advantageous over other methods such as individual interviews as it allowed participants to discuss their views with others [249, 250]. This group discussion can support mutual reinforcement and develop a greater understanding, which was considered appropriate as PACE was in the development stage. The use of individual interviews was also considered inappropriate for this study as the same researcher who had recruited and delivered the exercise programme was also conducting the qualitative methods. The peer support within a focus group reduces the potential that the same researcher would inhibit comments and discussion.

The sample of participants invited to the focus group was chosen as they had experience of taking part in the pre and post cohort study. All older people who gave informed consent for the pre and post cohort study were invited to take part in the focus group irrespective of whether they had started the PACE intervention and irrespective of the number of sessions they had attended. This was to allow a full range of perspectives to be explored. It is acknowledged that using pre-existing groups and participants that are familiar with each other may introduce bias [251], however, this could not be avoided in this sample. By inviting participants that had chosen individual home based sessions and participants who were unable to commence the exercise programme this may have reduced the effect of pre-existing group dynamics.

The focus groups took place in the Day Rehabilitation Service. This was considered appropriate as it was a familiar and appropriately resourced environment for older people with mobility limitations who may have been anxious about attending an unknown environment. It was an appropriate geographical location which was considered important in maximising attendance [249].

It was recognised that participants may not be able to attend the focus group due to health reasons given the nature of the older population in this study and therefore two focus groups were planned to allow as many interested participants to attend. It is acknowledged that this approach would result in smaller size groups. Smaller groups were considered appropriate in this study as participants were chosen based on their specific knowledge of the PACE intervention. They would also allow participation from each older person, which may be more challenging in a larger group [249].

Facilitation of focus groups is important to ensure unbiased responses [251] and to ensure that all participants are included [249]. The researcher who delivered the exercise programme facilitated the focus groups. This was considered appropriate as the participants may be more open to discussions with a familiar person in which they have developed a rapport. It is however acknowledged that this may have limited open discussion about negative perceptions with the intervention [249]. The beliefs of the researcher (outlined at the start of the thesis) and the experience of the researcher in delivering the PACE intervention will have influenced the facilitation and analysis of the focus groups. This is acknowledged and the results are discussed within this context. Two researchers are often used in focus groups with one researcher acting as facilitator and one note taking [249]. With a small group it was considered unnecessary to introduce an additional researcher, whose presence may have inhibited interaction amongst a small group of people.

A focus group schedule or discussion guide was required to ensure that the discussions were directed towards the objectives of exploring the acceptability of the PACE intervention [249]. The facilitator used open questions to generate discussion but also used more direct and closed questions to clarify points where appropriate as well as direct questions to ensure all participants were included [249]. The facilitator summarised discussions on flip chart paper throughout the focus group to clarify and to check understanding of the discussions. The focus group was managed to cover specific areas but also allowed for discussion in areas participants felt were important to cover. The focus group schedule (Appendix Q) was constructed in line with the study objectives of exploring acceptability, tolerability and feasibility. The schedule was developed to consider i) what

participants enjoyed and did not enjoy about the programme ii) the benefits and difficulties of the programme, iii) content and delivery of the programme iv) motivation and adherence strategies, v) scope for participants to raise other issues they considered to be relevant. The focus group was digitally recorded to allow transcription after the event.

The researcher reflected on the running of the first focus group before the second group to ensure the schedule and facilitation were appropriate.

#### **6.4.9 Adverse events**

Adverse events were defined as any unfavourable and unintended sign, symptom, syndrome or illness. An adverse event included the following:

1. Exacerbation of a pre-existing illness
2. Increase in frequency or intensity of a pre-existing episodic event or condition
3. Condition detected or diagnosed during delivery of the intervention even though it may have been present prior to the start of the study
4. Continuous persistent disease or symptom present at baseline that worsens following the start of the study

A Serious Adverse Event (SAE) was considered any adverse event that occurred and resulted in any of the following:

1. Death
2. A life-threatening adverse event
3. Inpatient hospitalisation/ prolongation of existing hospitalisation
4. A disability/incapacity

Only adverse events that occurred during the study procedures, delivery of the exercise intervention by the therapist or when the participant was performing the home exercise programme were considered adverse events for the study. Events that met the above definition but did not occur directly during the exercise programme or study procedures were not reported. This was considered appropriate and obtained ethical approval due to the nature of the participants in the study. Where events occurred

during the delivering of the intervention or study procedures these were assessed for seriousness, expected and causality. Participants were asked before each session if they had experienced any pain, injury or fatigue following the last session. The protocol stated that serious adverse events would be reported to the ethics committee through annual reporting and any unexpected serious adverse events would be reported within seven days. A spreadsheet of events was maintained and discussed regularly with the primary academic supervisor Professor Pip Logan who acted as Chief Investigator to ensure adverse events were closely monitored.

#### **6.4.10 Data analysis**

##### ***Participant characteristics***

Descriptive statistics and measures of central tendency were used to describe the characteristics of the study sample. Muscle strength variables were calculated for male and female participants separately due to the anticipated gender differences in muscle strength scores and to compare the sample characteristics with normative reference values. Normality of the collected data was explored by examining the histogram plot and distribution curve for each variable (Appendix R). Where the data was normally distributed the sample mean and the standard deviation was presented for continuous variables (e.g. the Timed Up and Go Test) to provide a description of the sample. Where the data was not normally distributed the median and interquartile range was calculated.

##### ***Delivery, fidelity and tolerability to the intervention***

###### Attendance

Attendance was defined as taking part in a group or home based supervised sessions. The reasons why participants did not attend a session were recorded.

###### Fidelity to the exercise programme

Data on the number of each exercise completed in each session was analysed to identify where participants had not been able to follow the progression schedule. The number of incidences where progression was not achieved and the reasons were counted.

### Barriers and facilitators to delivery

Textual data from the field notes were analysed using content analysis to establish themes and the frequency of the themes. Conventional content analysis is referred to as an inductive approach that does not use a pre-determined framework and theory, instead using the data to identify themes [252]. It is however acknowledged that there is always a reductionist element to qualitative research due to the constraints and the focus of the research [253]. Content analysis '*goes beyond merely counting words*' [252], p. 1278] instead helping to provide further understanding of the topic. In this study, the field notes written by the researcher were structured to identify barriers and facilitators to delivering the programme which imposed a framework to the subsequent analysis and reflects a more deductive approach.

Debate exists whether thematic analysis is an analytical method in itself or a tool used in other analytical approaches [254]. The principles of thematic analysis were used in this study as part the content analysis method. Qualitative analysis is often criticised for a lack of transparency and detail in how the analysis was conducted and how the analysis supports the conclusions that have been drawn [254]. The rationale for each stage of the analysis process should, therefore, be made explicit to increase the confidence in the findings. The stages of content analysis and the rationale are presented in Table 34. The analysis was conducted by the researcher who had delivered the exercise programme and recorded the field notes.

**Table 34: Stages of content analysis**

<b>Stage of analysis</b>	<b>Rationale</b>
The field notes for all exercise sessions were considered as one data set.	The group and one-to-one sessions were considered together as the intervention included both options based on the preferences of older people.
The field notes were read by the researcher and initial comments and reflections made.	To allow familiarity with the data.
The data was read word for word and codes derived.	To allow codes to emerge from the data relating to barriers and facilitators.
The codes were reviewed to develop themes under the main categories of barriers and facilitators.	To allow grouping of related codes for more focused interpretation of the data.
A definition was developed for each theme.	To allow transparency over what the theme included.
The frequency of occurrences of each theme and examples of responses were presented.	The frequency of occurrences allowed identification of the most common barriers and facilitators.

### ***Pre and post-intervention outcomes***

Due to the diversity of the participants, and small sample, conducting statistical comparisons of pre and post means was not appropriate. Statistical comparisons to determine whether the changes with the intervention were significant were also not appropriate for the aim of the study.

#### Describing the changes

The pre and post outcome data was analysed on a case-by-case basis for each participant. The absolute and percentage change for each participant for each variable was calculated to provide a descriptive summary of the changes following the PACE intervention. It was acknowledged that there were limitations with both the absolute and percentage change scores. Absolute changes do not account for baseline differences in participants and may not have given an indication of the scale of the change. Low baseline scores do however amplify the percentage change with small absolute changes resulting in larger percentage changes [255]. Page [256] recommends that both the absolute and percentage change should be reported in clinical studies to allow the findings to have more clinical relevance. In addition clinically important differences (outlined below) are presented in terms of absolute and percentages changes across the literature. Both methods have been presented to allow transparency to the reader and to fully describe the data whilst acknowledging the limitations of both methods.

A summary of the change across participants was conducted to fully describe the data. The absolute and percentage change scores for each variable were checked for normality and where normally distributed the mean change and standard deviation was calculated. Where the data was not normally distributed the median and interquartile range was calculated. Normality was checked by reviewing the shape of the histogram plot and comparing the mean and median values. The 95% confidence intervals were then calculated for the mean/median absolute and percentage changes for each variable to provide an estimate of where the true value of the mean/median change might lie. It was acknowledged that the confidence intervals were likely to be very wide due to such a small data set.

### Outcomes of success

This study aimed to demonstrate the potential of the intervention prior to evaluation in a definitive trial. It was, therefore, important to state what was considered to be evidence that the intervention was sufficiently developed to a point where it could reasonably be expected to have an effect. Minimum clinically important differences in the quantitative outcome measures were identified using existing literature (Table 35). Minimum clinically important differences (MCID) can be defined as the smallest change in an outcome that would be considered meaningful to a patient [256]. Due to the underlying theory of the PACE intervention in progressing to supported standing exercises, the primary outcomes of success were lower limb muscle strength and the number of participants progressing to supported standing exercises. For the intervention to demonstrate potential benefit in the outcome 50% or more of the participants were required to achieve the minimum clinically important differences in lower limb muscle strength and progress to supported standing exercises. The minimum clinically important differences for the secondary outcomes are presented but were not considered markers of success at this development stage.

**Table 35: Minimum clinically important differences**

<b>Outcome</b>	<b>Minimum Clinical Important Difference (MCID)</b>	<b>Evidence</b>	<b>Comment</b>
Lower limb muscle strength (Quadriceps strength)	4.6kg	Bohannon [257]	Smallest change needed to transition from dependent to independent with sit-to-stand. Individual participant value of 4.6kg used instead of group mean value of 8.3kg. Other values across literature reporting mean group percentage changes after strength training interventions in community settings include no change [160], 27% [75] and 46% [180].
Functional exercise capacity (6-minute walk test)	25 metres	Perera [242] Holland [258]	Range of changes provided across the literature. Minimum value used due to the mobility limitations of the participants.
Mobility (Timed Up and Go Test)	31%	Kristensen [259]	Provided percentage change needed for individual patients which accounted for baseline score. Difficulty determining MCID for this patient group and wider literature on hip fracture used due to mobility limitations and mean TUG time comparable with this sample.
Upper limb strength (Grip strength)	13 lbs	Lang [260] Nitschke [261]	Difficulty determining MCID for this sample and literature on older people with a wrist fracture and stroke used.

The number of participants completing each outcome was presented. If 10% of the sample were unable to complete the outcome measure then the measure was considered inappropriate for this population. Recruitment field notes were reviewed to summarise issues with completion of the measures in this population.

### ***Acceptability and participant views***

The focus group data was analysed using Framework Analysis [262]. This is an approach that was developed through social policy research and can be considered a thematic analytical approach that provides a structured output [263]. Developed by Ritchie and Spencer [262], Framework Analysis provides a matrix based approach to qualitative analysis that is not aligned to a particular epistemological standpoint and is viewed as a method of data analysis rather than a research paradigm [264]. It offers a flexible yet systematic approach that allows for a clear audit trail of how the conclusions are supported by the data [264]. Whilst this flexibility can be advantageous there are suggestions it can lead to inappropriate use of the method [247]. The process of analysis that was conducted needed to be clearly outlined to improve rigour [264].

A deductive approach to analysis was considered appropriate as the focus groups were addressing clearly defined objectives. An inductive analytical approach would have been appropriate for more exploratory investigation without any pre-defined limits which was not the remit of this work. The focus groups in this study were part of a range of data sources in the development of a complex intervention and designed to elicit the views of older people on key components of the intervention.

The following stages of analysis were conducted which are presented as distinctive components, however, it is acknowledged that these components are interdependent.

#### **1. Pre-defined framework developed**

A pre-defined framework was constructed (Appendix S) using the themes and principles identified through the consensus development process in chapter three as well as the systematic review findings presented in chapter four and wider exercise literature in chapter one. This ensured that the framework was logically developed using expert views and the current literature. To validate the framework it was independently reviewed by

Professor Pip Logan (primary supervisor). To allow for any views expressed through the focus groups that did not fit with the pre-defined framework an additional code of 'other' was added to ensure this data was not missed. It was acknowledged that this framework could be adapted in the context of the data through the creation and removal of codes however the original framework and any adaptations would be clearly reported and justified by the data.

## 2. Transcription and familiarisation with the data

The focus groups were transcribed verbatim by the author and using a pre-defined transcription protocol (Appendix T). The protocol was developed to ensure that the content of the discussions was captured as the main focus of the analysis. Transcribing the groups can help '*immerse*' the researcher in the data and is strongly encouraged for novice qualitative researchers [263], p.4]. One of the transcripts was read by Professor Pip Logan (primary supervisor) to ensure familiarisation with the data.

## 3. Thematic charting

Sub-themes within the framework were applied using an Excel spreadsheet and NVIVO by the author (an example of initial coding and transfer is presented in Appendix U). The completion of this stage by the author alone follows a worked example by Ward et al [264]. It is acknowledged that in line with the conventions of Framework Analysis as outlined by Ritchie and Spencer [262] sections of the transcripts should be summarised within the framework rather than the use of verbatim material. This is to allow efficient processing of large amounts of data. This approach was however adapted as the small amount of data in this thesis allowed integration of direct quotes into the framework without the matrices becoming too unwieldy and difficult to manage.

## 4. Discussion

The application of the sub-themes was discussed in a face-face meeting by the author and Professor Pip Logan (Primary Supervisor) to improve rigour [264].

## 5. Summarising

The columns in each sub-theme of the framework were summarised to identify the key perspectives of each theme.

## 6.5 Results

As each source of data is answering more than one study objective the results of the study are presented in order of the study procedures. A summary of the findings for each objective is presented at the end of the results section.

### 6.5.1 Recruitment of participants

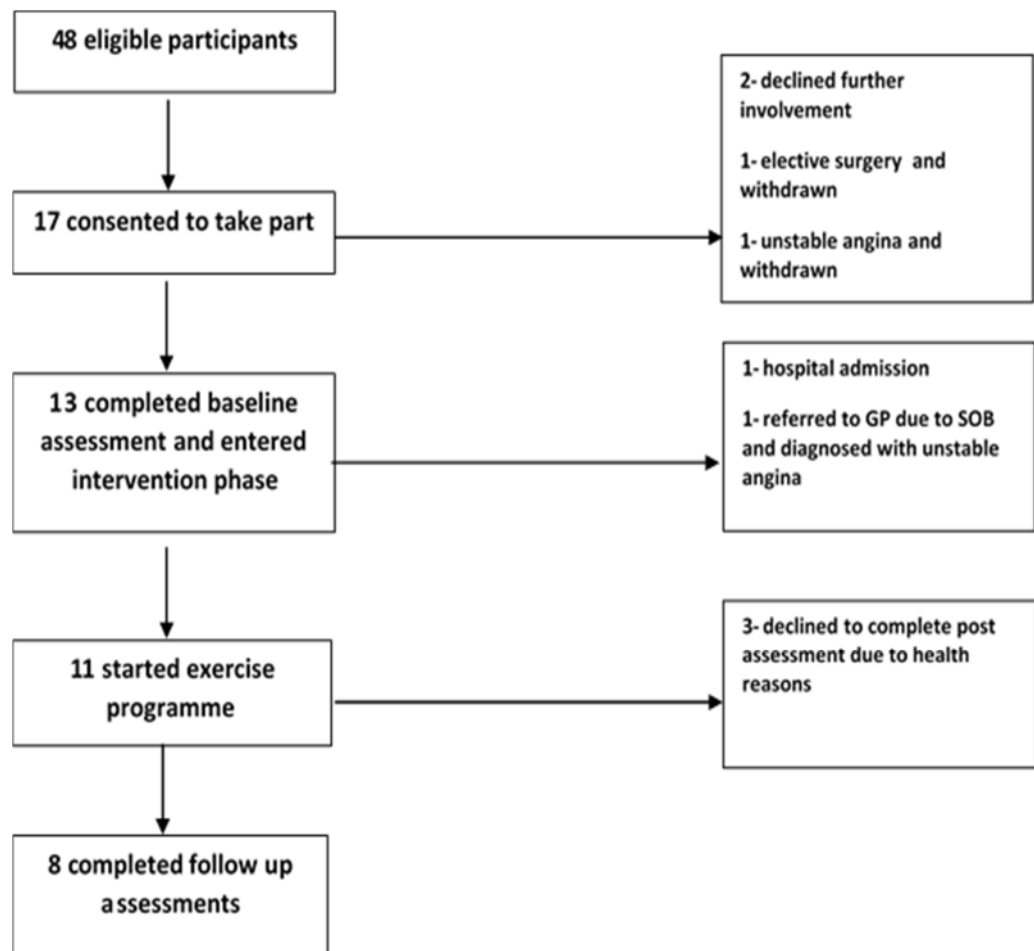
Seventeen participants gave informed consent for the exercise component of the study. Table 36 presents the number of eligible participants identified, the number invited to take part along with reasons that participants were not invited. The number of recruitment visits and patients providing consent is detailed along with reasons given for declining to take part. Recruitment took place between April 2015 and August 2015.

**Table 36: Screening and recruitment of participants**

Number identified on electronic patient system	Reasons for not being invited
87	Did not have mental capacity to consent based on team discussion=3 In hospital=6 Recent injurious fall =3 Receiving end of life care=1 Currently attending Age Well programme=9 Dead=2 Did not attend the day rehabilitation service= 15
Number of letters sent	Reasons for declines on telephone assessment
48	Not well enough= 5 Completing own exercise programme= 1 Receiving other therapy= 4 Recent bereavement= 1 Considered too much= 2 Unable to contact = 1 No reason = 10
Number of participants visited	Reasons for decline after visit
24	Hospital admission=1 Awaiting operation= 1 Considered too much=3 Receiving other therapy= 1 Did not have mental capacity to give informed consent =1
Number consented	
17	

Forty-eight potential participants were identified and seventeen (35%) were recruited to the study. Thirteen of those recruited (76%) started the exercise programme. Figure 18 shows the number of participants in each

part of the exercise component study giving reasons where participants did not progress in a session.



**Figure 18: Flow diagram of exercise component**

### 6.5.2 Characteristics of participants

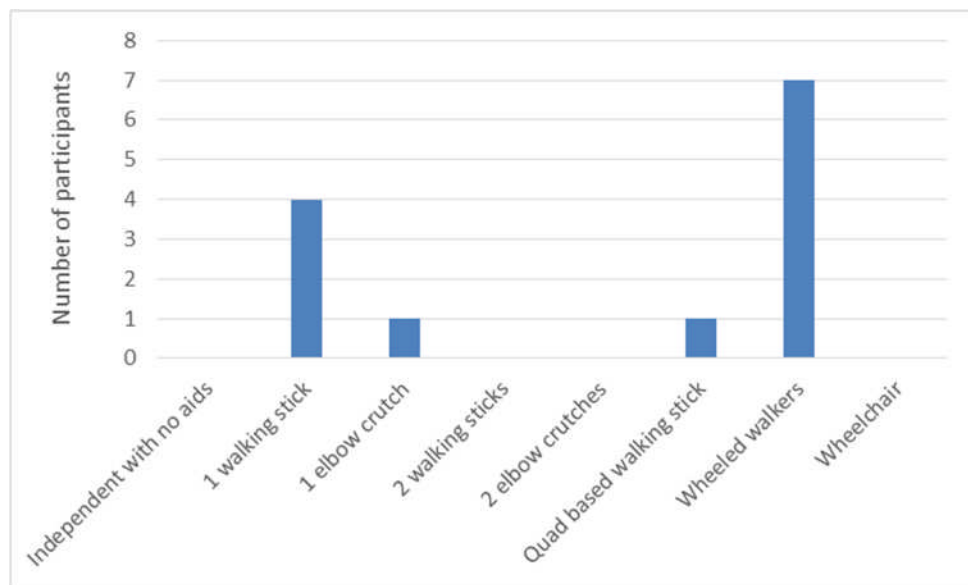
Of the thirteen participants who completed baseline assessments five were male and eight female, their characteristics are summarised in Table 37. Mobility limitations in the participants were demonstrated by the poor median score of 24.5 seconds to complete the Timed Up and Go Test with the slowest participant completing the test in 110 seconds and one participant unable to complete the test due to poor mobility. Participants presented with multiple health conditions with 88% reporting more than one health condition. The categories used for health conditions are presented in Appendix V.

**Table 37: Baseline characteristics of participants**

	Mean $\pm$ SD	Range
Age (years) (n= 13)	82.08 $\pm$ 5.89	72-93
Number of reported medical conditions (n=13)	3.25 $\pm$ 1.35	1-6
Timed Up and Go Test (seconds) (n=12)	24.5 (26)*	16-110
Knee extensor strength (kg)		
Left Female (n=8)	4.72 $\pm$ 1.64	2.20-7.10
Left Male (n=4)	7.63 $\pm$ 4.94	3.00-13.60
Right Female (n=8)	4.65 (3.63)*	3.30-8.00
Right Male (n=5)	7.28 $\pm$ 3.05	2.6-10.10
Grip strength (lbs)		
Left Female (n=8)	21.25 $\pm$ 10.94	10-45
Left Male (n=4)	57.5 (21.25)*	32-60
Right Female (n=8)	28.88 $\pm$ 13.5	15-55
Right Male (n=5)	57.60 $\pm$ 12.30	38-70

\* Data are recorded as median and IQR as variable is not normally distributed

The preferred mobility aid used by participants is presented in Figure 19 with seven (54%) participants using a form of a wheeled walker and all participants using a walking aid, demonstrating lower levels of mobility.

**Figure 19: Preferred mobility aids of participants**

Thirteen participants completed the EQ-5D-5L questionnaire and the individual EQ-5D-5L health profiles are presented in Table 38. An overall self-reported assessment of health is demonstrated by the visual analogue score with a mean of 69.62 ( $\pm 8.026$ ) out of 100.

**Table 38: EQ-5D health profiles**

Participant ID	EQ-5D-5L profile	Visual analogue scale
1	2 1 3 4 2	70
2	3 2 1 1 1	80
3	3 2 3 2 1	70
4	2 1 2 2 1	70
5	3 1 2 1 3	50
6	3 2 3 3 2	65
7	3 1 2 1 1	80
8	2 1 1 1 2	75
9	2 1 1 2 1	70
10	5 5 5 3 1	60
11	2 1 2 2 2	70
12	3 1 3 1 1	75
13	3 1 1 1 1	70

Table 39 presents the EQ-5D-5L scores as a dichotomous variable using no problems (level 1) and problems (level 2 to 5) to describe the reported abilities of the sample. Limitations in abilities were identified with all participants self-reporting a problem with their mobility and 69% reporting problems with usual activities. In contrast, 69% of the sample reported no problems with self-care.

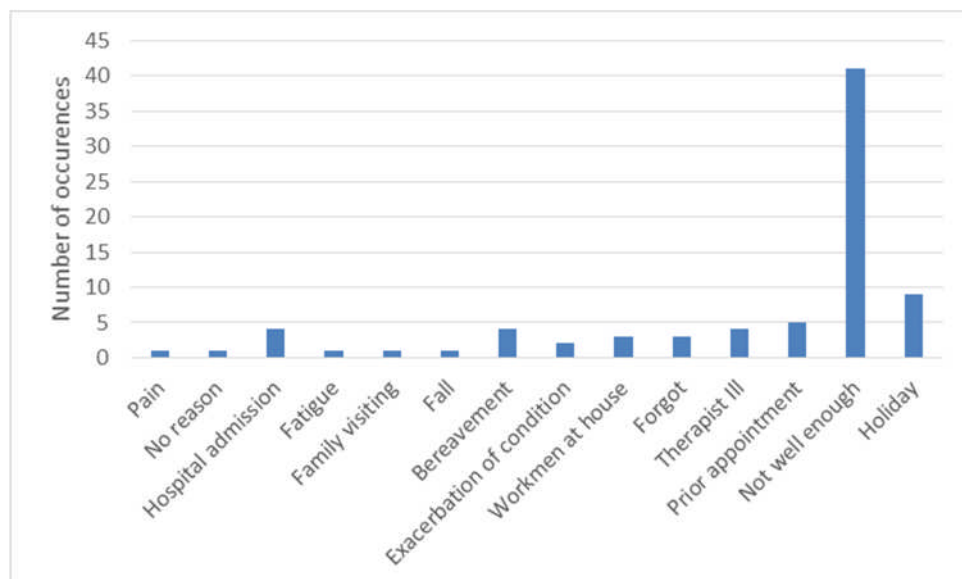
**Table 39: Frequency of problems and no problems**

Domain of EQ-5D-5L		Number of participants
Mobility	No problems	0
	Problems	13
Self-care	No problems	9
	Problems	4
Usual activities	No problems	4
	Problems	9
Pain	No problems	6
	Problems	7
Anxiety	No problems	8
	Problems	5

### 6.5.3 Delivery, fidelity and tolerability

#### **Attendance**

The mean attendance to the supervised sessions was 15.8 ( $\pm 7.01$ ) sessions with 66% of the available twenty-four sessions per participant attended. Attendance ranged from three to twenty-two sessions with none of the participants attending all the available supervised sessions. One participant declined two supervised sessions per week and therefore only one supervised session was arranged each week with the participant completing the other session unsupervised. Reasons for non-attendance are presented in Figure 20 and identifies that delivery of the programme was most frequently compromised by participants health ( $n=41$ ).



**Figure 20: Reasons for not attending supervised sessions**

Exercise diaries were returned by six participants and completed by four participants. Where completed participants reported completing an additional session once a week. Comments included '*much improved*' and one participant reported on week ten they were doing '*much more standing holding the chair*'. Other comments relating to factors that impacted on the completion of the exercise included feeling '*very tired*' and a '*dragging in this leg*'. Two participants were not provided with a home exercise programme due to concerns by the health professional over safety and poor technique when completing independently.

### ***Fidelity to the exercise programme***

Multiple reasons for participants not being able to complete the exercise programme in line with the intended delivery were recorded and are presented in Table 40. The most common reason (n=10) was missed sessions resulting in a lack of progression with the exercise protocol. Tiredness, prior to and during the session, was recorded in the case report form (n=9) and was identified as a reason for needing to modify the delivery of the programme. Existing pain or pain not related to the exercise programme, that required modification of the programme was recorded on 7 occasions.

**Table 40: Reasons for modifying exercise programme**

<b>Reason</b>	<b>Number of occurrences</b>
Declined	1
Hot weather	1
Lack of time	1
Anxiety	3
Poor technique	3
Fatigue with current level of exercise prescription	3
Exacerbation of medical condition	3
Pain	7
Observed tiredness	9
Missed sessions	10

Seven out of the eight participants (88%) completing the post assessments were able to participate in supported standing exercises as part of the programme.

Music was not used in the exercise sessions as participants felt they would have difficulty hearing the exercise instructions.

### ***Adverse events***

A summary of the events that occurred during the study is presented in Appendix W identifying the point in the study where the events occurred and if they occurred during the delivery of the exercise programme or study procedures.

There were two episodes of pain which were potentially related to the exercise programme which required the programme to be modified for one session. Both these occurrences resolved by the following session and were not considered serious.

Tiredness was observed by the therapist during the session for one participant, however, the participant reported no changes in their fatigue levels.

Only one other event occurred during the exercise programme and was considered directly related. This was an incident where a participant was hit in the face with a resistance band when carrying out the exercise session unsupervised. It was not categorised as a serious adverse event.

### ***Barriers and facilitators to delivery and participation***

Researcher maintained field notes for each exercise session identified barriers and facilitators related to the delivery and acceptability of the programme. Seventy-two codes were identified from the initial analyses which were separated by barriers and facilitators resulting in 33 codes relating to barriers and 39 codes relating to facilitators. Codes were then grouped under themes resulting in 12 themes relating to facilitators and 17 relating to barriers (Appendix X). The barriers and facilitators are presented in Figure 21 and Figure 22 with the size of the text representative of the frequency that it was reported.



**Figure 21: Facilitators to delivery**



**Figure 22: Barriers to delivery**

The most common facilitator was participants being able to see a benefit from the exercise programme (n=29) which supported delivery and participation. Participants reported improvements such as '*my shoulder is back to normal*' [Field Note (FN) 18/06/15] and '*my legs have got stronger*' [FN 27/08/15]. Enjoyment of the programme was commonly (n=27) identified throughout the field notes with participants stating '*I love coming to the group*' [FN 01/06/15] and '*I have really enjoyed it today*' [FN 07/07/15].

Acceptability of a group intervention was explored with the support of other group members identified as a motivator. This motivation was however limited by the varying abilities between participants which was identified as a potential barrier when participants were not able to achieve the same progress as others. This was highlighted in the field notes when a participant completed a sit to stand without using their hands which appeared to surprise other participants who were not able to do the same. The perception of their own and each other's abilities was identified as introducing an element of competition which could both encourage or hinder participation.

Medically related issues was the most commonly reported barrier (n=30) limiting the ability to deliver the programme. This included episodes of

dizziness, shortness of breath, visual impairments, acute illness and exacerbations of a long-term condition.

Fatigue (n=12) which limited participation and delivery was observed by the therapist and reported by participants. One participant stated '*I've not had a good night's sleep for ages*' [FN 23/07/15] and the therapist observing that '*several members [sic] quite tired- yawning*' [FN 23/07/15].

An additional barrier (n=8) to delivery was participants taking responsibility for their own participation because they deferred to the professional leading the sessions and the professional felt constrained by their responsibilities within a healthcare setting. Feeling that the programme was not sufficiently challenging in the early stages was identified as a barrier (n=9) with participants wanting to feel that they had worked.

Delivery of the home exercise programme and increasing independence with the programme was challenged by poor technique and the need for supervision and correction of technique. This was supported by an incident with a resistance band during an exercise that the participant had been advised not to carry out unsupervised (FN 21/08/15).

#### **6.5.4 Pre and post-intervention outcomes**

The changes in the physical and quality of life outcome measures for each participant are presented along with whether these changes were clinically meaningful. Observations on the completion of each outcome are stated to identify the appropriateness of completing this measure. A summary of the changes across all participants are provided to fully describe the data and the histogram plots for each variable are presented in Appendix R.

Eight participants completed the pre and post outcome measures of the Timed Up and Go Test, grip strength, quadriceps strength and the EQ-5D-5L. Unless otherwise stated n=8 for all the following outcomes. The median attendance of participants completing pre and post outcomes was 85%.

##### ***Functional exercise capacity (6-minute walk test)***

Six participants completed the 6-minute walk test before it was withdrawn from the baseline and post-intervention assessments due to being inappropriate for the sample population. All six participants required frequent rest periods due to reported shortness of breath, upper limb

discomfort and lower limb fatigue and no participant was able to ambulate for the 6 minutes. The total number of metres walked ranged from 16 to 60 metres. Researcher maintained field notes identified concern over mobility and having to walk with participants during the test due to safety. One participant stopped the test after 2 minutes 40 seconds due to upper limb discomfort when using their three-wheeled walker. One participant declined to complete the test due to anxiety over their shortness of breath. Due to the issues with completion and the small number of participants completing the measure the 6-minute walk test data was not analysed and is not presented.

### ***Mobility (Timed Up and Go Test)***

Table 41 presents the pre and post scores for the Timed Up and Go Test and a decrease in seconds represents an improvement in mobility. Four participants improved on the Timed Up and Go Test, one participant maintained the same time and three participants demonstrated a decline in their mobility. No participants improved by the minimal clinically important difference.

**Table 41: Pre and post scores for the timed up and go test**

<b>Pre-test time (Seconds)</b>	<b>Post-test time (Seconds)</b>	<b>Absolute change (Seconds)</b> Decrease represents improvement in mobility	<b>Percentage change</b> Decrease in change represents improvement in mobility	<b>MCID</b>
95	100	5	5.20	No
18	22	4	22.20	No
25	23	-2	-8.00	No
24	23	-1	-4.20	No
40	39	-1	-2.50	No
23	21	-2	-8.70	No
16	17	1	6.25	No
17	17	0	0.00	No
<b>Median Change (IQR)</b>		-0.5 (5.00)	-1.25 (13.04)	
<b>95% Confidence Interval</b>		-2 to 4.325	--8.2275- 11.43	

Researcher maintained field notes identified the Timed Up and Go Test was a simple measure which was easy to explain and administer in both the clinic and home setting. Issues with the recommended chair height were

identified with two participants unable to stand from a chair of 44-47cm and therefore 49cm chair height had to be used and one participant unable to complete the test at all. Twelve out of the thirteen participants (93%) who completed baseline assessments were able to complete the measure if the chair height was adapted. Issues with changes in neurological medications for Parkinson's disease and exacerbation of medical condition the post-test score were reported by the participants and recorded in the field notes.

### ***Upper limb strength (Grip strength)***

Table 42 presents the pre and post test scores for left grip strength in pounds. As grip strength is reported in both pounds and kilograms across the literature the data has also been converted to kilograms in Appendix Y. Five participants demonstrated an improvement in left grip strength, one participant demonstrated no change and two participants demonstrated a decline. One participant (12.5%) achieved the minimal clinically important difference.

**Table 42: Pre and post scores for left grip strength**

<b>Pre-test Score (lb)</b>	<b>Post test Score (lb)</b>	<b>Absolute change (lb)</b>	<b>Percentage change</b>	<b>MCID</b>
25	28	3	12.00	No
58	54	-4	-6.90	No
20	25	5	25.00	No
60	63	3	5.00	No
15	20	5	33.33	No
25	25	0	0	No
45	25	-20	-44.44	No
57	70	13	22.81	Yes
<b>Mean Change (<math>\pm</math>SD)</b>		0.63 $\pm$ 9.64	5.85 $\pm$ 24.42	
<b>95% Confidence Interval</b>		-7.43 to 8.68	-14.56 to 26.26	

Table 43 presents the pre and post test scores for right grip strength. Five participants' demonstrated improvements in grip strength and three demonstrated a decline. No participants achieved the minimal clinically important difference.

**Table 43: Pre and post scores for right grip strength**

Pre-Test Score (lb)	Post Test Score (lb)	Absolute change (lb)	Percentage change	MCID
32	30	-2	-6.25	No
55	50	-5	-9.09	No
25	30	5	20.00	No
65	70	5	7.69	No
20	25	5	25.00	No
22	25	3	13.64	No
55	45	-10	-18.18	No
60	70	10	16.67	No
<b>Mean Change (<math>\pm</math>SD)</b>		1.38 $\pm$ 6.52	6.19 $\pm$ 15.56	
<b>95% Confidence Interval</b>		-4.08 to 6.83	-6.81% to 19.19%.	

Researcher maintained field notes identified that this outcome was simple and easy to administer in both the clinic and home setting. 93% of the sample at baseline was able to complete this measure. One participant declined to complete the test on the right side at baseline due to a history of a right sided stroke. Supporting the forearm on the arm of the chair was reported to improve the test for the participants with some participants struggling to hold the dynamometer without this support. One participant reported exacerbation of a left upper limb musculoskeletal condition prior to completing the post assessment.

#### ***Lower limb strength (Quadriceps strength)***

The data for quadriceps strength is presented in kilograms. As data are presented in kilograms and newtons across the literature the data has been converted to newtons in Appendix Y. Left and right quadriceps data were combined to give a total lower limb strength outcome. This was considered appropriate as both contribute to functional activity [257] and would be required to progress to supported standing exercises. All eight participants demonstrated an improvement in lower limb strength as presented in Table 44. Five (62.5%) participants demonstrated an improvement above the minimum clinically important difference of 4.6kg with two participants approaching this level (4.1 kg and 4.0 kg).

**Table 44: Pre and post test scores for lower limb strength**

Pre-test score (kg)	Post-test score (kg)	Absolute change (kg)	Percentage change	MCID
9.4	19.1	9.7	103.19	Yes
23.7	33.5	9.8	41.35	Yes
14.6	16.5	1.9	13.01	No
19.4	23.5	4.1	21.13	No
9.8	22.1	12.3	125.51	Yes
8.9	12.9	4.0	44.94	No
9.0	15.1	6.1	67.78	Yes
10.4	22.0	11.6	111.53	Yes
<b>Mean Change (<math>\pm</math>SD)</b>		7.44 $\pm$ 3.91	66.01 $\pm$ 42.88	
<b>95 % Confidence Interval</b>		4.17 to 10.71	30.20%-101.91%	

93% of the sample at baseline was able to complete this measure.

Differing chair heights in situ in the home setting presented issues with complying with the test protocol. The outcome was standardised to ensure the pre and post-test were the same for each participant. Where alternatives were in situ that could maximise the test position such as stair lifts and perching stools these were used and enhanced compliance with the test protocol. Issues with lower leg swelling and pressure from the dynamometer were reported, with a towel used to improve participant comfort. Perceived issues with maximal effort on testing were reported in the researcher field notes. Participants reported concerns over maximal efforts due to anxiety and shortness of breath.

### ***Health-related quality of life (EQ-5D-5L)***

Table 45 presents the changes reported by participants in each of the domains of the EQ-5D-5L. The changes have been categorised into no changes from the pre-test score, an improvement in scores (demonstrated by a decrease in the profile number) and deterioration (as demonstrated by an increase in the profile number). Fifty percent of participants reported no change in their perception of their mobility after the intervention with 37.5% reporting an improvement. 87.5% reported no changes in self-care, usual activities or pain following the intervention.

**Table 45: Changes in EQ-5D-5L status**

	No change	Improved	Deteriorated
<b>Mobility</b>	4	3	1
<b>Self-care</b>	7		1
<b>Usual activities</b>	7		1
<b>Pain</b>	7	1	
<b>Anxiety</b>	6	1	1

### 6.5.5 Focus group results

#### *Recruitment*

Two separate focus groups were undertaken and a breakdown of the participants in each group is provided in Table 46. Two participants were unable to attend the focus group as planned due to health reasons. All participants who attended the focus groups started the exercise programme and the range of sessions attended is presented in Table 46. The researcher reflected on the running of each of the focus groups with a summary of the reflections presented in Appendix Z.

**Table 46: Focus group participants**

	Gender breakdown	Age range (years)	Range of supervised sessions attended
<b>Focus group one</b>	3 males 1 female	74-88	8-22
<b>Focus group two</b>	2 females 1 male	79-93	20-22

#### *Adaptation of the framework*

The initial framework (Appendix S) was adapted based on the context of the focus group data (as summarised in the methods section) and the main changes to the themes and sub-themes are summarised in Table 47. The theme of practicalities was created and the sub-themes of access, transport and location moved under this theme as this reflected their meaning more appropriately. The revised framework is present in Table 48.

**Table 47: Summary of changes to the framework**

Theme	Removed sub-themes	Justification
Defining	1.1 Range of exercise for older people	No data mapped to sub-theme
	1.3 Chair provides stability	No data mapped to sub-theme
	1.6 Other	No data mapped to sub-theme
Intended participants	2.2 Barriers to other exercise	No data mapped to sub-theme
Benefits	3.4 Activities of daily living	No data mapped to sub-theme
	3.5 Mobility around joints	No data mapped to sub-theme
	3.7 Co-ordination	No data mapped to sub-theme
Structure	4.7 Music	No data mapped to sub-theme
	4.8 Other	No additional sub-themes identified in the analysis
Format	5.1 Rolling programmes	No data mapped to sub-theme
	5.5 Tailored to individual needs	No data mapped to sub-theme
	5.8 Format other	No data mapped to sub-theme
Risk management	6.3 Health assessments	No data mapped to sub-theme
	6.9 Other	No additional sub-themes identified in the analysis
Theme	Changed sub-themes	Justification
Intended participants	2.7 Other - Similar needs	<i>'Well we are all in similar positions'</i>
Benefits	3.8 Other- Family observations	<i>'The youngest daughter thinks I have improved a lot but the one I spend most time with is not too sure'</i>
	3.8 Other - Confidence	<i>'It gives us a confidence'</i>
	3.8 Other - Discipline	<i>'Gives us a discipline you know, we can... Went through a system'</i>
Barriers/ Motivators	7.6 Other - Anxiety	<i>'I was a bit anxious before about whether I would be alright doing it. I couldn't see any reason why I shouldn't but I just got a bit anxious about the weeks ahead'</i>
	7.6 Other - Motivation	<i>'It is important as you can't really just sit in a chair all day long you have got to get some motivation from somewhere'</i>
Theme	Moved sub-theme	Justification
Practicalities	7.1 Access 7.2 Location 7.3 Transport	Practical aspects of the programme which influences the acceptability and therefore separate theme of practicalities created and sub-themes of access, location and transport moved under this theme.

**Table 48: Revised framework**

Theme	Sub-themes							
<b>1. Defining</b>	Used flexibly based on needs	Progression to standing programmes	Primarily seated					
<b>2. Intended participants</b>	Related to falls	Reasons unable to take part in other forms of exercise	Medical problems	Reduced mobility	Age	Similar needs		
<b>3. Benefits</b>	Mood/Well-being	Social interaction	Muscle strength	Walking	Confidence	Discipline	Family observations	
<b>4. Structure</b>	Tailored to individuals	Preferences for strength equipment	Challenging intensity	Progressively challenging strength training	CV training	Supported standing programmes	Standing programmes	
<b>5. Format</b>	Length of session	Barriers to more sessions	Preferences for number of sessions	Preferences for group/1:1	Home exercise programme			
<b>6. Risk Management</b>	Skilled Instructors	Qualifications	Healthcare professionals	Participant responsibility	Monitoring	Pain		
<b>7. Barriers/Motivators</b>	Clearly defined goals	Perceived benefits	Anxiety	Motivation				
<b>8. Practicalities</b>	Access	Location	Transport					

The results are presented in relation to the study objectives of exploring the acceptability, observed benefits and the perception of whether this sample of older people were appropriate for chair based exercise. Quotes are used to support the discussion of the findings. A summary for each of the eight themes and the sub-themes of the framework are presented in Table 49 to Table 56. FG is used throughout the presentation of the results as an abbreviation for Focus Group.

The results are presented with the acknowledgement that the therapist who had delivered the PACE intervention conducted and analysed the focus group data. The belief of the researcher that the PACE intervention warranted development will have influenced this data.

### **Defining**

The theme of defining chair based exercise was discussed in relation to progressing to standing programmes and primarily seated programmes. Participants supported the view that chair based exercise is the starting point to progressing to more advanced exercise programmes emphasised by the following statement:

*'The basic programme you have done automatically feeds into a standing up programme doesn't it?*

[ID2, FG1]

The acceptability of the PACE intervention was explored in relation to the perception of chair based exercise. There were views from one focus group that *'you can do quite a lot of exercises on your chair'* [ID1, FG2] and many exercises can be done *'all from the chair'* [ID1, FG2] with agreement from other group members *'yes you can, oh I like the chair exercises'* [ID2, FG2]. This was however contrasted with one participant in the other focus group who felt *'if you are sat down it makes you lazy'* but that *'it all depends on what the ability of the person is'* [ID2, FG1].

The sub-themes related to defining chair based exercise are summarised in Table 49.

**Table 49: Defining**

<b>Used flexibly based on need</b>	Different reasons why older people may be taking part in chair based exercise.
<b>Progression to standing programmes</b>	This was a basic level programme that would logically lead into a standing programme. Conflict over whether participants felt they could have done more standing with variation in abilities.
<b>Primarily seated</b>	There is a lot you can do seated that is considered exercise, however, varying views that seated exercise can be considered 'lazy'.

***Intended participants***

The majority of the discussions around the intended participants of the PACE intervention concerned the influence of medical conditions and ageing on exercise participation. In exploring whether chair based exercise was appropriate for this group of older people one participant discussed that *'there are some things you just can't physically do because of you age'* [ID2, FG1] and that there are forms of exercise that they can no longer undertake *'I mean I used to be on the floor doing push ups and that and I can't do it anymore I find my shoulders hurt too much'* [ID2, FG1]. This was supported by other participants who discussed past medical conditions such as *'a stroke, all down one side'* which has led to problems *'with this leg'* [ID4, FG1]. Discussions in the second group supported these views with participants agreeing that *'I think your age has a little bit to do with it'* [ID3, FG2] and *'you have to remember people's age'* [ID2, FG2].

One participant felt they were in a *'limbo position'* due their medical conditions as they were waiting for an operation on their hearing which was affecting their balance and that this meant their abilities were unpredictable:

*'You know this balance thing and all that. Sometimes I am alright and then all of sudden it's like weerrr you know'*

[ID2, FG2]

Variation in the perceived abilities of participants was discussed relating to whether the programme was appropriately targeted. Discussions explored the perception of the abilities of other group members in relation to age and physical limitations with one participant stating *'... some find it more difficult because they were, how do you put it nicely, they were in a worse condition that what you were, you know?'* [ID2, FG1]. In contrast, some discussions reflected a more positive perception of others abilities:

*ID3: 'I think your age has a little bit to do with'*

*ID1: 'Well you do, you do wonderful love'*

[Focus Group 2]

There was, however, a sense of being in a '*similar position*' [ID2, FG2] together and in the '*same predicament*' [ID1, FG2] which meant as a group they had '*similar thought*' [ID2, FG2] on how to approach exercise. There were very few discussions relating to mobility limitations being the reasons for participation.

**Table 50: Intended participants**

<b>Related to falls</b>	Reduced fear of falling from attending.
<b>Reasons unable to take part in other forms of exercise</b>	Not able to do the same exercises as before due to being weaker and getting older.
<b>Medical problems</b>	Medical conditions influence the ability to exercise consistently.
<b>Reduced mobility</b>	Variation in the perception of the mobility levels between individuals.
<b>Age</b>	Age influences the exercise programme and ability to take part.
<b>Similar needs</b>	In it together as we are in a similar position.

### ***Benefits***

The physical benefits were not commonly discussed and where reported focused on an increased strength in both arms and legs as supported by the discussion below:

*ID2: 'Yes I did, I noticed my legs were getting a bit stronger'*

*ID3: 'Well yes I've felt better with the exercise. I have felt a lot better. Someday I have been a bit different but most days I can say I've felt better'*

*ID1: 'Well my legs have felt a bit stronger and my hands have been a bit stronger'*

[Focus Group 2]

The importance of the social benefits associated with the PACE intervention was commented on by the participants with one stating the '*social aspect is more important than people think*' [ID2, FG2] and it was '*nice meeting in a group*' [ID2, FG1]. Social benefits dominated the discussions with participants identifying the issue of being lonely as supported by the discussion below:

*ID2: 'The social aspect is more important than people think though'*

*ID1: 'Yes'*

*ID2: 'We always feel we have been talking to ourselves or morning but instead of that we have been talking in a group'*

*ID3: 'Yeah'*

*ID3: 'Some days you don't speak to anybody especially Sunday I don't like Sunday nobody is about it's just quiet and you don't speak to anybody'*

*ID1: 'There is a lot of lonely people in the world isn't there'*

*ID3: 'Oh ei'*

*ID1: 'We have to think ourselves lucky'*

*ID3: 'Oh yeah'*

[Focus Group 2]

Participants in focus group two agreed that they were *'looking forward to the sessions'* [ID1, FG2] which they considered had an influence on their general well-being and this was supported by discussion in focus group one with participants agreeing they had developed a sense of *'camaraderie'* [ID2, FG1]. A sense of purpose with attending a group was explored by participants with one stating *'then when you get home you are full of beans and you are telling your family what you have been doing and what you haven't been doing' [sic] you get yourself washed and nicely smelling and you know you put a little bit of effort in your appearance'* [ID1, FG2].

Participants in both focus group discussions stressed the importance of confidence and the building of confidence through participating in the exercise programme. This was supported by the repeated use of the phrase *'confidence that is the main thing'* [ID4, FG1 and ID1, FG2] used across both focus group discussions. Confidence was discussed in relation to building confidence in physical abilities with one participant stating *'I can walk and have a discipline and a confidence'* [ID4, FG1]. A more general sense of confidence from attending group sessions was also discussed supported by the following discussion:

*ID1: 'You have built your confidence up a lot haven't you?'*

*ID3: 'Ooh yeah'*

*ID1: 'I mean you were so quiet weren't you?'*

*ID3: 'Oh yes I was'*

[Focus Group 2]

A summary of the sub-themes related to the potential benefits discussed by participants is presented in Table 51.

**Table 51: Benefits**

<b>Well-being</b>	Sense of purpose to attending a regular group. Improves general well-being.
<b>Social interaction</b>	Social aspects of a group are beneficial and important. There is a lack of social interaction for some older people.
<b>Muscle strength</b>	Arms and legs felt stronger.
<b>Walking</b>	Walking and confidence with walking improved.
<b>Confidence</b>	Building confidence is very important and the exercise programme has helped to build confidence in relation to physical abilities and general confidence.
<b>Discipline</b>	A sense of discipline from attending.
<b>Family observations</b>	Family observations of attending are contradictory. Family are pleased with doing something.

### **Structure**

Participants across both focus group discussions identified the variation in abilities between participants and some participants perceived that they were more able than other group members reflecting different levels of acceptability with the intervention.

*ID2: 'But I mean you can't say that for everybody as other people were struggling obviously. I mean we vary don't we in our abilities. I mean it wasn't a general common level of group. There were some better than others'*

*ID4: 'Yep. Some are better than others. He is better than me, he is better than me you know'.*

[Focus Group 1]

Group delivery was however considered an acceptable structure in being able to accommodate varying abilities when the facilitator asked about a group of different abilities.

*ID4: 'No'*

*ID1: 'No'*

*ID2: 'It possibly helped the matter I think but definitely there were different abilities'*

*ID2: 'I mean some find it more difficult because they were, how do you put it nicely? They were in a worse condition than what you were, you know'*

ID4: 'Yeah'

ID4: '*...I think my point is here, different abilities, people with the different abilities, have to adjust yourself according to the situation*'

[Focus Group 1]

Debate emerged in both group discussions regarding the most appropriate equipment for the strength exercises. Reasons for preferring the weights over the resistance bands included weights being '*more constant*' [ID2, FG1] and that they do '*more to your muscles on your legs*' [ID1, FG1] while being able to '*cheat with the rubber band*' [ID2, FG1]. In contrast some participants preferred using the resistance bands as they '*didn't get much benefit from the weights*' [ID3, FG1], and were concerned that not all participants could '*manage the weights*' [ID1, FG1] and there were exercises such as '*that one when you put your knees together*' [ID2, FG2] that couldn't be done using the weights.

Discussion around the intensity of the programme occurred throughout both the focus groups with debate over whether the intensity was appropriate for all participants. Some participants felt the programme was '*challenging enough yeah*' [ID1, FG1] and they were '*not more advanced than what I have done here no*' [ID2, FG1]. In contrast some participants felt that they would have liked it if it was a '*little heavier going*' [ID2, FG2] and '*a bit harder*' [ID3, FG2].

Participants generally considered the progression to standing exercises to be beneficial and it was a bit '*more supportive of yourself*' [ID1, FG1] and that '*you had to exert yourself a bit more*' [FG1, ID4]. One of the participants who had not been able to progress to the supported standing programmes felt frustrated at not being able to '*join in*' [FG1, ID3] highlighting the different abilities in a group.

The structure of chair based exercise programmes was discussed in both focus groups under the sub-themes presented in Table 52.

**Table 52: Structure**

<b>Tailored to individual needs</b>	Everyone varies in their abilities and some are perceived to be better than others.
<b>Preferences for strength equipment</b>	Disagreement over the most beneficial method of using the weights or bands and depends on the individual.
<b>Challenging intensity</b>	The programme could have been more challenging for some, however, some could not have done more.
<b>Progressively challenging strength training</b>	Progression, where reported, was perceived to be alright.
<b>CV training</b>	These exercises are good as you know you are doing them and they are working.
<b>Supported standing programmes</b>	Perceived to be beneficial as supporting yourself more. Frustration by group members who were not able to do these exercises.
<b>Standing programmes</b>	Standing exercise is perceived to be more challenging and beneficial.

**Format**

Discussions around the format of delivering the programme were dominated by the group or one-to-one delivery with participants exploring advantages and disadvantages of both approaches. Group delivery was generally reported to *'push you'* [ID4, FG1] and that *'you had to keep going in a group'* [ID1, FG1]. One participant did, however, report they *'worked harder at home'* [ID3, FG1]. The use of the exercise diary to record completing the exercises at home was not considered helpful by participants in focus group two with agreement that it *'was not for me'* [ID3, FG2] and that they did the exercise but *'didn't write it up'* [ID2, FG2].

The length of the programme and number of sessions was discussed by all participants in both groups with differences in acceptability and tolerability highlighted. Several participants discussed that they would have liked more sessions with one participant reporting *'they looked forward to it so longer, longer is better for me'* [ID2, FG2]. Another participant felt that twelve weeks *'was a long time up front but it went quickly so it was alright'* [ID3, FG2]. There was, however, a conflict between having a longer duration and needing more variety in the programme supported by the discussion below when the facilitator asked about the level of variety in the programme:

*ID1: 'If you were doing it longer you would'*

*ID2: 'Boring doing the same thing every time'*

[Focus Group 1]

The frequency of sessions per week was debated amongst participants in the second focus group with more sessions welcomed by some participants:

*ID 1: 'I should have liked more'*

*ID 3: 'Oh yeah I had twice a week and I could have done it 3 times I enjoyed it'*

[Focus Group 2]

In contrast, one participant felt that more sessions would not be beneficial as it would be *'too tiring'* [ID3, FG2].

The sub-themes identified from the discussions relating to the format of chair based exercise are presented in Table 53.

**Table 53: Format**

<b>Length of session</b>	Just right.
<b>Barriers to more sessions</b>	Being too tired can limit the number of sessions.
<b>Preference for the number of sessions</b>	Number of sessions depends on individual abilities and perception of ability. If the programme was ongoing it would need to be varied as it could become boring
<b>Preferences for group/1:1</b>	Group programmes were generally considered more beneficial in making you work harder and keeping you motivated. Individual differences in preferences for group or one-to-one sessions.
<b>Home exercise programme</b>	Fine to complete at home on your own but you can rest more.

### ***Risk management***

The ability of the instructor to *'appreciate why some people can do some things and some people can't'* [ID2, FG2] was identified as important with the need for instructors to know *'what they are doing'* [ID1, FG2]. The level of qualification needed was considered difficult to identify for older people with one participant stating *'well we don't know that, you wouldn't know that would you?'* [ID2, FG1]. The ability to do the job rather than the level of qualification was stressed by one participant:

*ID 2: 'Well I have seen some very, some very highly qualified people but what I thought about their ability to do the job that is a different matter.'*

[Focus Group 1]

Tolerability of the programme in relation to adverse events and pain was not discussed extensively in either of the group discussions. An ache following the exercise programme was explored briefly by one group who

considered you do ache 'a little bit' [ID1, FG2] and that 'it made your arms ache' [ID3, FG2]. The participants also discussed they would stop exercising if they were in pain following the advice of the therapist. Participants also discussed that they felt they had a responsibility to take advice and support to engage with the programme with one participant stating 'you are here to help us so it is up to us to make it, to help' [ID1, FG2].

The sub-themes identified from the discussions relating to managing the risks associated with programmes are presented in Table 54.

**Table 54: Risk management**

<b>Skilled instructors</b>	An instructor should know what they are doing and appreciate why some people can do things and others can't.
<b>Qualifications</b>	Qualifications are not as important as the perceived ability of the person to do their job.
<b>Healthcare professionals</b>	GP or someone recommending the programme may influence participation.
<b>Participant responsibility</b>	There is a responsibility of older people to listen to the help and advice.
<b>Monitoring</b>	Monitoring with telephone or home visits could be beneficial to check it is being done and done correctly.
<b>Pain</b>	The exercises can cause an ache but if in pain would stop exercising.

### ***Barriers and motivators***

Acceptability and tolerability of the intervention were affected by participant anxiety. The anxiety surrounding attending a group programme was stressed by the participants in focus group two supported by one participant in focus group one. Anxiety was discussed prior to attending the programme as supported by the following discussion:

*ID1: 'You whittle about different thing don't you?'*

*ID2: 'Yeah I did. I was a bit anxious before about whether I would be alright doing it. I couldn't see any reason why I shouldn't but I just got a bit anxious about the weeks ahead'*

[Focus Group 2]

There were also discussions around on-going anxiety when attending each of the sessions related to being ready to be picked up for group and waiting for the group to start:

*ID 2: 'Anxious to be ready, to be picked up that's the bit. That's your anxiety more than anything'.*

*ID 1: 'It's like being in a dentist surgery waiting to go in, you get yourself all worked up but everything works out fine really'*

[Focus Group 2]

The sub-themes identified that related to barriers and motivators are presented in Table 55.

**Table 55: Barriers and motivators**

<b>Clearly defined goals</b>	There was a lack of clearly defined goals from participants. Generally, goals included wanting to walk better and felt stronger.
<b>Perceived benefits</b>	Keeping your mind active was considered as a reason for wanting to attend.
<b>Anxiety</b>	Attending a group can cause anxiety over the unknown and about getting ready for each session.
<b>Motivation</b>	Motivation to attend was due to improving, observations from family members or wanting to please family, wanting to do something.

### ***Practicalities***

The provision of transport was considered important by all participants across both focus group discussions. A lack of transport would limit participation with discussions stating that without transport *'I can't come you see'* [ID4, FG1] with the cost of transport and the physical problems identified as issues with accessing their own transport. The following discussion highlights the importance of transport:

*ID3: 'yeah they do get you here. I wouldn't come I mean we wouldn't be able to come would we. I mean your family couldn't do that as they are so busy'*

*ID2: 'Of course they are'*

*ID1: 'I mean all people that are still working are busy aren't they?'*

*ID3: 'Yeah'*

*ID2: 'Well you are not worrying about phoning taxis and when it is all laid on for you it is a big plus '*

*ID3: 'It's a big help'*

[Focus Group 2]

The location of group programmes and the distance needed to travel was explored with longer distances considered in terms of whether *'your body would endure'* [ID4, FG1] the travel with acceptability of the current

programme reported due to the close proximity of the group sessions to participants homes. Themes identified that related to practical issues of the acceptability and ability to deliver the chair based exercise programme are summarised in Table 56.

**Table 56: Practical issues**

<b>Access</b>	Would pay for sessions.
<b>Location</b>	Long distances may be difficult for some older people.
<b>Transport</b>	The provision of transport is important for being able to attend a group.

## 6.6 Summary of results

As each objective is answered by a number of results a summary of the main findings for each objective is presented in Table 57 to Table 61 Table 61.

**Table 57: Can the PACE intervention be delivered?**

	<b>Key findings</b>	<b>Interpretation</b>
<b>Number and proportion of participants recruited</b>	48 participants identified, 17 consented, and 11 started the exercise programme.	It is viable to identify and recruit older people and commence the PACE intervention.
<b>Reasons people decided not to take part</b>	Health related (n=7) Too much (n= 5) Other therapy (n= 5)	Health, other therapy and perceived fatigue most common reasons for not taking part and identify considerations for future trials and implementation of the PACE intervention.
<b>Proportion of older people participating in PACE</b>	11 participants started and 9 (82%) completed intervention period.	It is viable for older people to start and complete the exercise programme.
<b>Barriers and facilitators identified in field notes maintained by the researcher</b>	Medical conditions were the most commonly reported barrier to delivering the programme. Facilitators included if participants could see a benefit and support from other participants in a group environment.	Delivery of the programme is compromised by the fluctuation in health needs, however, if the programme is tailored and flexible it can be delivered.

**Table 58: Is the PACE intervention acceptable and tolerated by older people?**

	<b>Key findings</b>	<b>Interpretation</b>
<b>Qualitative data from participant focus groups</b>	Older people reported enjoying attending the programme with physical and social benefits reported. Differences in the perception of the intensity and length of the programme with some participants considering it to be sufficiently challenging and an appropriate length. Other participants felt a more intense programme over a longer duration would have been more appropriate for them.	The programme appears acceptable if individually tailored, however, the intensity was perceived differently between participants and it needs to be targeted appropriately.
<b>Field notes maintained by the researcher</b>	Older people reported enjoying attending the programme with observations of motivation and support between participants.	The programme appears to be acceptable to older people if it is tailored to individual needs.
<b>Adverse events recorded in the case report form</b>	One incident occurred during delivery of the programme and considered directly related to the programme. Tiredness observed and existing conditions and pain required modification of the programme.	The programme appears to be tolerated by older people, however, fatigue and pain needs to be monitored.
<b>Attendance rates to the exercise programme</b>	66% of all session's available sessions were attended. None of the participants attended all of the available sessions Being unwell was the most common reason for not attending.	Attendance to the programme is affected by health of participants which emphasises the need for flexible delivery.

**Table 59: Are the health outcomes compatible with the underlying theories?**

	<b>Key findings</b>	<b>Interpretation</b>
<b>Assess in the PACE intervention results in the primary outcomes of success</b>	Clinically meaningful improvements in mobility and grip strength not observed, all participants improved their lower limb muscle strength with 62.5% achieving clinically meaningful changes and two participants approaching this level of improvement. Supported standing exercises could be included in the programme for 88% of participants completing the programme.	Endurance was unable to be determined using the chosen outcome measure.  Criteria for success of improving lower limb strength and progressing to include standing exercise was primarily achieved in line with the underlying theory of the PACE intervention.
<b>Perceived benefits through participant focus groups</b>	Older people reported improvements in muscle strength, reduced social isolation and improved well-being.	From a participant perspective, the intervention changed muscle strength, quality of life and reduced social isolation.

**Table 60: What are appropriate outcomes?**

	Key findings	Interpretation
<b>Researcher field notes on outcome measures</b>	Issues with standardising knee extensor strength between participants in community setting. Grip strength and Timed Up and Go Test easy to complete. Issues from researcher and participants regarding completion of 6-minute walk test.	Six-minute walk test may not be suitable for use with the group of people. Grip strength and Timed Up and Go Test suitable for completion (if chair height is varied) in this group. Hand held dynamometer for lower limb muscle strength suitable for within participant use but may not be suitable for formal evaluation between groups.
<b>Number completing pre and post assessments</b>	13 completed pre-assessments and 8 completed post assessments. Grip strength and quadriceps strength not completed by one participant due to previous history of a stroke.	

**Table 61: Are appropriate older people participating?**

	Key findings	Interpretation
<b>Description of the sample in relation to mobility, strength, self-reported health status and the number of medical conditions</b>	The sample had low grip and quadriceps strength. The Timed Up and Go Test scores ranged from 16-110 seconds with a median of 24.5 seconds.	The sample varied in their mobility however all demonstrated some mobility limitation, all had poor lower limb muscle strength with multiple health conditions and were suitable for the PACE intervention.
<b>Qualitative feedback in participant focus groups and research field notes.</b>	Progressing to standing exercise was identified as important with some older people considering they could have been done more challenging exercises than in this programme.	The intensity and challenge of the intervention need to be tailored to individual needs to facilitate participation.

## 6.7 Discussion

### 6.7.1 Summary of findings

This study has demonstrated that the PACE intervention can be delivered and that a viable number of older people can participate. Positive participant feedback demonstrated the acceptability of the intervention, however, attendance was compromised by the poor health of participants. Few adverse events were reported during the delivery of the intervention suggesting the PACE intervention was tolerated by older people. Barriers to exercise delivery and progression were identified and included multiple medical conditions and fatigue. Facilitators to enhance delivery included

participant's enjoyment and perceived benefits of programme attendance. The views of older people stressed the importance of targeting the PACE intervention at those unable to participate in standing programmes and the need to progress to standing and walking programmes where possible.

All participants demonstrated improvements in quadriceps strength with clinically meaningful improvements achieved by over 50% of the sample with 7 out of the 8 participants (88%) able to progress to supported standing exercise. This demonstrated that the primary outcome of success had been achieved. Improvements in muscle strength did not, however, translate into improvements in functional mobility. Participants reported benefits in strength and confidence with mobility. Upper limb muscle strength improvements were not demonstrated.

### **6.7.2 Strength and limitations**

The outcomes of this study need to be considered within the limitations of a sample of older people who had previously taken part in a structured exercise programme. The potential benefits of the intervention may be confounded by participation in the previous programme and the potential benefits of the PACE intervention may have been underestimated. To reduce this limitation participants had to have at least a month of not attending the service to allow for a washout period.

It is also acknowledged that the older people who took part may not be representative of the wider population who may demonstrate less self-motivation and engagement with exercise programmes. Caution must therefore be applied in generalising the findings from this sample of well-motivated older people to a wider population.

It was acknowledged that there was a modest sample of older people included in this study. This was, however, appropriate to the study aims in exploring the acceptability and deliverability of the programme as part of the development of a complex intervention. The sample is also a similar size to that of other work where exercise programmes for older people have been developed [265].

The pre and post study design used here was appropriate to the study aims, however it may have introduced performance and detection bias. The

delivery of the exercise programme and completion of the outcome measures by a single researcher was a limitation in the study design.

The viewpoint of the researcher and their attitude towards chair based exercise may have influenced the delivery of the intervention and the subsequent findings. The clinical effectiveness would need to be established in a robust randomised controlled design where the viewpoint of the researcher and bias could be reduced through careful study design and conduct.

### **6.7.3 Recruitment**

The under recruitment of older people and strict study exclusion criteria means that research studies are often not representative of the wider older population [266]. This study was designed to have broad and inclusive eligibility criteria to reflect the intended users of chair based exercise however delivery in a clinical service may have constrained the inclusion of participants. The recruitment and completion of the exercise programme in this study does however demonstrate that it is viable to identify older people and deliver the PACE intervention in a research setting.

It is acknowledged that the recruitment of older people into research studies is challenging and requires careful consideration, taking into account the views of older people [266]. The recruitment processes employed in this study were developed in collaboration with older people with a view to maximising recruitment. Nevertheless there was a high refusal rate from the initial contact by letter when followed up by telephone which is supported by other research including older people [232]. This could, however, be attributed to the recruitment source with participants previously attending an exercise programme with reported reasons for not taking part including being too fatigued when they previously attended. There may, therefore, be differences between older people's willingness to participate in a rehabilitation exercise programme and a research exercise programme.

### **6.7.4 Participant characteristics**

The logic model (Figure 14, chapter five) outlined that the PACE intervention was intended for older people who were unable to take part in standing programmes which could be due to a variety of reasons. This was intended to ensure the participants were appropriate for chair based

exercise as the start of the progressive pathway of exercise for older people.

The sample in this study presented with similar mobility levels to those in the good quality study of progressive resistance training by Latham et al [160] and the medium quality study by Baum et al [81] (described in chapter three) as demonstrated by the range of Timed Up and Go Scores. Poorer levels of mobility were however identified in comparison to the other systematic review literature as demonstrated by the Timed Up and Go Test scores and use of mobility aids [165, 169, 177, 178]. There were considerable differences in the Timed Up and Go Test scores between participants in this study. None of the participants were in the normative scores for their age group [267] with only two participants considered at the lower end of the normative scores when their age and walking aid were considered [268].

The EQ-5D-5L identified that all participants considered they had a problem with mobility which supports the mobility limitations demonstrated by the Timed Up and Go Test scores and mobility aids used by participants. The height of the chair used in the Timed Up and Go Test is known to influence scores and a height of 44-47cm is reported as optimal [269]. Two participants in this study were unable to stand from a chair within this range and it could be considered that these participants were unable to complete the Timed Up and Go Test reflecting more severe mobility limitations. In a feasibility randomised controlled trial of a home-based exercise programme for older people if participants were unable to complete the Timed Up and Go Test, Clegg [189] used a score of 300 seconds, which was the slowest recorded score in the original development of the measure. This was not used in this pre and post cohort study as groups were not being compared however this would have reflected a higher median Timed Up and Go Test score for the sample indicating poorer levels of mobility.

Older people scoring 30 seconds or more on the Timed Up and Go Test are suggested to present with mobility impairments, reduced functional abilities and increased dependency for activities of daily living [267]. Clegg [189] used the Timed Up and Go Test scores to stratify older people taking part in a home-based exercise programme with those scoring 30 seconds or greater allocated to a lower level programme. A functional exercise

programme in care homes used 20 seconds or greater to allocate older people to the appropriate exercise level [180] and this criterion is also being used in an ongoing chair based exercise feasibility study [270]. Previous studies have however reported scores as low as six seconds [190] for older people participating in chair based exercise. Using the criteria of 20 seconds some of the participants in this study would not have been considered appropriate for chair based exercise based on their mobility alone. This reflects the difficulty in determining standardised criteria for chair based exercise programmes when other considerations such as medical conditions, confidence and safety may influence the decision-making process.

Grip strength is considered a marker of health with a weaker grip strength associated with mortality and morbidity [271]. The Southampton grip strength protocol used in this study was reported to provide a detailed protocol offering improved standardisation for measuring grip strength to allow comparisons across studies with older people [240]. Normative values by gender and age do however pull data from a variety of measurement protocols which limits the reliability of the results. Comparison of the sample against the mean values from population data [272, 273] identified lower grip strength for the majority of the sample (85%) in this study. This may reflect the compromised health of participants in this study and reflect the appropriateness for participation in the PACE intervention.

The participants in this study were suitable for a strengthening intervention due to the low baseline levels of muscle strength. The knee extensor strength of the sample in this study was lower than published normative values [274, 275]. There is however a lack of data on adults eighty years and over [275] which limits the comparisons for participants in this study with a mean age of 82 years.

#### **6.7.5 Deliverability, fidelity and acceptability**

Delivery of the PACE intervention in line with the logic model was viable however delivery needed to be flexible to account for the changing health needs of participants. The need for this flexibility has been identified in other research of exercise programmes in similar groups of older people [180].

Tailoring programmes to meet individual and fluctuating needs of older people was identified by both the therapist and participants. Progression was achieved in a number of ways in the delivery of the PACE intervention which included; increasing the number of repetitions, the number of sets, the level of resistance, supported standing exercise, the duration of aerobic activity and the number of exercises included in the sessions. Whilst progression was possible it was compromised by multiple factors such as the health of participants, missed sessions and fatigue. This resulted in modification to the training protocol, with a need to gradually build back up the intensity. These fluctuations do not mean that the PACE intervention cannot be delivered instead they highlight the need for flexible models of delivery to support older people with changing health needs and suggest that standardised protocols and programmes of a fixed duration may be of limited use.

Older people appear to be aware of the health benefits of physical activity however participation remains low thereby stressing the importance of exploring the barriers and facilitators to engaging in exercise. Fatigue was identified as a potential barrier to delivery of the exercise programme which may be due to participants being unaccustomed to doing exercise. As PACE was intended for those older people with compromised health and mobility who are unable to take part in standing programmes it appears logical that medical conditions were the most common barrier to engagement and progression of the exercise programme. This supports the wider views of older people who identify physical ailments as a potential barrier to long-term exercise engagement [276]. Instructors with the clinical knowledge and experience of working with older people may help to increase safe participation for older people with multiple pathologies and was identified by participants in this study in supporting the effective delivery of the programme.

The safety of the intervention was supported by the occurrence of few adverse events occurring during the delivery of the programme which is consistent with other exercise programmes in similar populations [191]. Events such as falls, chest infections, and hospital admissions occurred throughout all aspects of the study but were not related to the exercise programme. These events did however influence the delivery of the programme and further stresses the challenges of this population. There is

evidence that low-intensity interventions can increase the risk of falls in care home settings [277], however, this was not observed here with the falls reported during or after the exercise intervention attributed to existing inner ear problems and environmental factors. The increased risk of falls in this population does, however, warrant close monitoring in the current provision of chair based exercise and future research in this area.

The role and responsibility of a qualified therapist in an NHS service may have influenced the delivery of the programme. There is an increasing risk aversion culture within the NHS due to the fear of litigation and there are also differences in risk taking between individual therapists and professional groups working with older people [278]. The fidelity of the exercise protocol may, therefore, be dependent on the skills and attitudes of the instructor and the culture of the context in which they work. Giving more responsibility to older people in determining the intensity of the exercise programme may allow more engagement and empowerment, however it may pose further risks of the intervention.

#### **6.7.6 Outcomes**

Collecting reliable outcomes in this population is acknowledged as a challenge due to compromised health and mobility and fluctuations in health. The pre and post study design used here is at risk of potential bias from both the researcher and participants. Participants were aware of the study aims which may have influenced the findings in measures which required active engagement such as muscle strength. Participants were not made aware of their pre-test score in order to reduce this limitation and the researcher did not have the pre-test scores available during the collection of the post-test data. Future research evaluating the intervention would need to consider blinding of researchers to reduce the potential risk of detection bias.

Progression to supported standing exercise was achieved by 88% of the older people completing the exercise programme in this study. Other exercise programmes developed for older people have used chair based exercise as the starting point for participants with poor mobility [189] however there was a lack of detail over whether participants progressed to supported and free standing exercises within these studies which limited the ability to determine the effect of seated exercise on providing a basis

for progress to standing programmes. This study has identified that progression to supported standing exercise is possible and further work is needed to identify progression to unsupported standing programmes. Older people supported the expert view that progression to standing programmes should be encouraged [125] with chair based exercise used as an entry level programme for those unable to do standing programmes. Experts agreed the programme should be delivered at a moderate intensity for all participants [125] in line with recommendations from published guidelines [13]. Achieving a challenging intensity for all participants was limited in a group setting in this study due to the range of abilities of participants. It may be that some more able participants in this study could have progressed to participating in dynamic standing exercise with one-to-one supervision and that the PACE intervention was not sufficiently challenging. This stresses the importance of determining who should be doing chair based exercise and ensuring participants are progressed to supported standing exercises and free standing exercises where possible.

Improvements in knee extensor strength post-intervention were identified which were not consistent with changes in mobility. There are inconsistent findings for the size of knee extensor strength improvements following progressive resistance training with improvements ranging from 9% to 174% [279] with larger improvements seen with higher intensity programmes. The larger improvements, such as those reported by Fiatarone et al ( $174\% \pm 31\%$ ) [27], followed high-intensity programmes that are often conducted in research settings using resistance training machines [280] and excluding older people with compromised health [281]. These large improvements are contradicted by the findings of the good quality studies presented in chapter three, that were conducted in participant's homes [160, 176], long-term care facilities [169] and community facilities [177, 178], which reported no effect on muscle strength.

The progression of resistance exercise in this study was low due to the participants abilities and starting resistance; however improvements in muscle strength were observed and studies which have used similar progression [282] and larger progressions [160] have not shown such large improvements. The volume of resistance training may account for the improvements seen in this study with lower resistances and an increased

number of repetitions used. One emerging theory is that the volume of training is an important element [30] and that low intensity and higher repetitions may be more appropriate where there are issues of tolerability at higher intensities.

The large improvements in quadriceps strength observed in some participants in this study may be due to the unreliability of the measurement technique which relies on individual effort which is likely to be poorly reproducible except in highly trained individuals. In addition bias from participants who were aware of the study aims may have been introduced by an increased effort at the post-test. Larger samples would be required to address these issues of unreliability. The participants also demonstrated low baseline measures of muscle strength and therefore had the potential for larger improvements [283].

Determining clinically meaningful changes is complex and there is a range of approaches that can be taken which include expert consensus, anchor-based methods and distribution methods [284]. The criteria for a clinically meaningful change in lower limb muscle strength was difficult to determine from the available literature. A functional approach outlined by Bohannon [257] which used retrospective data to determine the change needed to be able to independently sit to stand was used and was considered appropriate to the underlying theory of the PACE intervention. The work by Bohannon [257] was however based on a small sample (n=5) and there were large confidence intervals which demonstrate a lack of precision in the findings. The absolute and percentage mean changes presented by Bohannon [257] were not considered appropriate for the individual participant approach used in this study. Instead, the lowest change needed for a participant to transition to independence with sit to stand was considered more appropriate for determining individual meaningful changes with the PACE intervention. Based on the group changes Bohannon [257] suggested that a 43% change may be considered clinically meaningful. If the results had been considered within this context the PACE intervention would still have demonstrated the potential for improving lower limb strength with a mean change of 66% across all the participants. Other researchers [265] developing exercise programme for older people demonstrated a group mean change of 4.7kg (using the one repetition maximum) in lower limb muscle strength and concluded the intervention

was worthwhile evaluating further. Against this criteria, the PACE intervention demonstrated worthwhile improvements with a mean change of 7.4kg. Reviewing the PACE intervention against these different criteria emphasise that the primary outcome of improving lower limb muscle strength was achieved.

Whilst there has been work on establishing the reliability, validity and minimal detectable changes of lower limb muscle strength using a hand held dynamometer for older people there is still a lack of clarity over what is considered a clinically meaningful change [285] and the reporting of clinically meaningful changes across trials is poor [286]. There are better-established minimum clinically important differences at a functional rather than impairment level in measures such as the 30-second sit to stand and gait speed [287]. In formal evaluation of the PACE intervention, the minimal clinically important differences of these functional measures could be used to determine if muscle strength had contributed to functional gains which may be more meaningful to older people.

Issues with standardising the protocol for the measurement of quadriceps strength in the community setting identified here are not consistent with the existing literature [235]. Previous studies have reliably measured quadriceps strength with community-dwelling older people using a hand held dynamometer, which supported the use of the measure in this study [235], however increased reliability has been demonstrated (in younger participants) when testing in a supine position [288] which was not done in this study. There are also reported limitations in other patient groups, such as palliative care patients, where tester strength was identified as a key consideration for reliable results [289]. As the same tester conducted all testing in this study this factor is unlikely to have affected the findings. Nevertheless as the measurement was standardised for each participant which was appropriate for the study design and case wise analytical approach, the PACE intervention can be considered to have met the primary outcome of improving lower limb strength.

Use of the 6-minute walk test was identified as problematic for this population and the study was unable to determine the effect on cardiovascular fitness. This may seem logical given the mobility and health limitations of the sample and the walking requirement of this test. It was trialled in this study given the reported reliability and validity of the

measure and its use for community-dwelling older people. The seated step test [290] may offer a more useful approach when the 6-minute walk test is problematic due to mobility, however, the reliability and validity of this measure has not been established [290]. In addition, participants have previously been excluded due to cardiac conditions which may preclude its use for the intended participants of the PACE intervention [Simonsick and Fried cited in VanSwearingen and Brach [290]]. Alternative outcomes for cardiovascular endurance would need to be explored in future evaluation such as the step test however the reliability of this measure for this group would first need to be established.

Although no issues with the completion of the grip strength measure were identified there were inconsistent findings between participants. Individual factors observed by the researcher may have accounted for the differences between participants such as increased anxiety and exacerbation of long-term conditions. No participants achieved clinically meaningful improvements in grip strength which are consistent with the findings from other research where only small effects [168, 172] have been reported. Grip strength is suggested to be one of the clinical marker of frailty [149] along with gait speed and mobility [188]. Although the PACE intervention was not targeted specifically at frail older people grip strength and Timed Up and Go scores could potentially be used to identify participants of PACE where referral for further assessment of frailty may be indicated to ensure they are getting the appropriate additional care.

Clinically meaningful improvements in mobility were not demonstrated by the PACE intervention using the Timed Up and Go Test, however, some participants felt their walking had improved and family members had also observed improvements. The fluctuating status of this population was identified through a decrease in mobility in participants who had experienced changes in neurological medication and recent illness prior to completing the post assessment. This does, however, reflect the real-world setting and is likely to be an issue for future evaluation of the intervention. The lack of effect of the PACE intervention on mobility was consistent with the good quality studies in the systematic review that demonstrated chair based exercise had very limited effect on mobility [160, 166, 169, 176, 178]. Experts debated the use of chair based exercise on ambulation; however there was a 68% agreement that it can improve ambulation which

was reaching the threshold for consensus. Clinically meaningful changes to mobility may however only be possible with dynamic standing exercises which were not included in the PACE intervention.

The EQ-5D-5L questionnaire was used as a generic measure of self-reported quality of life due to its use in evaluating other exercise programmes and clinical practice. It is also commonly used in the economic evaluation of interventions and therefore establishing the feasibility of completion is important prior to a definitive trial. Although there were no issues with the completion of the questionnaire the relevance of the statements to older people has been questioned by Hulme et al [291] who suggested that the responses to the questions did not cover the views of older people. Other measures that may be more appropriate to the intended participants such as the Older Peoples Quality of Life questionnaire [292] are recommended for future evaluation of the intervention.

The social isolation of older people is increasingly recognised as a contributor to a poor quality of life and physical health [293]. The importance of the social benefits associated with the PACE intervention was stressed by older people and dominated the reported benefits. This may be reflective of the priority of social interaction in this isolated group of older people with social benefits considered more important than physical health benefits. This may however not be true for other community settings, such as care homes, where social interaction may be encountered routinely through existing group activities and support from care staff and other residents.

Older people emphasised the way the intervention had helped to build their confidence which was an area that was not considered by the randomised controlled literature (chapter four) and was only considered briefly by experts (chapter three) in relation to activities of daily living. Older people discussed confidence in relation to the intervention building their confidence with walking but also a general sense of confidence with the group interactions. Building confidence may be a way of improving participation and adherence to exercise programmes for older people and starting at a low level with gradual increases in intensity recommended to build confidence [294] as employed in the PACE intervention. Questionnaires such as the CONFBal, which is a measure of balance

confidence when performing tasks such as stair climbing [295], and the Falls Efficacy Scale which relates to functional tasks [296], may have limited use in determining the effect of the PACE intervention as it is unlikely to affect these outcomes without progression to dynamic standing balance exercises. Confidence to continue to exercise may be more appropriate if longer term participation is considered a key outcome and the exercise self-efficacy scale [297] has been demonstrated to identify the belief of older people to continue exercising in line with recommended dosage and intensity. Further work is needed to identify which component of confidence older people consider is related to the PACE intervention in order to determine how to measure changes in confidence levels and build this element into the underlying theory and anticipated outcomes.

## **6.8 Conclusions**

This study has evaluated whether the PACE intervention could be delivered and whether it was compatible with its underlying theory. The primary outcomes of success were achieved indicating that the intervention had a clear theoretical underpinning and there is evidence to support this theory in practice. The study has identified areas where the intervention can be strengthened and the underlying theories refined. These areas will be discussed in chapter seven.

## 7 Chapter Seven: Discussion and conclusions

This chapter summarises the findings and the implications of the findings of this thesis. Conclusions are stated and further areas of work proposed.

### 7.1 Summary of findings

This thesis developed a chair based exercise intervention- PACE, using multiple research methods and guided by the MRC Complex Interventions Framework [3]. The thesis met the objective of systematically developing the PACE intervention using the stages described below.

**Developing theory-** In view of the lack of clarity over chair based exercise, the first stage was to start to develop the theory of the PACE intervention. As a starting point an expert consensus process was completed using a Delphi technique (chapter three). Consensus was reached on 46 statements relating to seven domains of chair based exercise: definition, intended users, potential benefits, structure, format, risk management and evaluation [125]. This provided a greater understanding of the intervention which was previously lacking.

**Identifying the evidence base-** The second stage was to identify the evidence base using the findings of the Delphi technique to establish what was known about chair based exercise to guide the PACE intervention. A systematic review on the physical and mental health benefits of chair based exercise was conducted (chapter four). The review identified a small number of good quality studies (n=7), covering a range of physical and mental health domains. Chair based exercise was delivered in a range of settings and using different formats with a lack of detail on the progression to standing programmes reported. There were a broad range of characteristics of older people taking part in chair based exercise including wheelchair users to older people who were independently ambulant. There was no good quality evidence to demonstrate that chair based exercise improved muscle strength or activities of daily living and insufficient good quality evidence to determine the effect on other health domains.

**Planning the PACE intervention-** the next stage was to synthesise the expert opinion and findings from the literature review and the principles of exercise physiology and behaviour change strategies to develop a theoretically driven intervention based on best available evidence (chapter

five). A systems approach was used to describe the underlying theories for the PACE intervention as a coherent system. A logic model was then used as a framework for describing how it was anticipated that the PACE intervention would be delivered.

**Modelling processes and outcomes-** The fourth step was to assess the feasibility of delivering the PACE intervention, to explore the acceptability and tolerability in older people and to assess whether it achieved the intended outcomes. This was done through a pre and post cohort study in an NHS community setting followed by focus groups with older people (chapter six). This demonstrated it was viable to deliver the PACE intervention in a community setting and it was acceptable and tolerated by older people if it was tailored to individual needs. There was variation in the physical abilities of participants and the reasons for undertaking the intervention. Delivery was challenged by the health status of participants and a high degree of tailoring of the intervention was required. The importance of progressing to standing programmes was stressed by participants in line with the expert views. The primary outcomes of success (lower limb muscle strength and progression to supported standing exercise) were achieved.

## **7.2 Strength and limitations**

The limitations of each component of the thesis have been presented in detail in the relevant chapters and the findings discussed in the context of these limitations.

The Delphi technique used expert views to establish a consensus on chair based exercise however these views may not be based on up-to-date knowledge and different experts may have given different opinions.

The systematic review synthesised the best quality evidence to identify what was currently known about the health benefits of chair based exercise. This review was robustly conducted by two reviewers and using a pre-defined protocol. The robustness of the conclusions drawn was however limited as meta-analysis was not possible due to the diversity of the included studies.

A logic model was used to provide a visual representation of how the PACE intervention was intended to be implemented. This approach explicitly

stated the underlying assumptions of how the intervention expected to address a defined problem [227]. The linear relationship between the components of the logic model may, however, have oversimplified a much more complex and dynamic set of interactions [298].

The pre and post cohort study was conducted by a single researcher therefore imposing constraints on the size and design of the research. The potential for the introduction of performance and detection bias with a single researcher delivering the intervention and completing the data collection was acknowledged as a limitation, and strategies such as concealment of pre-outcome data at the post data collection were used to reduce the potential for bias. The pre and post cohort study recruited older people who had previously taken part in an exercise programme which may have influenced the recruitment and underestimated the objective findings. In addition, the acceptability of the PACE intervention cannot be generalised to all older people as the sample had previously participated in a structured exercise programme and were motivated to participate in the study.

### **7.2.1 MRC framework approach**

A strength of the work was that the development of the research area was derived from the views of clinicians, older people, and providers of chair based exercise. The MRC framework [3] was then used to guide the development of the PACE intervention. Whilst this framework identified the areas to consider in the intervention development, methodological guidance was lacking and appropriate methods were used for each component. The development of the PACE intervention followed a logical approach with each component supporting the next stage of development. The methods used for each of the components may, however, have resulted in some important areas being missed. For example, the systematic review only synthesised randomised controlled trials and other research designs, such as qualitative work, may have provided further insights into the delivery of chair based exercise. Older people were also not involved with the formal consensus development process, however, their views were integral to the development of this thesis and in the modelling stage discussed in chapter six.

For healthcare interventions there appears to be an increased focus on understanding not only whether an intervention works, but under what circumstances and for whom. These contextual factors are largely ignored by the MRC framework which may limit adoption of the right interventions in the right settings. Realist evaluation has emerged as a growing methodological field during the time of this thesis, offering an approach to understanding causality within a specific context. Guidance in applying realistic principles to the MRC framework was published in 2016 [123] which may have supported the development of the PACE intervention. On reflection, there was much overlap between the systems approach and logic model used to outline the theories of the PACE intervention and realist principles, with the influence of context acknowledged. A realist review (in place of the narrative systematic review that was conducted) may have been limited by the lack of detail in much of the quantitative literature on chair based exercise and the lack of qualitative work. The adoption of reporting frameworks, such as TIDieR [181] and the more recent Consensus on Exercise Reporting Template [299] may, however, mean that a realist review is possible in the future.

Upon completion of the modelling phase of this thesis Wight et al [300] published the '*Six steps in quality intervention development (6SQuID)*'. Although the focus was on public health the guideline outlined six practical steps (Figure 23) to developing an intervention which could be applied to the development of interventions such as PACE. This guideline wasn't available during the development of PACE; however the programme of work conducted in this thesis mirrors many of the suggested steps.

- 1. Define and understand the problem and its causes.**
- 2. Clarify which causal or contextual factors are malleable and have the greatest scope for change.**
- 3. Identify how to bring about change: the change mechanism**
- 4. Identify how to deliver the change mechanism**
- 5. Test and refine on a small scale**
- 6. Collect sufficient evidence of effectiveness to justify rigorous evaluation/implementation**

**Figure 23: Six steps in quality intervention development**

### **7.3 Clinical implications**

Translation of findings into clinical practice should be considered at all stages of the research process. Prior to this work, there was a lack of clarity over the concept of chair based exercise and identifying the evidence was difficult. This has been addressed in this thesis. Although the PACE intervention has not been formally evaluated there are findings from the development process that can support the current delivery of chair based exercise across community settings.

Implications of the findings of this thesis are outlined below:

- Not all chair based exercise interventions are clinically effective at improving physical health outcomes and providers of programmes need to carefully consider the intervention package to ensure there are realistic expectations of the outcomes related to characteristics of interventions.
- Chair based exercise should not be the default choice of exercise for older people without consideration of individual preferences and needs. Not all older people welcomed chair based exercise interventions, with walking and standing programmes considered by some older people to be more beneficial with a greater sense of independence.
- Chair based exercise may be used as a form of recreation; however, this use needs to be made explicit and suitably marketed. It is not appropriate to claim significant health benefits if the programme is not targeted to achieve these.

- There is now a greater understanding of the intended participants of chair based exercise when it is used as an intervention.  
Programmes should be targeted at those older people unable to take part in unsupported standing exercise programmes. The reasons for being unable to take part in unsupported standing programmes may be due to limitations in mobility, confidence to exercise when standing, exacerbations of health conditions or safety when exercising unsupervised when standing, such as visual impairment or dizziness. Standardised criteria may be of limited use in determining eligibility to the programme. The reason for taking part in chair based exercise should be explicit and agreed with the older person.
- Health screening is recommended prior to commencing a chair based exercise intervention to allow the programme to be modified to individual health conditions. To maximise participation exclusion, should only be considered on the grounds of safety, using absolute contraindications to exercise and programmes modified to meet individual needs.
- There were potential negative implications from attending chair based exercise interventions which need to be balanced against the benefits of participating. Anxiety, fatigue and musculoskeletal pain with resistance exercise were identified which need to be reviewed throughout programmes.
- Progressing to supported and unsupported standing exercise was considered valuable to experts and older people and this should be actively supported if this is important and achievable by the participant.
- Providers should carefully consider the level of supervision given to complete the programme. Older people and the exercise leader considered more supervision would be beneficial to allow close monitoring of technique, maximise the intensity and minimise the risks.
- Considering the individual preferences of the participant may help to maximise participation and this may include offering group or individual home based sessions, offering different timings of sessions and offering a choice of exercise training equipment.

- Consideration should be given to ensure group sessions are locally delivered with appropriate transport mechanisms to support participation.
- Interventions may need a high degree of tailoring to account for individual health conditions and preferences of older people. Overly structured and prescriptive programmes that do not allow for changes to the delivery may be limited for this population.
- Compromised health was the most common factor influencing participation and programmes may need to be of a longer duration to account for missed sessions due to poor health to still achieve benefit.

## **7.4 Commissioning Implications**

It is also important to consider the implications of this thesis at a more strategic level for those commissioning and determining service provision. It is acknowledged that this thesis has not explored the effectiveness of the PACE intervention and the commissioning of the intervention cannot be fully recommended until clinical effectiveness has been established. The development work has however identified considerations for the commissioning of wider chair based exercise programmes which include:

- To allow for the degree of tailoring required a health professional with the appropriate knowledge and skills should deliver the programme.
- The programme should be a minimum of 12 weeks to allow for strength training changes.
- Involvement of the wider network of exercise provision in the community is recommended to support longer term participation and transition to supported and unsupported standing programmes

## **7.5 Optimising the intervention**

The findings from this thesis identify that for a specific population in a specific setting and under specific conditions, the PACE intervention has been robustly developed to a point where formal evaluation is justified. The intervention was feasible to deliver if individually tailored, largely acceptable to older people, with physical changes demonstrated at an impairment level and progression to supported standing achieved. The

underlying theory of the physiological response to muscle strengthening and progression to supported standing exercise was demonstrated in practice. Fletcher et al [123] suggest that the underlying theories of an intervention are informed by the findings of early testing and retrospective modelling of an intervention is appropriate. The modelling work in chapter six identified areas wherein the PACE intervention could be refined and these are explored below. The logic model is then re-presented in Figure 24 with the areas that have been refined highlighted.

### **7.5.1 Participants**

Ensuring the PACE intervention is targeted appropriately underpins its success and this has not been carefully considered in other chair based exercise research. The underlying theory of the PACE intervention relies on appropriate older people participating to ensure that the programme is acceptable and that the primary outcome of progression is attainable. Although there is a clear message that chair based exercise interventions, such as PACE, should be used for older adults unable to take part in standing programmes there were multiple reasons why older adults may not be able to take part in standing programmes. Older people themselves reported different reasons for taking part in the programme which included confidence, physical abilities and dizziness. The varying reasons for participation support assessment by a health care professional to determine the appropriateness of the intervention. The reason for not being able to undertake standing programmes should be clearly stated, discussed and agreed with the participant prior to taking part in the PACE intervention.

### **7.5.2 Supervision**

Older people appeared to welcome more supervision and support so that they knew they were '*doing it right*' indicating that the PACE intervention would benefit from offering more supervised sessions to those older people who found the unsupervised sessions challenging. This was supported by barriers such as participants requiring close monitoring, as identified by the therapist which limited the additional unsupervised session a week for some participants. The use of telephone support [189] and peer support [301] have been used as strategies to monitor and provide additional support for home-based exercise programmes. The issues of safety identified in this thesis would not be resolved with these strategies. The

intervention would, therefore, be developed to include supervised sessions three times a week if considered appropriate by the participant.

With this increased level of supervision there is a risk of increased dependency on the healthcare professional and consideration of how to support longer term independence with a time limiting intervention, such as PACE, may be needed. The PACE intervention could be developed to allow time in sessions to discuss ways of increasing activity outside the structured programme. Simple approaches such as regular sit-to stands may help to allow completion independently.

### **7.5.3 Intensity**

The programme was developed to be delivered at a moderate intensity for all participants, however there were variations in the perceptions of whether participants had found the programme sufficiently challenging. Closer monitoring of the intensity of the programme may help to ensure it is appropriate for all participants and allow greater resistances and progression. The '*talk test*' was used as a pragmatic way for participants to determine the intensity that they were working, however, this may not have been sensitive enough to ensure the programme could be tailored to the appropriate intensity and alternative approaches may be preferential. Heart rate monitors could be used as a reliable, objective way of determining intensity which has been used in research-based chair based exercise interventions [86]. Such methods may, however, have limited use in helping older people to identify the intensity of the programme and may be more difficult to implement in a real-life setting. Using a scale such as the Borg Scale [204] could help to develop the PACE intervention to allow participants to self-assess their exertion thereby offering a more sensitive tool. This would also allow closer monitoring on the fidelity of the intensity of PACE in future evaluation.

### **7.5.4 Progression**

Older people and experts emphasised the importance of trying to progress to supported standing exercise and then ultimately unsupported standing programmes. Whilst this may not be appropriate for all participants of the PACE intervention, the opportunity to progress to unsupported standing programmes could be developed in the PACE intervention. It was not previously included as the aim was for a short term intervention that

provided the basic level training and the pre and post cohort study explored the rate of progression and what was realistic and achievable for this population. It is however now understood that further support within the PACE intervention to progress to unsupported standing programmes which are delivered clinically (such as the established FaME and OTAGO programmes outlined in chapter one) would improve the intervention. This progression may have more influence on improving functional mobility which was not demonstrated by the PACE intervention.

For some older people participating in the PACE intervention progression to supported standing programmes may not be possible and maintenance of strength and functional abilities may be the primary outcome. Consideration over how to support longer term participation in chair based exercise programmes delivered by the third sector may be needed to ensure that the effects of the PACE intervention can be sustained.

#### **7.5.5 Training**

Experts suggested that instructors should be suitably skilled and trained, with the knowledge and skills of working with older people. This was supported by the views of older people in the focus groups who felt it was important that instructors could '*appreciate why some people can do something's and some people can't*'. The characteristics of the instructor have been shown to influence older people in their participation in group exercise programmes [147] which aligns with the finding in this thesis that rapport with the leader facilitates the successful delivery of programmes.

Experts could not agree on the level of qualification needed to deliver chair based exercise programmes which was supported by the perspective of older people who considered that qualifications do not always transfer to the ability to '*do the job*'. The findings from this thesis indicate that the knowledge and skills of instructors to adapt the intervention to meet the different and changing needs of older people are very important. Delivery by a professional with the knowledge and skills of working with older people, which may include physiotherapists, occupational therapists and exercise therapists, is recommended to ensure that it can be appropriately tailored. This recommendation is supported by the NICE recommendations on physical activity programmes for older people [198]. It is acknowledged that this may limit wider implementation by volunteers and care staff,

however, the importance of adapting the PACE intervention to meet the complex needs of older people and ensuring that it is delivered at the appropriate intensity underpins the success of the intervention. A training package would need to be developed in further work, for the PACE intervention (as agreed by experts in chapter three) to ensure the fidelity of delivery and that leaders understand the rationale of the intervention.

### 7.5.6 Variation

The amount of variation that is permitted in the delivery of a complex intervention needs to be clearly established to ensure consistency across different settings [181]. Delivery of the PACE intervention required a flexible, individual approach due to the complex needs of the participants. The importance of tailoring the PACE intervention to meet the individual needs of participants and services was highlighted through expert opinion and echoed by the views of older people. Allowing such flexibility did, however, result in different durations, frequencies, intensities and progression of the programme. The core components and the degree of flexibility that is permitted in the PACE intervention need to be reconsidered in view of the feasibility findings and are summarised in Table 62.

**Table 62: Variation permitted in the delivery of PACE**

Core Components	Flexibility permitted
<ul style="list-style-type: none"> <li>• Clear reason for undertaking chair based exercise</li> <li>• Three supervised sessions a week offered</li> <li>• Completion of a minimum of two sessions per week</li> <li>• Progressive exercise protocol</li> <li>• Delivered by a health professional with knowledge and skills of older people</li> <li>• Health assessment prior to commencing</li> <li>• Chair used for sitting and supported standing exercises</li> <li>• Transport offered for group based programmes</li> <li>• Behaviour change strategies used to support participation</li> </ul>	<ul style="list-style-type: none"> <li>• Group or home based individual delivery</li> <li>• Rate of progression of exercises</li> <li>• Starting level of exercise protocol</li> <li>• Modification of exercise content due to co-morbidities</li> <li>• Choice of strength training equipment (resistance bands, hand weights or body weight resistance)</li> <li>• Duration of the programme determined by progression to unsupported standing programmes</li> <li>• Variety in warm up exercises to reduce boredom</li> </ul>

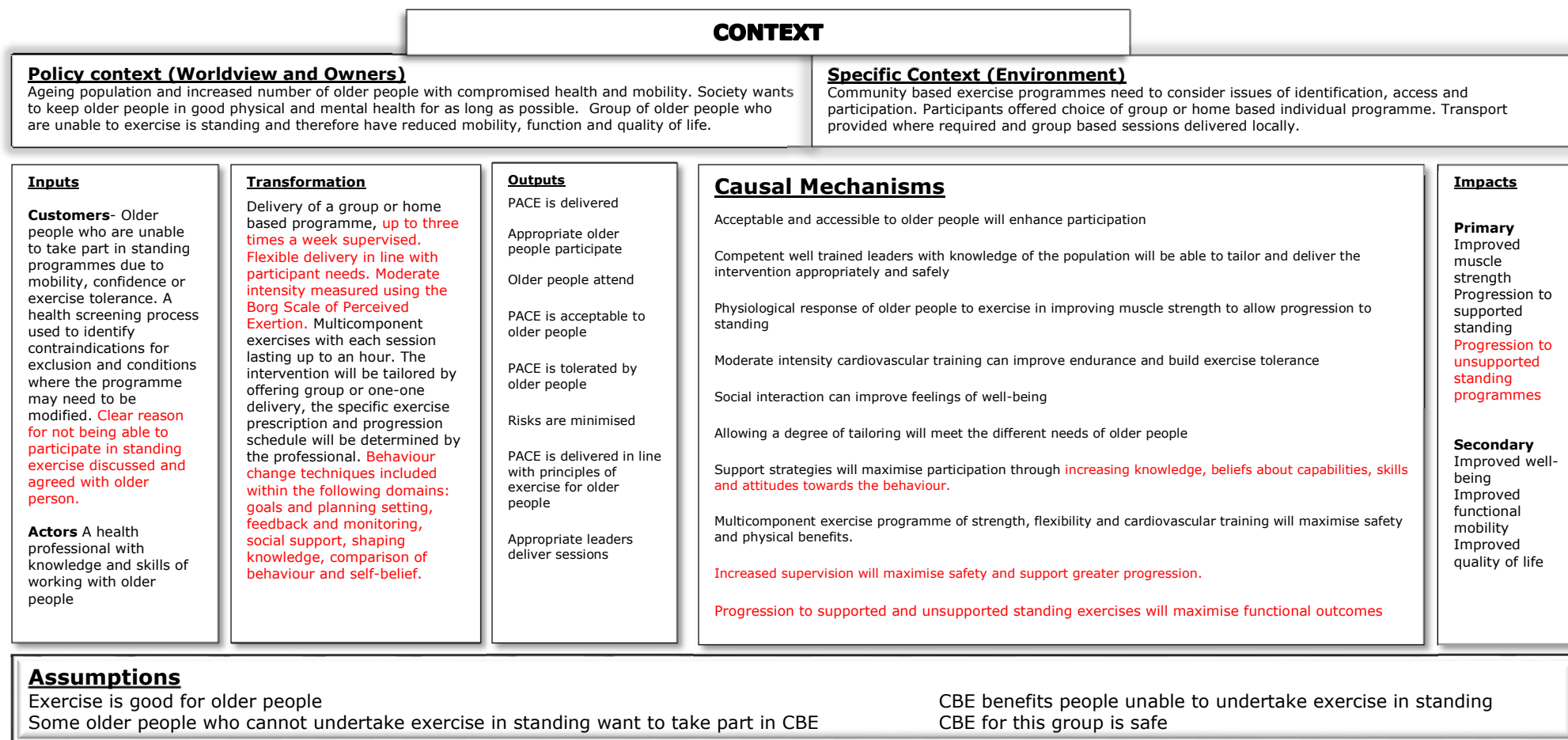
### **7.5.7 Supplementary interventions**

Whilst not considered by the modelling work in this thesis it may be appropriate to explore alternative interventions that could be used in conjunction with the PACE intervention to maximise physiological changes. Such interventions could include amino acid supplementation which stimulates protein synthesis [302, 303] and helps to overcome the anabolic resistance effect (described in chapter one). Barnes and Masud [304] suggest, in a clinical review of sarcopenia (a loss of muscle mass), that resistance training and amino acid supplementation '*show the greatest potential*' for improving functional outcomes. One of the studies [305] reviewed by Barnes and Masud [304] described that participants were only 48% compliant with taking the supplements and such feasibility issues would need to be explored in any future developments of the intervention.

More innovative and creative approaches that capitalise on advances in technology for supporting older people to participate in exercise may enhance the PACE intervention. One approach that is currently being explored is the use of smart phone and teleconferencing technology to deliver a home based falls prevention exercise programme for older people [306]. The findings from this work may have implications for the development of PACE for older people for whom accessing a community group programme may be challenging.

### **7.5.8 Revised logic model**

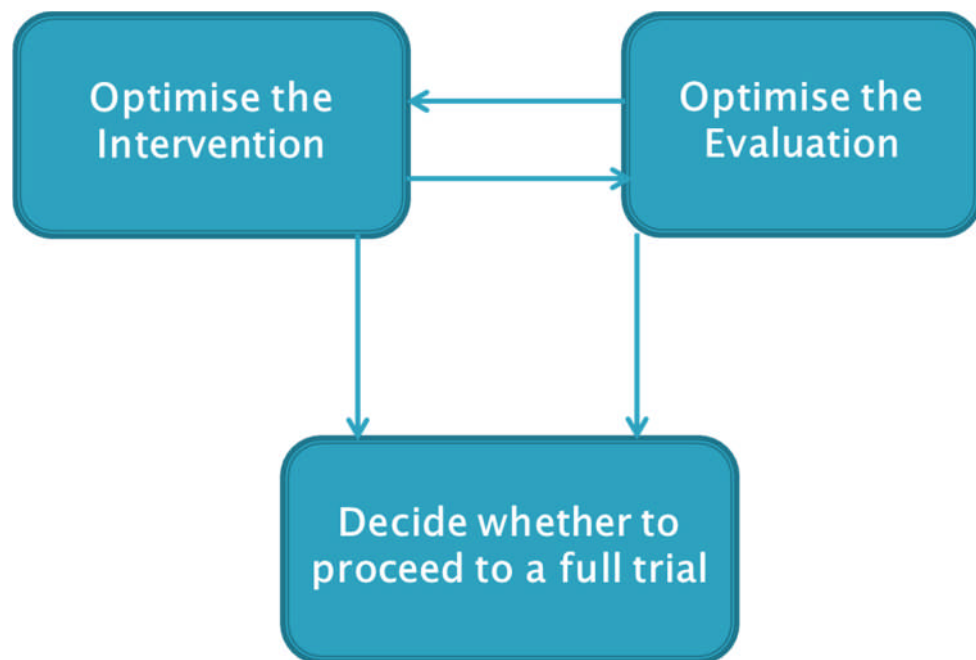
The development of a complex intervention is an iterative process that needs to respond to advancing knowledge and understanding. The logic model for the PACE intervention has been refined in view of the findings of this thesis and is presented in Figure 24.



**Figure 24: Revised logic model**

## 7.6 Optimising the evaluation

The research in this thesis, guided by the MRC Framework [3] aimed to develop the PACE intervention to a point where it was suitable for formal evaluation. It is not justifiable to run a definitive trial if the intervention is not fully understood and the parameters are not well defined. As it is considered the highest quality primary research a randomised controlled trial would be the most appropriate research design to formally evaluate the PACE intervention. In order to conduct a definitive trial, there should be sufficient understanding of the trial parameters to reduce the threat to the trial validity and ensure that the trial can be conducted [307]. Alongside optimisation of the PACE intervention, work is also needed to optimise the evaluation (Figure 25) which requires further feasibility work [117].



**Figure 25: Optimising the intervention and optimising the evaluation (Modified from Campbell et al [117])**

A conceptual framework of feasibility studies that inform randomised controlled trials was proposed by Eldridge et al [307]. As agreed through an expert consensus process the framework defined both pilot and feasibility work that prepared for a randomised controlled trial due to lack of understanding across the literature. Three types of study were identified; i) non-randomised pilot studies, ii) feasibility studies that are not pilot studies, iii) randomised feasibility studies. This aligns with the NIHR

definition of a feasibility study which states that they do not have to be randomised [308].

It is acknowledged that there may be multiple components to addressing feasibility in preparation for a definitive randomised controlled trial and the process may not be '*linear*' [307]p. 15]. It is, however, common to conduct a non-randomised feasibility study before a randomised feasibility study. The pre and post cohort study in chapter six can be considered a non-randomised feasibility study where elements of the intervention were tested. A randomised feasibility study is therefore proposed as the next stage of this work to inform the definitive randomised controlled trial. This is considered important in order to address the influence of the randomisation process on the recruitment and attrition rates and to explore the feasibility of the control group. The objectives of the feasibility randomised controlled trial are outlined below:

1. Determine the recruitment rates and willingness of participants to be randomised
2. Determine if the control group can be delivered and if it is acceptable to participants
3. Determine the most appropriate methods to assess the outcomes of the PACE intervention

There is an NIHR funded feasibility randomised controlled trial on chair based exercise currently being undertaken across care homes, day centres and community groups [270]. The PACE intervention differs from the NIHR funded study in respect to the intervention and setting used in this thesis, however it does demonstrate the growth of interest in this topic and the importance of optimising the method of evaluation before a definitive trial.

The areas that the feasibility randomised controlled trial of the PACE intervention would address are briefly discussed below.

### **7.6.1 Recruitment**

The recruitment of older people to research studies is a recognised challenge which requires appropriate resources, time and strategies that are acceptable to older people [232, 266, 309]. The pre and post cohort study presented in chapter six identified that it was possible to identify and

recruit older people to take part in the PACE intervention, however the recruitment rate was lower than participation in rehabilitation programmes (Appendix A) and other randomised controlled trials (chapter four). This may be reflective of the cohort previously participating in a rehabilitation programme and as such a definitive trial would need to consider selecting participants that had not previously participated in chair based exercise.

The pre and post cohort study ensured that all participants received the intervention which would not be the case in a randomised controlled trial. Older people may be less or more willing to participate if they do not receive the PACE intervention and are randomised to a control group. It is therefore not appropriate to use the recruitment rates from the feasibility study in this thesis to inform a randomised controlled trial. The willingness of participants to be randomised and the influence of this on participant recruitment and attrition needs to be explored by further feasibility work.

### **7.6.2 Control group**

A control group is needed for a randomised controlled trial as a comparator to the PACE intervention and the most appropriate control group is dependent on the research question. Randomised controlled trials have compared chair based exercise interventions with no intervention [173], attention controls such as group reminiscence [109] and conversation groups [84] and non-progressive exercise programmes [177]. Other research designs may include the use of a waiting list control which may be more acceptable as all participants would receive the intervention. The most appropriate control for a definitive trial would need to be established through further feasibility work which would include discussions with older people.

### **7.6.3 Outcomes**

Experts agreed on a range of physical and mental health benefits of chair based exercise which would need to be considered by a definitive trial. A feasibility randomised controlled trial would provide an opportunity to explore potential outcome measures for use in a definitive trial.

Progression to standing programmes may be considered the primary outcome of the PACE intervention, based upon the views of experts and older people, as well as the ability to progress participants in the feasibility study in this thesis. This could be evaluated using a binary measure of

whether participants were able to progress to unsupported standing programmes.

More functional measures of lower limb muscle strength may be more appropriate for a definitive trial to ensure the outcomes have clinical relevance. Such measures include the 30-second chair stand where the participant performs as many sit-stands as possible within 30 seconds and acts as a measure of the functional strength and endurance of older people. Although not considered a primary outcome a functional measure of upper limb muscle strength could be considered in place of the grip strength measured in the pre and post cohort study.

The 6-minute walk test was chosen for the pre and post cohort study as a valid and reliable test of functional exercise capacity that has been used to evaluate chair based exercise interventions [310] and with a lack of validated seated measures suitable for community use. Difficulty in completing this outcome in the pre and post cohort study was due to the participant's mobility and health and limits its use in a definitive trial. The 2-minute walk test has gained popularity in a clinical setting due to the reduced time taken to perform the test and for older adults with mobility limitations. Normative values have now been established [311] for this test which may provide a more suitable alternative to the 6-minute walk test for evaluating PACE. The seated step test [290] may also offer a more useful approach when the walk test is problematic due to mobility, however, the validity of this measure has not been established. The seated step test and 2-minute walk test could be explored in the feasibility randomised controlled trial to establish appropriate outcomes for a formal trial.

The EQ-5D-5L was used in the pre and post cohort study in chapter six as a measure of health-related quality of life. Although there were no issues with completion, the depth of the data and relevance to older people was limited. Questionnaires specific to the quality of life of older people, such as the Older People's Quality of Life questionnaire [292], could be explored in a feasibility trial. A lifestyle intervention for older people which is currently being evaluated [312] is using the SF-36 as a measure of quality of life as it was found to be more sensitive to what was being reported qualitatively by older people in prior feasibility work [313]. The feasibility randomised

controlled trial would allow this questionnaire to be explored in the evaluation of the PACE intervention.

The importance of well-being was stressed by the PPI groups at the start of this work as well as the experts in the consensus development process. Measuring well-being is complex and there is a range of quantitative measures such as the Warwick-Edinburgh Mental Well-being Scale [314] and the Perceived Well-being Scale [315]. A systematic review of the well-being measures for older people conducted by Goodwill [316] concluded that although all the measures identified considered aspects of well-being that were important to older people, none of the measures considered all of the important aspects. Qualitative methods such as observations and interviews may offer a different insight into the well-being of older people participating in the PACE intervention. Both quantitative and qualitative approaches would need to be explored in the feasibility trial to determine the most appropriate measures for a definitive trial.

## **7.7 Positioning PACE in the wider exercise community**

As outlined in chapter one, physical activity has been suggested to be one of the most promising interventions to sustain health in older life [11]. The underlying theory of the PACE intervention was to provide a basis for older adults to begin a structured activity programme. The logic model outlined the underlying theory of how the intervention was intended to achieve health benefits and where possible progress to standing programmes.

Time limiting interventions, which are often provided by health and social care, may not provide a sustainable way of maintaining the health benefits of physical activity. Consideration is therefore needed on how levels of physical activity can be sustained following the PACE intervention and similar time limiting standing programmes. A survey by the Royal College of Physicians [317] identified that NHS clinicians struggle to support older people to transition into exercise groups delivered by the third sector. The report identified that where available exercise groups were mainly chair based with a lack of standing groups delivered [317]. Sustained participation in chair based exercise programmes may maintain muscle impairments (as seen in chapter six) and may be suitable for some older people where progression is challenging or seated programmes are the

preference of the older person. Further work is, however, needed to ensure that there are appropriate standing and sufficiently challenging exercise programmes delivered in the community to meet the needs of older adults who are able to progress. This may require a cultural shift to empower older people to make choices about their level of activity and determine the level of intensity and challenge. The prevention of falls network for dissemination (ProFOUND) have run a three year project delivering training in standing strength and balance programmes. A cascade model of training using '*the train the trainer*' format was used to train exercise instructors in the OTAGO exercise programme across Europe. Evaluation of the project suggests that an increased number of evidence based programmes are now being delivered and that delivery include more intense and progressive programmes [318]. The longer terms impact of such projects which aim to support the sustained implementation of exercise programmes across community setting is however yet to be established.

## **7.8 Re-examining the root definition**

This thesis has considered a chair based exercise intervention (PACE) for a specific cohort of older people in a specific NHS community setting. The growing interest in the field of appropriate exercise strategies for older people with compromised health is demonstrated by NIHR funded feasibility work on chair based exercise [270], further published randomised controlled trials [310] and on-going reviews to establish the optimal characteristics of exercise programmes [319]. The use of chair based exercise in the management of specific health conditions such as cardiac [89] and heart failure patients [88, 320] is also a developing area. Advances in this area can help to support the development of the PACE intervention in different contexts.

The root definition of the PACE intervention was developed to address a defined problem which was tested within a specific context. It is acknowledged that the community setting definition outlined at the start of this thesis was very broad. Thus although the underlying theory of the PACE intervention has been modelled in one specific primary care community setting the theories may not hold true for all community settings included in the definition. The different characteristics between these settings provide an additional layer of complexity to the intervention that needs to be considered. In addition, there may be settings and patient

groups where chair based exercise interventions are indicated that did not fall within the scope of this thesis.

The root definition and casual processes of a chair based exercise intervention for these settings and patient groups may be different due to the differences in the target population, contextual factors and the anticipated outcomes. These include very dependent older adults in care homes and older adults who are immobile after surgery or severe illness which are now discussed.

### **7.8.1 Care home populations**

Although the definition of a community setting included care homes it is likely that this population will be more dependent with greater activity limitations than participants who took part in the PACE intervention in this thesis. The randomised controlled trial literature in the systematic review identified that chair based exercise interventions were conducted in care home settings [81, 109, 166, 168, 169, 172, 174, 175], however only one of these was considered good quality evidence [166]. The characteristics of the care home residents may have changed since the work conducted in some of these trials with an ageing care home population [321] and an increase in dependency levels [322]. Interventions that were developed for care home populations such as the work by McMurdo and Rennie in 1994 [109] and 1993 [172] may not apply to care home residents today.

Supporting exercise interventions that are sufficiently intense to elicit physiological changes for this group of older people may pose issues of tolerability, feasibility and safety. Conducting exercise at an appropriate intensity may also require one-one supervision. The high-intensity exercise programme conducted by Seynnes et al [174] targeted ambulatory care home residents who may not be the intended participants of a chair based exercise intervention. In contrast Chen et al [168] delivered an elastic band exercise programme to care home residents who used a wheelchair for mobility, however, the intervention used gentle stretching exercises to increase muscle strength rather than evidence-based principles..

Contextual factors of delivering exercise programmes in care homes may influence the intensity and frequency. Chin A Paw et al [323] demonstrated the difficulties of programmes that were delivered by external leaders with only one session a week possible. Delivery by internal care home staff may

be more appropriate as they are familiar with the resident's needs and this model has been adopted for other exercise programmes [70]. This may however result in the delivery of a less intense programme that is safe but ineffective. Further development of the PACE intervention is required for a care home population to determine the core components and appropriate outcomes.

It may also be reasonable to consider chair based exercise interventions as a form of recreational activity and not an intervention for care home populations. Older people may choose to engage in chair based exercise as a way of promoting general well-being and it may not be appropriate to impose strict parameters of intensity and frequency on these programmes. This activity does, however, need to be marketed appropriately to ensure the potential benefits align with the underlying assumptions and mechanisms of action. For example caution should be applied in claiming physical benefits, such as improvements in muscle strength, as they do not fit with the physiological principles required to achieve such changes. Formal evaluation of these programmes may not be appropriate and instead should focus on participation and participant feedback.

### **7.8.2 Temporary immobile populations**

The use of chair based exercise for older people who were unable to carry out standing exercises as a consequence of an acute medical problem was recognised by experts in chapter three; however the principles of the intervention were considered the same for those with acute or longer term activity. It may however be more appropriate to consider that there were some differences in the principles of programmes for older people who are temporarily immobile. An intervention for this group may need to be of a higher intensity, higher frequency and of a shorter duration with the key focus on moving to unsupported standing exercises as soon as possible. Research on exercise for temporary immobile patients, such as post hip fracture, has been conducted to compare supine compared to standing programmes [324]. Research exploring the role of chair based exercise for this group has focused on community-based interventions post discharge from hospital [160] and rehabilitation healthcare settings [85]. Latham et al [265] conducted preliminary exploration of a progressive resistance training and walking intervention in an acute setting however the follow up randomised controlled trial was conducted after discharge [160].

It may be however that chair based exercise has a role in the more acute phase. Outcomes may include the length of stay, as well as the progression to standing exercises, with less emphasis on psychosocial benefit and enjoyment with participation. As with other treatment approaches, there may be a decision to participate in order to achieve the desired outcomes but this may involve a challenging and uncomfortable process. For example, an older person undergoing a hip replacement may not enjoy the surgical treatment process but this is necessary to achieve the desired outcomes. A feasibility study by Pedertsen et al [325] explored a progressive sit-to-stand intervention in the acute phase on medical wards. This work did, however, exclude older adults who were unable to stand initially which may be the target population for this type of intervention and 90% of those who were eligible did not take part in the study. In the follow up randomised trial protocol [326] they authors acknowledged this limitation and have adopted wider inclusion criteria. Once completed the findings of the work by Pedertsen and colleagues may have implications for the development of the PACE intervention for temporary immobile patients in acute healthcare settings.

## **7.9 Research Implications**

This thesis has developed a complex intervention to a point where formal evaluation is justified and has identified further area where the work could be developed. A summary of the research implications identified in this thesis is provided below:

- The PACE intervention has been systematically developed and feasibility work is now needed to optimise the evaluation methods of a definitive trial.
- Despite rigorous development of the PACE intervention, delivery in a real-world setting was challenging and required a flexible approach. Healthcare researchers developing complex interventions need to consider this early real-world testing as part of the development in order to support longer term implementation and participation.
- Systems thinking and visually describing the PACE intervention using a logic model provided a useful approach in the absence of other methodological guidance. This method may be beneficial to other researchers in helping to plan and share their understanding of a complex intervention.

- Further exploration of whether other populations may benefit from the PACE intervention is warranted and these include care home residents and older adults in acute hospital settings.
- Further work is needed to develop strategies to support participation in exercise programmes that are developed based on the views of older people.
- Further exploration of the views of older adults who haven't taken part in exercise programmes is needed to help develop interventions that support wider participation.

## 7.10 Researcher reflections

Welsh suggests that a rigorous programme of research requires that the researcher provides a '*transparent account of his/her journey through the research process*' [327], p. 201]. The researcher's beliefs and views about chair based exercise were set out in chapter one to provide transparency over the influence of the researcher through the programme of work in this thesis. A brief overview on the researcher's reflections throughout the process is outlined below to offer a transparent account of the research journey.

### 7.10.1 Researcher role

Although I had experience in working with older people as a community physiotherapist and formal training in research methods I had not carefully considered the boundaries between researcher and clinician. Conducting the pre and post cohort study as a physiotherapist within a community NHS team where I worked brought both positive and negative implications. As an NHS professional, potential participants may have seen this as a recognised service that they were familiar with. Being a research physiotherapist within an NHS service did, however, pose challenges with blurred boundaries between researcher and clinician. I had outlined on the information sheet for participants that they would need to be referred to the appropriate service as the study was solely looking at the delivery of an exercise programme. By outlining this in the information sheet I felt that I considered the scope of my role as a research physiotherapist, however on reflection I did not fully appreciate the challenges I faced in the real world. Over the course of the study, I was able to spend a lot of time with the participants who then felt able to discuss their health needs with me. I

struggled to create distinct boundaries between my role as a researcher and my professional identity as a physiotherapist. I felt I had a duty of care to act when participants raised health concerns; however, I had to carefully consider what I was able to do within my role. I consider that in future research I will need to continue to reflect on the scope of my research role and seek advice and support from peers.

#### **7.10.2 Position of the researcher**

The position of the researcher before this work was undertaken is described at the beginning of the thesis. Undertaking this work has shaped my beliefs and attitudes towards chair based exercise interventions. Although I was positive about the potential of chair based exercise, I struggled to identify the specific clinical presentation and characteristics where it would be indicated. Potentially due to the constraints of the service, resources and the risk aversion culture of my NHS trust, I may have not fully explored whether standing programmes could be undertaken by some older people. I now consider that chair based exercise programmes should only be used as an intervention for those older adults who are unable to participate in standing programmes and would be more explicit in my clinical decision making. I do however recognise that this is challenging to implement in NHS and care settings where there are limited resources and less flexibility in the service provision.

### **7.11 Conclusions**

This thesis has met the objective of developing a chair based exercise intervention- PACE, for community-dwelling older people to a point where formal evaluation is justified. A theoretically driven intervention has been developed and modelled to be feasible, acceptable and safe. A feasibility randomised controlled trial is recommended as the next stage of work to determine the parameters of a definitive randomised controlled trial.

By developing a greater understanding of the concept of chair based exercise and the intended outcomes there are further groups of older people where the intervention could be of benefit. These include the care home population and older people who are temporarily immobile due to an acute condition. Further work is needed to develop the PACE intervention for these patient groups.

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## Appendices

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## **Appendix A: Service evaluation report**

### **Service evaluation of Day Rehabilitation service: Summary Report**

**Completed by K. Robinson**

#### **Scope of Report**

This is a summary report of the service evaluation of the Day Rehabilitation therapy groups conducted by the author of the thesis.

#### **Aims and objectives**

The aims of this evaluation were to describe the chair based exercise programme delivered and describe the patient profiles of participants of the chair based exercise intervention.

The specific objectives of the service evaluation were to:

- Identify clinical decisions associated with allocation to the chair based exercise intervention
- Describe the patient pathway through the service and the chair based exercise intervention
- Identify any changes in allocation to the chair based exercise intervention
- Describe the clinical presentation of patients allocated to the chair based exercise intervention and compare with the clinical presentation of patients allocated to standing programmes

#### **Methods**

A retrospective cohort study design was chosen in order to meet the study aims. Describing current practice could be answered using routine data that was already collected by the service.

#### ***Governance approval***

Nottinghamshire Healthcare NHS Foundation Trust provided written confirmation that the project was considered a service evaluation (provided at the end of the report). A service evaluation is a systematic approach to defining current practice in order to make a judgement about what a particular service achieves [1]. It differs from research in that it does not test a hypothesis. It differs from clinical audit in that it does not measure a service against a specified standard. Service evaluation is an important part of quality improvement in healthcare services [2] in order to describe current practice and identify areas for development.

Ethical approval is not a requirement for service evaluation however in line with good practice the protocol and data extraction methods were reviewed by Nottinghamshire Healthcare NHS Foundation Trust Research and Innovation department (supporting letter is at the end of this report). This was to ensure the evaluation adhered to the appropriate governance procedures. The Day Rehabilitation team leader provided verbal approval for the evaluation and was consulted throughout the process.

### **Data collection**

Data about how the service and interventions were provided was collected from written leaflets given to patients and other clinical services service specifications and discussion with the team leader and therapy staff. Data were collected retrospectively from clinical records of patients referred within a 7 month period.

Data was collected from clinical records using a standardised spreadsheet designed to record data against the objectives of the evaluation. Retrospective data collection was considered appropriate in order to meet the aim of the evaluation and provide a description of practice. Data was collected at different time points: referral to the service; first assessment; allocation to exercise programmes and completion of exercise programme.

In line with good clinical practice, only data required to meet the aims and objectives of the evaluation was collected. No personal identifiable data was collected as this was not required to meet the evaluation aims. Data was collected from clinical records by a research physiotherapist who was a member of the Day Rehabilitation team in September 2015. The type of information collected and sources of data are summarised in Table 1.

**Table 1: Sources of information**

Type of information	Source
Number of patients referred	Referral Book
Number of patients assessed	Clinical records
Group allocated	Clinical records
Group attended	Clinical records
Attendance to therapy groups	Clinical records, appointment ledger
Reasons for non-attendance	Clinical records - running records
Pre-group outcome measures* (Timed Up and Go Test, Berg balance)	Clinical records -Physiotherapy assessment
Mobility status	Clinical records -The walking aid used by the patient recorded at initial assessment. The level of mobility was considered relevant to the walking aid used with the following scale from higher levels of mobility to lower levels of mobility: Independent 1 walking stick 1 elbow crutch 2 walking sticks 2 elbow crutches 1 quads stick Wheeled walkers Wheelchair
Clinical reasoning for group allocation	Clinical records -Physiotherapy assessment
Post-group outcome measures (Timed Up and Go Test, Berg balance)	Clinical records -Physiotherapy assessment
Outcome of group intervention (e.g. discharge, further therapy, referrals)	Clinical records- running records/discharge Letter

\*The Berg Balance Scale is a performance based test scored out of 56 with higher scores representing better balance [3]. The Timed Up and Go Test is a functional measure that times how long in seconds it takes a patient to stand up walk 3 meters turn around and return to sitting [4]. Lower times indicate better mobility.

### **Data analysis**

Descriptive statistics including measures of central tendency (mean, median and mode) were used to describe the sample of patients, to compare the attendance rates of the programmes and to compare pre and post-intervention outcome measures.

## **Results**

### ***Description of the interventions***

The chair based exercise intervention was provided by the Day Rehabilitation service, Bassetlaw Healthcare Partnership, Nottinghamshire Healthcare NHS Foundation Trust. The Day Rehabilitation service provided two exercise based therapy interventions delivered in a group setting. Both had the same aim of maximising functional mobility and independence in activities of daily living. Both were for adults aged 55 years and over.

The *Staying Steady* programme was a dynamic strength and balance exercise programme with educational sessions focused on falls risk reduction. The eligibility criteria were that participants could independently mobilise with a walking stick indoors and stand unsupported for longer than five seconds and independently mobilise around an exercise circuit. This programme could not be considered a chair based exercise programme according to the definition as it was not primarily a seated exercise programme. A description has been included to allow comparison with the chair based exercise programme.

The *Age Well* programme was designed to meet the needs of older people with greater mobility or health limitations than the *Staying Steady* programme and who were unable to stand unsupported. The *Age Well* programme provided chair based exercise in line with the expert Delphi definition where a chair is used to provide stability in sitting and standing and progression to standing is encouraged. Discussions with the team leader, therapists and review of the intervention criteria identified patients assigned to *Age Well* were clinically considered not able to participate in the dynamic standing group exercise circuit used in the *Staying Steady* programme. This aligned with the expert view that chair based exercise should be used for older people who are unable to participate in standing exercise programmes.

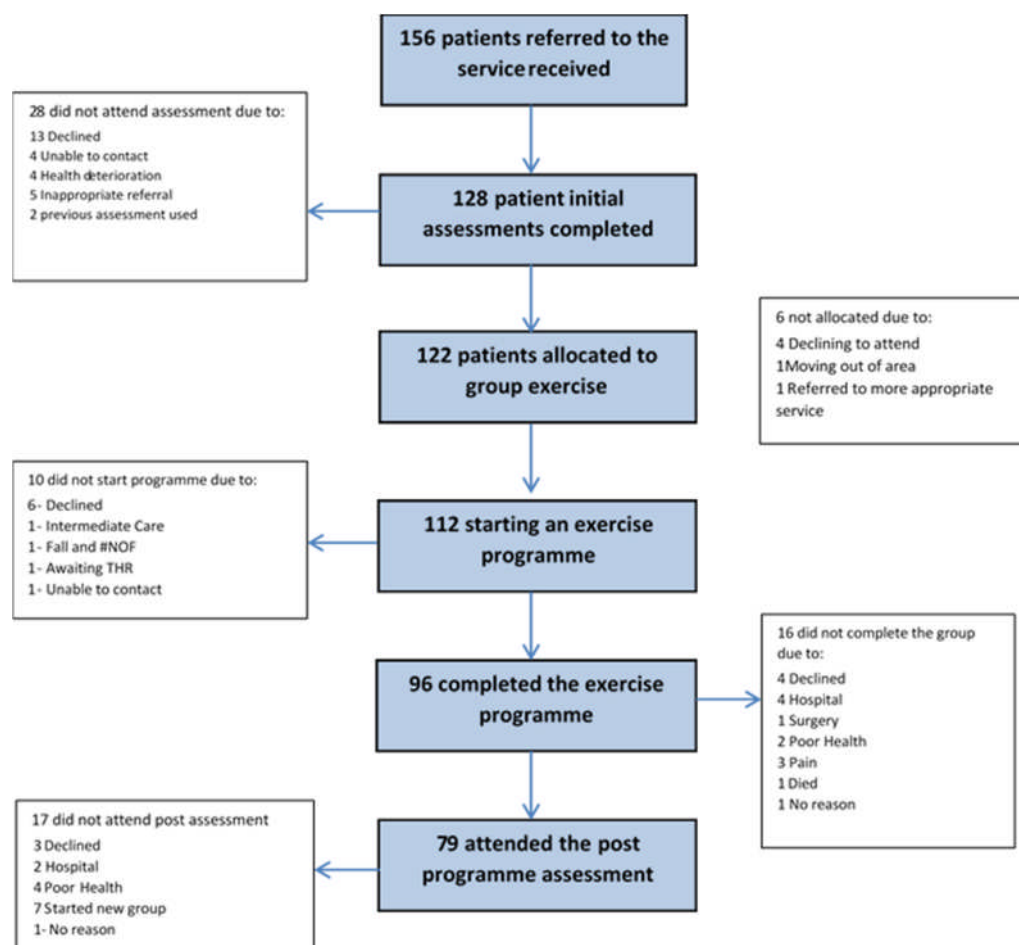
Patients were referred to the service by clinicians from other community NHS teams, GP's, self-referral, intermediate care, care home managers and acute hospital settings. Each new patient was assessed by a physiotherapist and after discussion with the older person, they were allocated to one of the programmes.

The chair based exercise intervention was delivered in a group twice a week for eight weeks for two hours each session, in a primary care centre. Transport was provided by the service using a volunteer car scheme and private taxis where patients were not able to provide their own transport. The intervention was delivered by a physiotherapist (band six) and a generic rehabilitation support worker (band two).

### ***Patient pathway***

One hundred and fifty-six patients were referred to the service between August 2014 and February 2015 inclusive. Figure 1 provides an overview of the number of patients referred, being assessed and attending the exercise based therapy groups. Eight percent of referred patients declined to attend for an initial assessment with the service and 3% of patients were unable to attend due to health reasons. From those attending the initial assessment 3% declined to then attend an exercise programme. From

those allocated to an exercise programme 5% declined to start the exercise programme and 2% were unable to start due to health reasons.



**Figure 1: Overview of patient pathway**

### ***Intervention allocation***

Table 2 provides a breakdown of the group allocations following the 128 patients completing their initial assessment.

**Table 2: Allocation breakdown**

Allocation	Number	Percentage
Standing Exercise	58	45%
Chair Based Exercise	64	50%
No allocation	6	5%

Six patients were not allocated to either of the exercise interventions. This was because one patient moved out of the area before a full assessment could be completed, one was referred to a more appropriate service (pulmonary rehabilitation) that was identified during the assessment and four patients declined the group programmes following the assessment. There was minimal change between the intervention which patients were allocated to and the group they actually attended, with only 4% of patients

changing groups. Two patients were moved from the chair based exercise programme to the standing programme as the clinician felt the group was too easy for them and they could benefit from the standing exercises. Three patients moved from the standing programme to the chair based exercise programme because they required more support or their health deteriorated.

Following allocation and any changes 56 patients attended the chair based exercise programme and 56 attended the standing exercise programme. Reasons for allocation to the chair based exercise intervention were identified where possible from the initial assessments and the reasons are presented in Table 3.

**Table 3: Reasons for group allocation**

Shortness of breath
Reduced exercise tolerance
Dementia related reduced exercise tolerance
Reduced strength and balance
Reduced strength and range of movement
Shortness of breath/dizzy
Dizzy/joint stiffness
Problems with balance, shortness of breath
Reduced confidence, fear of falling, reduced strength
Balance deterioration
Balance and strength exercises required
Poor eye sight
Fatigues easily
Minimal problems with balance
Problems with balance
Shortness of breath
Shortness of breath activity
Reduced balance and mobility
Wheeled Zimmer frame short distances

### ***Clinical presentation***

Table 4 shows the physical outcome measures completed at the pre-assessment for the chair based exercise group and the standing exercise group. The Timed Up and Go Test (TUGT) was measured in 43% of the chair based exercise patients and 20% of the standing exercise patients. In the chair based exercise group times ranged from 17 seconds to 90 seconds, whereas in the standing exercise group this was lower at 11-27 seconds.

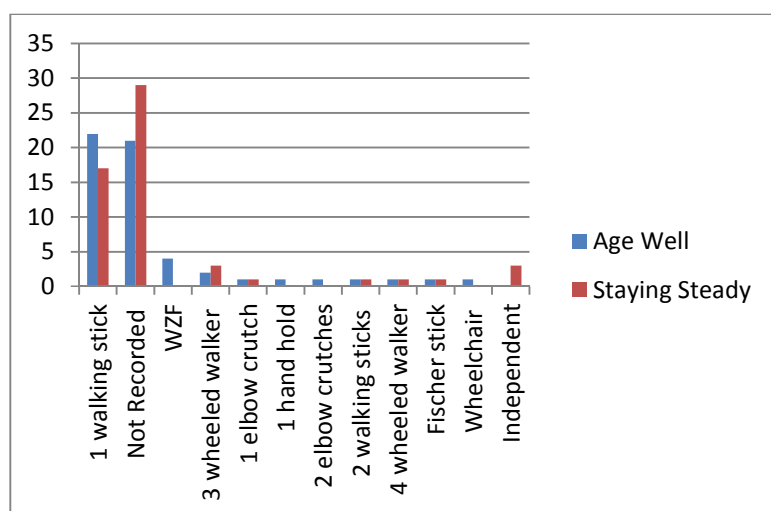
The Berg Balance Scale (BBS) identified poorer balance in chair based exercise patients with a mean score of 28 compared to 39 in standing exercise patients, however, there was some overlap in the groups.

**Table 4: Clinical presentation of patients allocated to each group**

	No of times completed		Mean score		Range	
	CBE	Standing	CBE	Standing	CBE	Standing
<b>TUGT (seconds)</b>	24	11	32.46	21.09	17-90	11-27
<b>BBS (score/ 56)</b>	39	48	28	39	8-46	23-54

The mobility status was recorded at the pre-allocation to programme assessment in 35 (64%) chair based exercise and 27 (44%) standing exercise patients. Figure 2 presents the number of patients using each mobility aid.

There were four patients using walking frames in the Age Well group in compared on to none in the Staying Steady group. In contrast, some patients attending the Staying Steady group were independently mobile with no walking aid and no patients in the Age Well group were mobile without a walking aid.

**Figure 2: Mobility status of patients allocated to each group**

### Attendance

Attendance rates are presented individually for chair based exercise and standing programmes in which identifies similar average rates of attendance. There were a higher numbers of patients attending all 16 sessions in the standing programme (38%) compared to the chair based exercise programme (20%). Health-related reasons such a chest infection, ear infection, leg ulcer was the most common reason for non-attendance with 23 incidences in the Age Well group and 17 incidences in the Staying Steady group. There were a high number of incidences where no reason was reported for absence from a group with 21 cases in the Age Well group and 28 in the Staying Steady group.

**Table 5: Attendance**

	Chair based exercise (n= 56)	Standing (n= 56)
Mean	12.32	12.45
Median	14	15
Range	1 -16	1-16
Number attending all sessions	11	21

**Outcome of therapy**

Of the 56 chair based exercise patients, 46 (82%) completed the group based programme. However the Timed up and Go Test was only completed with 5 patients that completed the programme which limits comparison with the baseline scores. The Berg Balance assessment was completed with 57/79 (58%). shows the physical outcome measures completed at the post programme -assessment for patients.

Pre and post Berg Balance scores were completed for 21 (36%) chair based exercise patients with an increase in scores identified post assessment for chair based exercise.

**Table 7: Outcome of therapy for BBS**

	CBE (n=21)	Standing (n=30)
Pre-assessment mean	25.5	39.1
Post-assessment mean	32.1	39.7

**Summary of findings**

This study describes the current delivery of two exercise therapy based programmes delivered as a group in an NHS setting and this study can be used in future evaluation trials as a baseline for usual care. The results indicated that chair based exercise programmes can be delivered to older patients who have limited mobility. It was not possible from this evaluation to explore any indications of benefit in relation to mobility due to a lack of routinely collected data before and after the chair based exercise programme. Improvements in balance following the chair based exercise programme were however demonstrated with a mean gain of 6.6 on the Berg Balance Scale. Patients allocated to the chair based exercise programme were less mobile and had poorer balance than those allocated to the standing programmes however there was some overlap between the patient profiles in each group.

**Strengths and limitations**

This study used retrospective data and is limited by the amount of missing data in the mobility of chair based exercise patients before and after the intervention and in the reasons for not attending programmes. These results must, therefore, be interpreted cautiously as the mobility profile of chair based exercise patients may have been different to the small sample presented here.

This evaluation was conducted using a pre-defined protocol and using a standardised data extraction tool which provided a robust approach to data collection.

The chair based exercise programme demonstrated issues of feasibility and acceptability in a fragile cohort of older people with a number of older people declining to attend with health reasons reported a barrier to attendance. Further development is needed to ensure the programme is acceptable to older people to maximise attendance and outcomes.

### ***Clinical presentation***

Describing the clinical presentation of patients in the chair based exercise and standing exercise group was challenging from the findings of the evaluation. The inconsistent use and completion of outcome measures and range of measures used limited the description of older people participating in chair based exercise.

The Timed Up and Go Test and Berg Balance score which were the most commonly used measures reflect the measures used in much of the published literature to assess the outcome of the intervention. The sample of patients attending the chair based exercise programme in this study appear to have greater limitations than many participants in the published literature where quicker mean Timed Up and Go Test scores and Berg Balance Scores are reported.

The clinical presentation of patients in this study may reflect the therapeutic nature of the service where exercise programmes are used for rehabilitation. In contrast, where chair based exercise is used as a health promotion tool, the participants may have different profiles and different needs. Identifying a clear rationale for the use of chair based exercise is essential in order to make sure that the programme is appropriately and logically adapted to meet these needs.

### ***Data collection***

Data collection was identified as an issue in this evaluation with differing protocols for the completion of outcome measures. This limits the confidence in the findings of this evaluation as there is uncertainty about the validity of the outcomes.

Data may be collected more pragmatically in a clinical environment where individual patient outcomes are considered a higher priority than the pooled data across groups. There was, however, a lack of completion of the same outcome measure at post assessment limiting the ability to determine individual patient outcomes. Ensuring that patient outcomes can be assessed through completion of the same outcomes and using a standardised protocol before and after the therapy groups is recommended to support the clinical reasoning process.

### ***Service recommendations***

The following recommendations are therefore suggested for clinical services providing exercise rehabilitation in groups:

- Use standardised outcome measures
- Assess all patients at the same time points
- Ensure outcomes are measured at least before and after the programme
- Use standardised protocols to complete the outcome measures
- Record reason if outcome measure is not completed
- Agree under what circumstances patients will move programmes

- Record reasons for non-attendance

## Conclusion

This study has described the clinical presentation of older people attending a chair based exercise programme and compared this with older people attending a standing programme. The chair base exercise patients in this study had poorer mobility and balance than participants in other chair based exercise research studies [5]. This is maybe indicative that research studies recruit younger, less disabled participants due to strict eligibility criteria, consenting procedures and recruitment processes, whilst clinical services deliver exercise programmes to a more generic patient population.

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4. Herman, T., N. Giladi, and J.M. Hausdorff, *Properties of the 'Timed Up and Go' Test: More than Meets the Eye*. Gerontology, 2011. **57** (3): p. 203
5. Dinan- Young S, Lenihan P, and Tenn T. *Is the promotion of physical activity in vulnerable older people feasible and effective in general practice?* British Journal of General Practitioners, 2006. **56** (531): p. 791-793.

## Abbreviations

#	Fracture
BBS	Berg Balance Scale
TUGT	Timed Up and Go Test

## Service evaluation governance letter:

positive

Nottinghamshire Healthcare   
NHS Foundation Trust

Research & Innovation Department  
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Porchester Road  
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E-mail: [Shirley.mitchell@nottshc.nhs.uk](mailto:Shirley.mitchell@nottshc.nhs.uk)

Date of letter: 03 August 2015

Katie Robinson  
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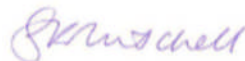
Dear Katie

### Service Evaluation – Day Rehabilitation Therapy Groups

Following our discussions regarding your evaluation proposal I am writing to inform you that the Trust Research and Innovation Department agree that this project falls into the category of service evaluation.

Please could you send our department a copy of the report once the project is complete so we can add this to the portfolio of service evaluation projects.

Yours sincerely



Shirley Mitchell  
Head of Research and Innovation

The Resource, Duncan Macmillan House, Porchester Road, Nottingham NG3 6AA  
Chair: Dean Fathers, Chief Executive: Ruth Hawkins



## **Appendix B: Telephone consultation information sheet (Chapter Three)**

### **Context: Exercise for Older People**

In line with the current Physical Activity Guidelines older people are advised to take part in some form of exercise every day to maximise the health benefits. Engaging in physical activity for older people with complex needs can prove challenging with very few being able to carry out the well evidenced strength and balance training programmes. Chair based exercise programmes are often used to engage the older person in physical activity with little published evidence to identify the health benefits for this specific client group.

### **Consensus Development**

There appears to be a lack of consensus from both literature and clinicians as to the purpose and role of chair based exercise for older people. Consensus development on this topic may therefore help to standardise chair based exercise programmes to allow further testing through high quality research programmes as well as exposing further areas for development. Formal consensus development techniques are suggested to be useful in exposing all opinions and options regarding a complex area and could therefore be useful in defining and standardising chair based exercise programmes for this patient population. Consensus development techniques require careful methodological planning to maximise their validity and as such some preliminary exploratory work is indicated to inform the formal consensus development process.

### **Informal Telephone Discussions**

You are invited to take part in a short (approx. 30 minute) informal telephone discussion to explore your views on chair based exercise for older people. The information gathered through these discussions is intended to inform a more structured consensus development process which you may also be interested in taking part in. The discussion will be around your views on all aspects of chair based exercise including its purpose, clinical implications, rationale, effectiveness and any other areas that are uncovered within the discussions. This is designed to be an exploratory scoping exercise with no predefined ideas or statements. The information you provide will only be used to form the basis of a consensus development process and will not be used for any other purpose.

**If you have any further questions please do not hesitate to get in touch.**

**Thank you for your time**

**Katie Robinson**  
**Research Physiotherapist**  
**Nottingham University Hospitals**  
[katie.robinson4@nhs.net](mailto:katie.robinson4@nhs.net)

**01158230470**

## Appendix C: Governance for Delphi technique (Chapter Three)

Direct line/e-mail  
+44 (0) 115 8231063  
Louise.Sabir@nottingham.ac.uk

20<sup>th</sup> March 2013

Professor Pip Logan  
B108a, B Floor  
Division of Rehabilitation and Ageing  
School of Community Health Sciences  
QMC Campus  
Nottingham University Hospitals  
NG7 2UH



Medical School Research Ethics  
Committee  
Division of Therapeutics &  
Molecular Medicine  
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Tel: +44 (0) 115 8231063  
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Dear Professor Logan

**Ethics Reference No:** L14032013 CHS Ageing & Rehab

**Study Title:** Developing a consensus on the principles of chair based exercise for frail older people- A Delphi Study.

**Chief Investigator/Supervisor:** Professor Pip Logan, Division of Rehabilitation and Ageing, School of Community Health Sciences.

**Co Investigators:** Katie Robinson Research Physiotherapist/Associate staff member, Division of Rehabilitation and Ageing, School of Community Health Sciences, Dr Tahir Masud, Consultant Geriatrician and Professor in Geriatric Medicine, Healthcare for Older People, Nottingham University Hospitals, Dr Paul Leighton, Research Fellow in Qualitative Research.

**Duration of Study:** mid-March 2013-September 2013 6mths **No of Subjects:** 35

Thank you for your recent application which was considered by the Committee at its meeting on 14<sup>th</sup> March 2013 and the following documents were received:

- Chair Based Exercise-Delphi Study: Application Form, version 1.0, 26.02.13.
- Chair Based Exercise-Delphi Study: Protocol, version 1.0, 24<sup>th</sup> Feb 2013.
- Chair Based Exercise-Delphi Study: Service User Participant Information Sheet, Version 1.0, 26.02.13.
- Chair Based Exercise-Delphi Study: Expert Participant Information Sheet, version 1.0, 26.02.13.
- Chair Based Exercise-Delphi Study: Consent Form Service Users, version 1.0, 27.02.13.
- Chair Based Exercise-Delphi Study: Consent Form Experts, version 1.0, 27.02.13.

These have been reviewed and are satisfactory and the study is approved.

Approval is given on the understanding that the Conditions of Approval set out below are followed.

### Conditions of Approval

You must follow the protocol agreed and any changes to the protocol will require prior Ethics' Committee approval using the attached notification of amendment form.

This study is approved for the period of active recruitment requested. The Committee also provides a further 5 year approval for any necessary work to be performed on the study which may arise in the process of publication and peer review.

You promptly inform the Chairman of the Research Ethics Committee of

- (i) Deviations from or changes to the protocol which are made to eliminate immediate hazards to the research subjects.
- (ii) Any changes that increase the risk to subjects and/or affect significantly the conduct of the research.
- (iii) All adverse drug reactions that are both serious and unexpected.
- (iv) New information that may affect adversely the safety of the subjects or the conduct of the study.
- (v) The attached End of Project Progress Report is completed and returned when the study has finished.

Yours sincerely



**Dr Clodagh Dugdale**  
**Chair, Nottingham University Medical School Research Ethics Committee**

## Appendix D: Participant Information Sheet for experts in Delphi technique (Chapter Three)

University of Nottingham  
Division of Rehabilitation and Ageing  
University of Nottingham Medical School



### Project Title:

Developing a consensus on the principles of chair based exercise for frail older people- A Delphi Study

**Name of Investigators:** Professor Pip Logan  
Tahir Masud (Honorary Professor)  
Katie Robinson (Research Physiotherapist)

### Healthy Volunteer's Information Sheet

You have been invited to take part in a consensus development process regarding chair based exercise programmes for frail older people. The following information is provided to ensure that you have all the relevant information about the study before deciding whether to take part. Please take time to read the following information sheet and ask if anything is unclear or you would like more information. Thank you for reading this.

### Background

In line with the current Physical Activity Guidelines older people are advised to take part in some form of exercise every day to maximise the health benefits. Engaging in physical activity for frail older people with complex needs can prove challenging with very few being able to carry out the well evidenced strength and balance training programmes. Chair based exercise (CBE) programmes are often used to engage the frail older person in physical activity with little published evidence to identify the health benefits for this specific client group. There appears to be a lack of consensus from both literature and clinicians as to the purpose and role of CBE for frail older people. Consensus development on this topic may therefore help to identify the key principles of chair based exercise programmes for frail elderly populations which could then be evaluated through a larger programme of research.

This study aims to utilise expert consensus and the views of older people participating in chair based exercise programmes to:

1. Define chair based exercise programmes for the frail elderly population
2. Develop a core set of principles of chair based exercise programmes for frail older people

Chair Based Exercise- Delphi Study  
26.02.13

### **What does the study involve?**

We are conducting a Delphi Technique with experts in chair based exercise with a view to establishing a consensus on the principles of CBE programmes. The Delphi process will involve a series of online questionnaires which ask you for your expert opinion and feedback on a bank of statements relating to CBE. The results of each round will be collated and will then inform the following round in order to work towards reaching a consensus on a set of principles.

You will be invited to take part via e-mail and if you are interested in hearing more a member of the research team will contact you to describe the study. If you would then like to take part you will be sent a consent form to sign and return to the research team. If we have not received a consent form within 10 days a member of the research team will send you a second e-mail as a reminder. If we do not hear from you after this we will not contact you about the study again.

On receipt of a signed consent form you will be sent the first round of the online survey and asked to complete and return this within one week. After approximately three weeks you will be sent a revised online survey and again asked to complete and return this within one week. You will be asked to participate in a maximum of four rounds of surveying.

If you have not returned the surveys within the one week time frame the research team will send you a reminder e-mail after one week and one again after two weeks. Unfortunately due to time constraints if you have not completed the survey within three weeks of the initial e-mail you will not be able to be included in subsequent rounds of the Delphi. to

An overview of the Delphi Process is outlined below:

- *Round One*

You will be sent an online survey via e-mail which will ask for your agreement with and comments on a bank of statements about CBE. It is anticipated that this survey will take no more than 30 minutes to complete and you will be asked to complete this within one week. A reminder e-mail will be sent one week and then two weeks after to prompt you to complete the survey.

- *Subsequent Rounds*

The results of stage one will be analysed and returned to you in another online survey for you to complete in the same way. A maximum of four rounds of survey will be undertaken.

### **Why have you been chosen?**

You have been invited to the study as you considered an expert in exercise for older people and chair based exercise.

### **Do you have to take part?**

It is entirely up to you to decide whether or not to take part. You also have the right to withdraw at any point of the study and are not obligated to complete all rounds of the Delphi Process. If you do decide to take part you will be asked to complete and sign and return a consent form prior to the study commencing.

**What are the possible disadvantages and risks of taking part?**

There are no identified risks or potential for harm from taking part in the study. The only disadvantage that is foreseen by the study team is the time taken to complete the online surveys (Approximately 1 ½ hours in total)

**What if something goes wrong?/Who can I complain to.**

In case you have a complaint on your treatment by a member of staff or anything to do with the study, you can initially approach the lead investigator. If this achieves no satisfactory outcome, you should then contact the Ethics Committee Secretary, Mrs Louise Sabir, Division of Therapeutics and Molecular Medicine, D Floor, South Block, Queen's Medical Centre, Nottingham, NG7 2UH. Telephone 0115 8231063. E-mail [louise.sabir@nottingham.ac.uk](mailto:louise.sabir@nottingham.ac.uk).

**Will my taking part in this study be kept confidential?**

All feedback provided through the process will be kept anonymous from other participants. Any personal information collected will be kept securely and used only to acknowledge your input in the study on dissemination (if you consent for this to happen).

**What will happen to the results of the research study?**

The results of this process will be discussed for acceptability with participants of chair based exercise programmes through a structured focus group. It is intended that this work will help in the development of a chair based exercise intervention which will then be tested first through a pilot study and then through a pragmatic randomised controlled trial.

**Who is organising and funding the research?**

This study is supported by a grant from the Nottinghamshire County Primary Care Trust which is being managed by University Hospital NHS Trust Research and Innovation Department.

**Who has reviewed the study?**

Nottingham University Medical School Ethics Committee has reviewed the study.

**Contact for Further Information**

If you have any questions or would like any further information please do not hesitate to contact the research team:

Katie Robinson (Research Physiotherapist)  
Telephone: 0115 8230470  
[Katie.robinson@nottingham.ac.uk](mailto:Katie.robinson@nottingham.ac.uk)

Thank you for taking the time to read this information sheet and for your interest in the study.

## Appendix E: Agreed statements from team workshop (Chapter Three)

<b>Definition</b>	<p>Chair based exercise should be a primarily seated exercise programme</p> <p>A minimum of 50% of each programme should be seated</p> <p>Any standing exercises should be done using the chair for support</p>
<b>Target Population</b>	<p>For use with older people with activity limitation who cannot participate in other forms of exercise</p> <p>For use with older people who are chair bound as a consequence of an acute medical problem from which they might improve and progress to weight bearing exercise</p> <p>Encouraged for older people who are concerned about stability in movement</p> <p>CBE should not be used as a falls prevention intervention</p> <p>Where possible CBE should be used as a starting point to progress to standing programmes</p>
<b>Purpose</b>	<p>The is beneficial for improving muscle strength and mobility</p> <p>CBE is beneficial for improving mood and well-being</p> <p>CBE is beneficial for improving activities of daily living</p> <p>CBE is beneficial for improving personal activities of daily living</p> <p>CBE is beneficial for reducing pain</p> <p>CBE is beneficial for improving confidence with activities of daily living</p> <p>CBE is beneficial for improving social interaction</p> <p>The goal of CBE should be clearly defined for each individual participant</p>
<b>Delivery</b>	<p>CBE programmes should ideally be carried out in a group environment</p> <p>Each CBE session should last no longer than one hour</p> <p>Each CBE session should be a minimum of 5 minutes and gradually built up to an hour</p> <p>CBE sessions should ideally be carried out a minimum of once a week</p> <p>Programmes should be continuous with no fixed duration</p> <p>Rolling CBE programmes are appropriate with new participants joining at any point</p>

Components	<p>Each session should include a component of strength resistance training, endurance training and cardiovascular fitness training</p> <p>CBE programmes should include progressive resistant strength training</p> <p>Strength training should be done using resistance bands</p> <p>Each session should begin with an appropriate warm up</p> <p>Each session should end with an appropriate cool down</p> <p>CBE programmes should not use music</p> <p>Cardiovascular training should be performed at a comfortable intensity for all participants</p> <p>Cardiovascular training should be performed at a moderate intensity for all participants</p> <p>Each session should include developmental stretches</p> <p>Strength training should be targeted to meet nominated programme aims</p>
Instructors and Safety	<p>CBE programmes should be run by a suitably skilled and trained leader</p> <p>Programmes do not have to be delivered by health care professionals</p> <p>Instructors should have knowledge and skills of working with frail older people</p> <p>Instructors should be aware of medical conditions which could disqualify participation on the grounds of safety</p>
Tailoring	<p>Members of CBE groups should be given choice as to which exercises are delivered</p> <p>Group members should be encouraged to actively take part in the management and running of the group</p> <p>CBE programmes should be tailored to meet individual needs</p> <p>The structure of sessions and exercises undertaken should be varied between sessions</p> <p>The goal of CBE should be clearly defined for each individual participant</p>
Evaluation	<p>There is a need for high quality evaluation of clinical and cost effectiveness of chair based exercise for older people</p> <p>Standardised outcome measures should be used routinely throughout programmes to evaluate effectiveness</p>

## Appendix F: Example of the development of statements

Area: Defining			
	Seated	Amount of seated vs standing	Supported standing and use of chair
Stakeholder 1	exercise in a chair		
Stakeholder 2	mostly seated	more than 25% seated	
Stakeholder 3		vast majority	supported standing
Stakeholder 4	Remain seated	no more than 10 mins standing	wouldn't expect people to do exercise not in the chair
Stakeholder 5	All performed sitting		
	Predominantly in chair		
Stakeholder 6		very little standing	
Stakeholder 7	some sitting down	some done in standing	uses chair throughout for support all around chair
Stakeholder 8		not just seated exercise	exercises based around chair
Stakeholder 9	seated exercise		anything that works around a chair
Stakeholder 10			
Stakeholder 11	exercise mainly based in sitting	mainly in sitting	
Systematic review	primarily seated		
<b>Statements discussed at consultation Meeting</b>			
Primarily seated exercise programme			
At least 75% seated activity per session			
Any standing should be done using the chair for support			
<b>Agreed statements from meeting</b>			
Chair based exercise should be a primarily seated exercise programme			
A minimum of 50% of each programme should be seated			
Any standing exercises should be done using the chair for support			
<b>Comments</b>			
Agreed on % needed to try to give clear definition, 50% given to allow experts to agree/disagree and move towards consensus.			
Use of words most/predominantly and primarily used to describe CBE. Primarily chosen for statement.			
General agreement that the chair can be used for supported standing and the definition should include all exercises around a chair. Also in line with discussions on progression and intended users.			

## **Appendix G: Example of between round feed-back (Chapter three)**

Appendix E contains an extract of the between round feed-back given to the experts through the Delphi Technique described in chapter three.

*Thank you for all your comments and feedback in Round 2. These have been extremely interesting and useful in moving towards a consensus on the principles of Chair Based Exercise for Older People.*

*This document presents the free text comments made by all participants in Round 2 for each of the statements. A response to each comment has been to provide justification for whether any modifications have been made or not. This document is intended to provide a more detailed breakdown of the responses from Round 2 and the rationale for the formulation of Round 3 of the process. The survey instrument includes the scoring for accepted statements along with a summary of comments and justification for any statements that have been modified. The survey instrument can be completed independently of this document as this document is only intended to provide further details for those participants who may find it useful when considering their responses to Round 3.*

*The accepted and removed statements are presented first in tabular format. The comments made are presented next to the relevant statement along with a brief response to justify whether any modifications are required.*

*The statements that were rescored in Round 2 are then presented along with any comments made and a response to each comment. The outcome of the rescoring and comments is then present to identify whether the statement has been accepted, removed or revised.*

## **Music**

Music can be beneficial as part of programmes if used appropriately and it is welcomed by participants (87.5% agreement)

<b>Comments</b>	<b>Response</b>
<i>Music is very important and this has been reported by the majority of the instructors involved in my studies delivering chair based exercise. However, choice of music particularly with those with dementia is important as can aggravate behaviour if the wrong music is chosen. Again, reported directly through qualitative research.</i>	Comment reflects agreement with the statement in that music can be beneficial therefore no modifications needed.
<i>The issue is the reason music is used - e.g. sing along with actions for fun (used for those with memory problems and less motivated to exercise), faster paced for aerobic, back ground for post session cool down / stretch</i>	Comment suggests that the reasons music is used needs to be considered carefully and the statement uses the word appropriate therefore no modification needed.
<i>Music can help people in the group feel more included in the group, it can help people to keep a rhythm and there is some evidence to suggest that music can help with memory and therefore may enable the participant I work with to participate more fully</i>	Comment reflects agreement with statement in that music can be beneficial therefore no modifications needed.
<i>Depends on the participants- need to ask beforehand. Also, some feel music is too loud or not loud enough. Sensory needs require careful consideration</i>	Comment is in line with statement that music can be used if the participants agree therefore no modification needed.
<i>Music gives the instructor something to hang the exercises on, the use of verse and chorus and counting the beats give participants something to give the exercises shape. Singing means they are breathing! adds life to the class!</i>	Comment reflects agreement with the statement that music can be beneficial and therefore no modification needed.
<i>Music is very powerful, however the difficulty is finding - music that suits everyone</i>	Comment reflects agreement with the statement that music can be beneficial and therefore no modification needed.
<i>But only in appropriate components</i>	Word appropriate used in comment is used in the statement therefore no modification needed.
<i>Still feel that music can be difficult to use as can make participants go too slow / fast if not VERY carefully chosen and changes with each section of a class or programme</i>	Comment suggests that the reasons music is used needs to be considered carefully and the statement uses the word appropriate therefore no modification needed.

**Outcome:** Statement accepted

## **Appendix H: Systematic review protocol (Chapter Four)**

### **Aims and objectives of the review**

To ensure the quality and effectiveness of exercise provision, practice should be guided by the best available evidence, and robust evidence for the effectiveness of CBE has not been published for this specific population. Wide-spread adoption of chair based exercise should only be contemplated if it is shown to be both clinically and cost effective. The aim of this study is to collate what is already known about CBE programmes for older people in order to guide current practice, and identify areas for further development and research.

Objective: To systematically review the literature on the physical health benefits of chair based exercise for older people.

### **Criteria for considering studies for this review**

#### ***Types of studies***

Due to the small number of randomised controlled trials identified in the previously published review the following primary research study types will be eligible for inclusion in the review; randomised and other controlled studies; cross-sectional studies, case-control studies, case-series studies; cohort studies.

As randomised controlled trials represent the highest level of primary research then if sufficient RCT are identified other study design designs will not be presented.

#### ***Types of participants***

Studies will be included where the focus is on older people. This will be determined by the mean age reported in the study being 65 years and over. This age limit will be applied to exclude studies of CBE that are primarily applied to younger groups such as wheelchair athletes and spinal rehabilitation.

#### ***Types of exercise programmes***

Studies where the intervention is considered to be chair based will be included. Chair based exercise will be considered where the programme is implied to be primarily seated using the following consensus definition:

*'a primarily seated, structured and progressive exercise programme that is part of a continuum of exercise for older people, which uses a chair to provide stability, and is delivered by instructors that are suitably skilled and trained to work with frail older people'.*

*Programmes that use a chair to promote stability in sitting and standing will be considered chair based exercise based on the consensus understanding [125].*

Programmes that include a significant component of walking or standing exercises will be excluded.

### ***Types of outcome measures***

Any physical health benefit will be considered as part of this review. This will include - but is not limited to - muscle strength, muscle endurance, functional abilities, activities of daily living, mobility and balance. Studies will only be included if the outcome is measured using a validated tool.

Any mental health benefit will be considered as part of this review. This will include but is not limited to- anxiety, depression, cognition and behaviour. Studies will only be included if the outcome is measured using a validated tool.

### **Search strategy for identification of studies**

The following databases will be searched: Medline, CINAHL, PsychINFO, Cochrane, DARE, Health Technology Assessment (HTA) reports, NHS Economic Evaluation Database, Physiotherapy Evidence Database (PEDro) and The Allied and Complementary Medicine Database (AMED).

Databases will be searched from the date of their inception to the present day. The databases have been chosen as subject specific databases relevant to therapeutic exercise and older people, in order to ensure a comprehensive review of available literature. Search terms related to the broad concepts of exercise, older people and seated exercise will be defined, searched separately and then combined. Limitations of the previous review identified the difficulties in searching for chair based exercise as a full phrase which was rarely cited in titles and abstracts [59]. Key words of chair, seated and sitting will, therefore, be selected to ensure a full search of the literature. Keywords from the papers identified in the previous publish review also shaped the search strategy with the inclusion of keywords such as rehabilitation. This search strategy was constructed to include all older people and used a wide range of terms to capture the breadth of studies.

Search terms: the following search will be used for Medline, CINAHL, AMED and PsychINFO:

1. Exercise/
2. Exercise.mp
3. Exercise therapy/
4. Exercise therapy.mp
5. Rehabilitation/
6. Rehabilitation.mp
7. Aged/
8. Frail Elderly/
9. Frail elderly.mp
10. Older people.mp
11. Elderly.mp
12. Chair.mp
13. Seated.mp
14. Sitting.mp
15. 1 or 2 or3 or4 or 5 or 6
16. 7 or 8 or 9 or 10 or 11
17. 12 or 13 or 14
18. 15 and 16 and 17
19. Limit 18 to 65 years and over

*Hand searching:* The reference list of included studies will be searched.

### **Study selection**

The process of selecting studies will be carried out independently by two reviewers (KR and VH). Titles and abstracts will be screened by the two reviewers to identify articles to retrieve in full.

Full articles will be reviewed by the two reviewers against the inclusion criteria. Reasons for exclusion will be recorded. Disagreements will be resolved by the independent assessment of a third reviewer (TM).

### **Data extraction**

Data will be extracted from the included studies independently by each the two reviewers. Data will be extracted using a standardised spreadsheet which will include details of the intervention, reported health benefits; compliance and long-term follow up.

### **Data synthesis**

Meta-analysis will be performed where it is possible to pool the data from comparable studies. It is however anticipated that meta-analysis may not be possible given the variety of outcomes identified in the previous review.

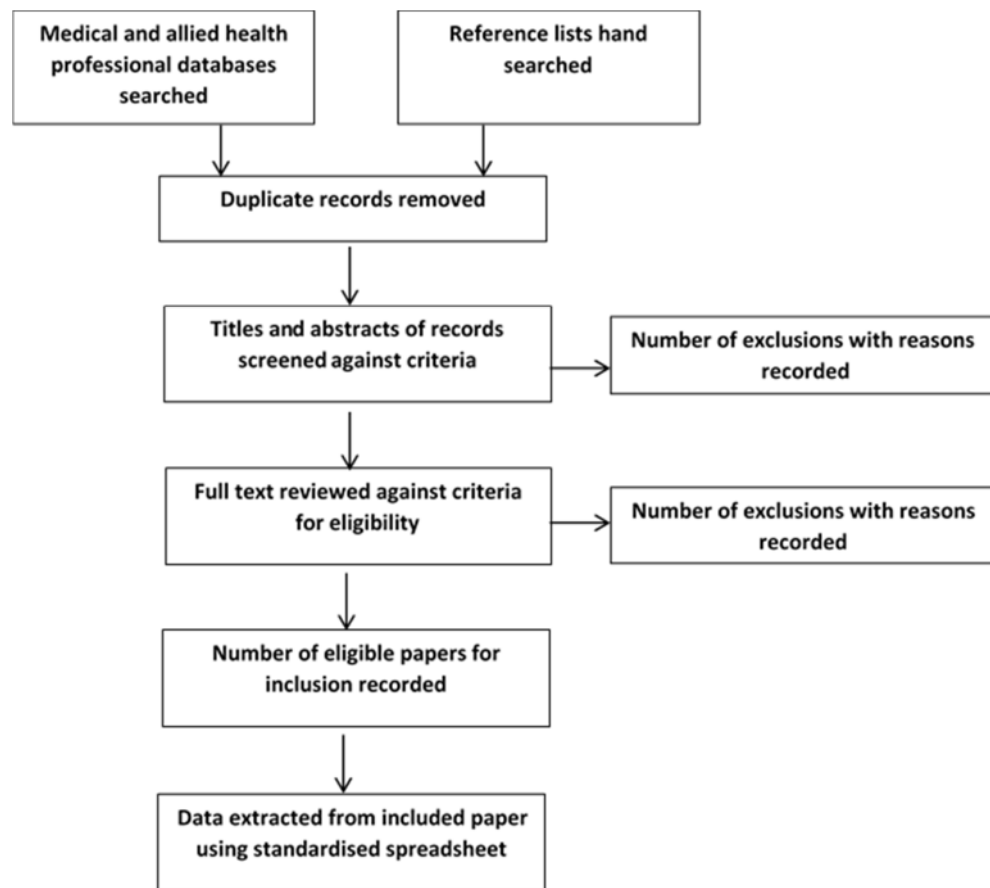
If meta-analysis is not possible a narrative synthesis of the data will be reported. The interventions will be described to examine the range and pattern of use of the components of chair based exercise programmes. Health benefits reported in the papers will be presented and the strength of the effect reported where possible (significance and effect size).

### **Quality appraisal**

For randomised controlled trials the CASP tool and Cochrane risk of bias summaries will be conducted independently by each of the reviewers. For non-randomised trial designs, the McMaster Checklist will be conducted independently by each of the reviewers.

### **Summary of methods**

Figure 1 provides a summary of the methods to be used in the review.



**Figure 1: Summary of methods**

## **Appendix I: Systematic review classification (Chapter Four)**

Include= 1

Exclude= 2

### **Reasons for exclusion**

1- not 65+

2- not CBE

3- wheelchair

4- spinal

5- no exercise intervention

6- not primary research

7- multifactorial

8- not in English or unable to access

9- not outcome of interest

## Appendix J: CASP tool for randomised controlled trials (Chapter Four)

**Available from** Critical Appraisal Skills Programme (2017). CASP Randomised Controlled Trial Checklist. [online] Available at: <http://www.casp-uk.net>



### 11 questions to help you make sense of a trial

#### How to use this appraisal tool

Three broad issues need to be considered when appraising the report of a randomised controlled trial:

- Are the results of the trial valid? (Section A)
- What are the results? (Section B)
- Will the results help locally? (Section C)

The 11 questions on the following pages are designed to help you think about these issues systematically.

The first two questions are screening questions and can be answered quickly. If the answer to both is **yes**, it is worth proceeding with the remaining questions.

There is some degree of overlap between the questions, you are asked to record a **yes, no or can't tell** to most of the questions. A number of prompts are given after each question. These are designed to remind you why the question is important. Record your reasons for your answers in the spaces provided.

There will not be time in the small groups to answer them all in detail!

**These checklists were designed to be used as educational tools as part of a workshop**

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## (A) Are the results of the trial valid?

### Screening Questions

1. Did the trial address a clearly focused issue?

☐ Yes

☐ Can't tell

☐ No

Consider: An issue can be 'focused' in terms of

- The population studied
- The intervention given
- The comparator given
- The outcomes considered

2. Was the assignment of patients to treatments randomised?

☐ Yes

☐ Can't tell

☐ No

Consider:

- How was this carried out, some methods may produce broken allocation concealment
- Was the allocation concealed from researchers?

Is it worth continuing?



Detailed questions

3. Were patients, health workers and study personnel blinded?

☐ Yes

☐ Can't tell

☐ No

Consider:

- Health workers could be; clinicians, nurses etc
- Study personnel – especially outcome assessors

4. Were the groups similar at the start of the trial?

☐ Yes

☐ Can't tell

☐ No

Consider: Look at

- Other factors that might affect the outcome such as age, sex, social class, these may be called baseline characteristics

5. Aside from the experimental intervention, were the groups treated equally?

☐ Yes

☐ Can't tell

☐ No

6. Were all of the patients who entered the trial properly accounted for at its conclusion?

☐ Yes ☐ Can't tell ☐ No

Consider:

- Was the trial stopped early?
- Were patients analysed in the groups to which they were randomised?

## (B) What are the results?

7. How large was the treatment effect?

Consider:

- What outcomes were measured?
- Is the primary outcome clearly specified?
- What results were found for each outcome?
- Is there evidence of selective reporting of outcomes?

8. How precise was the estimate of the treatment effect?

Consider:

- What are the confidence limits?
- Were they statistically significant?

### (C) Will the results help locally?

9. Can the results be applied in your context?  
(or to the local population?)

☐ Yes ☐ Can't tell ☐ No

Consider:

- Do you have reason to believe that your population of interest is different to that in the trial
- If so, in what way?

10. Were all clinically important outcomes considered?

☐ Yes ☐ Can't tell ☐ No

Consider:

- Is there other information you would like to have seen?
- Was the need for this trial clearly described?

11. Are the benefits worth the harms and costs?

☐ Yes ☐ Can't tell ☐ No

Consider:

- Even if this is not addressed by the trial, what do you think?

## Appendix K: Governance for pre and post cohort study (Chapter Six)

### Ethical Review



National Research Ethics Service  
NRES Committee North West - Lancaster

Barlow House  
3rd Floor  
4 Minshull Street  
Manchester  
M1 3DZ

Telephone: 0161 625 7819

20 February 2015

Professor Pip Logan  
Division of Rehabilitation and Ageing  
Medical School  
University of Nottingham  
NG7 2UH

Dear Professor Logan

Study title:	Developing a Chair Based Exercise Programme for Older People: A Proof of Concept Study
REC reference:	15/NW/0162
Protocol number:	15007
IRAS project ID:	170552

The Proportionate Review Sub-committee of the NRES Committee North West - Lancaster reviewed the above application.

We plan to publish your research summary wording for the above study on the HRA website, together with your contact details. Publication will be no earlier than three months from the date of this favourable opinion letter. The expectation is that this information will be published for all studies that receive an ethical opinion but should you wish to provide a substitute contact point, wish to make a request to defer, or require further information, please contact the REC Manager Mrs Carol Ebenezer, [nrescommittee.northwest-lancaster@nhs.net](mailto:nrescommittee.northwest-lancaster@nhs.net). Under very limited circumstances (e.g. for student research which has received an unfavourable opinion), it may be possible to grant an exemption to the publication of the study.

#### Ethical opinion

On behalf of the Committee, the sub-committee gave a favourable ethical opinion of the above research on the basis described in the application form, protocol and supporting documentation, subject to the conditions specified below.

#### Conditions of the favourable opinion

The favourable opinion is subject to the following conditions being met prior to the start of the study.

1. Please revise the Participant Information Sheet in the following way:
  - (a) Please include the complaints procedure with local contact details for PALS (Patients Advice and Liaison Service) or equivalent under the heading 'What if there is a

- problem?' as the students' contact details are not adequate on its own.
- (b) Please state the exercises can be done at home.
- (c) Please include the word 'anonymised' when referring to the data.
- (d) Please include the word 'anonymised' when referring to the direct quotes.
- (e) The Committee did not feel it was necessary to inform the participants GP. Please revise the Participant Information Sheet to reflect that you will not be contacting their GP.

2. Please revise the Exercise Component Consent Form in the following way:
  - (a) The Committee did not feel it was necessary to inform the participants GP, therefore, please remove Point Number 4.

**You should notify the REC in writing once all conditions have been met (except for site approvals from host organisations) and provide copies of any revised documentation with updated version numbers. The REC will acknowledge receipt and provide a final list of the approved documentation for the study, which can be made available to host organisations to facilitate their permission for the study. Failure to provide the final versions to the REC may cause delay in obtaining permissions.**

Management permission or approval must be obtained from each host organisation prior to the start of the study at the site concerned.

*Management permission ("R&D approval") should be sought from all NHS organisations involved in the study in accordance with NHS research governance arrangements.*

*Guidance on applying for NHS permission for research is available in the Integrated Research Application System or at <http://www.rdforum.nhs.uk>.*

*Where a NHS organisation's role in the study is limited to identifying and referring potential participants to research sites ("participant identification centre"), guidance should be sought from the R&D office on the information it requires to give permission for this activity.*

*For non-NHS sites, site management permission should be obtained in accordance with the procedures of the relevant host organisation.*

*Sponsors are not required to notify the Committee of approvals from host organisations.*

#### Registration of Clinical Trials

All clinical trials (defined as the first four categories on the IRAS filter page) must be registered on a publically accessible database. This should be before the first participant is recruited but no later than 6 weeks after recruitment of the first participant.

There is no requirement to separately notify the REC but you should do so at the earliest opportunity e.g. when submitting an amendment. We will audit the registration details as part of the annual progress reporting process.

To ensure transparency in research, we strongly recommend that all research is registered but for non-clinical trials this is not currently mandatory.

If a sponsor wishes to request a deferral for study registration within the required timeframe, they should contact [hra.studyregistration@nhs.net](mailto:hra.studyregistration@nhs.net). The expectation is that all clinical trials will be registered, however, in exceptional circumstances non registration may be permissible with prior agreement from NRES. Guidance on where to register is provided on the HRA website.

**It is the responsibility of the sponsor to ensure that all the conditions are complied with before the start of the study or its initiation at a particular site (as applicable).**

### Ethical review of research sites

The favourable opinion applies to all NHS sites taking part in the study, subject to management permission being obtained from the NHS/HSC R&D office prior to the start of the study (see "Conditions of the favourable opinion").

### Summary of discussion at the meeting

The Committee requested changes to the paperwork as described above.

### Approved documents

The documents reviewed and approved were:

Document	Version	Date
Covering letter on headed paper	1.0	03 February 2015
Evidence of Sponsor insurance or indemnity (non NHS Sponsors only)		
GP/consultant information sheets or letters [GP letter to inform of participation]	1.0	03 February 2015
GP/consultant information sheets or letters [GP letter for end of study ]	1.0	03 February 2015
Interview schedules or topic guides for participants [Focus Group Topics ]	1.0	03 February 2015
Letter from sponsor		
Letter from statistician		
Letters of invitation to participant [Invitation Letter ]	1.0	03 February 2015
Participant consent form [Consent form for exercise component]	1.0	03 February 2015
Participant consent form [Consent form for focus group]	1.0	07 January 2015
Participant information sheet (PIS) [Participant Information Sheet]	1.0	03 February 2015
REC Application Form [REC_Form_12022015]		12 February 2015
Referee's report or other scientific critique report		
Research protocol or project proposal [Study Protocol]	1.0	03 February 2015
Summary CV for Chief Investigator (CI)		
Summary CV for student		
Validated questionnaire		

### Membership of the Proportionate Review Sub-Committee

The members of the Sub-Committee who took part in the review are listed on the attached sheet.

### Statement of compliance

The Committee is constituted in accordance with the Governance Arrangements for Research Ethics Committees and complies fully with the Standard Operating Procedures for Research Ethics Committees in the UK.

### After ethical review

#### Reporting requirements

The attached document "After ethical review – guidance for researchers" gives detailed guidance on reporting requirements for studies with a favourable opinion, including:

- Notifying substantial amendments

- Adding new sites and investigators
- Notification of serious breaches of the protocol
- Progress and safety reports
- Notifying the end of the study

The HRA website also provides guidance on these topics, which is updated in the light of changes in reporting requirements or procedures.

#### User Feedback

The Health Research Authority is continually striving to provide a high quality service to all applicants and sponsors. You are invited to give your view of the service you have received and the application procedure. If you wish to make your views known please use the feedback form available on the HRA website: <http://www.hra.nhs.uk/about-the-hra/governance/quality-assurance/>


#### HRA Training

We are pleased to welcome researchers and R&D staff at our training days – see details at <http://www.hra.nhs.uk/hra-training/>

With the Committee's best wishes for the success of this project.

15/NW/0162	Please quote this number on all correspondence
------------	--

Yours sincerely



**Signed on behalf of:**  
**Professor Jois Stansfield**  
**Chair**

Email: [nrescommittee.northwest-lancaster@nhs.net](mailto:nrescommittee.northwest-lancaster@nhs.net)

Enclosures: *List of names and professions of members who took part in the review*  
*"After ethical review – guidance for researchers"*

Copy to: *Ms Angela Shone, University of Nottingham*  
*Mrs Shirley Mitchell, Nottinghamshire Healthcare NHS Trust*  
*Miss Katharine Robinson, University of Nottingham*



**Health Research Authority**  
National Research Ethics Service

**NRES Committee North West - Lancaster**  
Barlow House  
3rd Floor  
4 Minshull Street  
Manchester  
M1 3DZ

Telephone: 0161 625 7818  
Fax: 0161 625 7299

26 February 2015 (revised 03 March 2015)

Professor Pip Logan  
Division of Rehabilitation and Ageing  
Medical School  
University of Nottingham  
NG7 2UH

Dear Professor Logan

**Study title:** Developing a Chair Based Exercise Programme for  
Older People: A Proof of Concept Study  
**REC reference:** 15/NW/0162  
**Protocol number:** 15007  
**IRAS project ID:** 170552

Thank you for your response of 26 February. I can confirm the REC has received the documents listed below and that these comply with the approval conditions detailed in our letter dated 20 February 2015

**Documents received**

The documents received were as follows:

Document	Version	Date
Participant consent form [Consent form for exercise component]	1.1	23 February 2015
Participant information sheet (PIS) [Participant Information Sheet]	1.1	23 February 2015
Research protocol or project proposal [Study Protocol]	1.1	

**Approved documents**

The final list of approved documentation for the study is therefore as follows:

Document	Version	Date
Covering letter on headed paper	1.0	03 February 2015
Evidence of Sponsor insurance or indemnity (non NHS Sponsors only)		
Interview schedules or topic guides for participants [Focus Group Topics]	1.0	03 February 2015
Letter from sponsor		
Letter from statistician		

Letters of invitation to participant [Invitation Letter ]	1.0	03 February 2015
Participant consent form [Consent form for focus group]	1.0	07 January 2015
Participant consent form [Consent form for exercise component]	1.1	23 February 2015
Participant information sheet (PIS) [Participant Information Sheet]	1.1	23 February 2015
REC Application Form [REC_Form_12022015]		12 February 2015
Referee's report or other scientific critique report		
Research protocol or project proposal [Study Protocol]	1.1	23 February 2015
Summary CV for Chief Investigator (CI)		
Summary CV for student		
Validated questionnaire		

You should ensure that the sponsor has a copy of the final documentation for the study. It is the sponsor's responsibility to ensure that the documentation is made available to R&D offices at all participating sites.

15/NW/0162	Please quote this number on all correspondence
------------	--

Yours sincerely



**Miss Regina Caden**  
REC Assistant

E-mail: [nrescommittee.northwest-lancaster@nhs.net](mailto:nrescommittee.northwest-lancaster@nhs.net)

Copy to: *Ms Angela Shone, University of Nottingham*

*Mrs Shirley Mitchell, Nottinghamshire Healthcare NHS Trust*

*Miss Katharine Robinson, University of Nottingham*

## **NHS Permissions**

positive

Nottinghamshire Healthcare **NHS**  
NHS Foundation Trust

Research and Development  
Institute of Mental Health  
University of Nottingham Innovation Park  
Triumph Road  
Nottingham  
NG7 2TU

E-mail: Shirley.mitchell@nottshc.nhs.uk  
Direct Line: 0115 7484321

Date of NHS Permission: 09/03/2015 (reissue 30/08/2016)

Katie Robinson  
Division of Rehabilitation and Ageing  
University of Nottingham  
School of Medicine  
Queens Medical Centre  
Nottingham  
NG7 2UH

Dear Katie,

**Study title:** Chair Based Exercise Proof of Concept Study V.1  
**IRAS/REC ID:** 15/NW/0162  
**Chief Investigator:** Professor Pip Logan  
**Sponsor:** University of Nottingham

Thank you for submitting your project to the Nottinghamshire Healthcare NHS Foundation Trust's R&D Department. The project has now been given NHS permission by:

Dr Julie Hankin: R & D Director, on behalf of Nottinghamshire Healthcare NHS Foundation Trust and  
Penelope Keith: Deputy Associate Director of Nursing, Quality and Patient Experience, Health Partnerships (community provider services)

NHS permission for the above research has been granted on the basis described in the application form, study protocol and supporting documentation. The following documents were reviewed:

Document	Version	Date
Research Protocol	1.1	23/02/2015
Participant Invitation Letter	1.0	03/02/2015
Participant Information Sheet	1.1	23/02/2015
Focus Group Schedule and Topic Area	1.0	03/02/2015
Consent Form Focus Group	1.0	07/01/2015
Consent Form Exercise Component	1.1	23/02/2015
R&D Form 170552/737858/14/400		12/02/2015

The Resource, Duncan Macmillan House, Porchester Road, Nottingham NG3 6AA  
Chair: Professor Dean Fathers, Chief Executive: Ruth Hawkins



CV – Chief Investigator (Professor Pip Logan)		
CV – Principal Investigator (Katie Robinson)		
Validated Questionnaire		

Permission is granted on the understanding that the study is conducted in accordance with the Research Governance Framework, ICH GCP [ONLY if applicable], and NHS Trust policies and procedures available <http://www.nottinghamshirehealthcare.nhs.uk/contact-us/freedom-of-information/policies-and-procedures/>

The research sponsor or the Chief Investigator, or the local Principal Investigator at a research site, may take appropriate urgent safety measures in order to protect research participants against any immediate hazard to their health or safety. The R&D office should be notified that such measures have been taken. The notification should also include the reasons why the measures were taken and the plan for further action. The R&D Office should be notified within the same time frame of notifying the REC and any other regulatory bodies. All amendments (including changes to the local research team) need to be submitted in accordance with guidance in IRAS.

Please note that the NHS organisation is required to monitor research to ensure compliance with the Research Governance Framework and other legal and regulatory requirements. This is achieved by random audit of research.

Yours Sincerely




Shirley Mitchell  
Head of Research and Development

CC:

Sponsor

Chief Investigator

## GCP Certificate

  
National Institute for  
Health Research  
Clinical Research Network

# Certificate of Attendance


Katie Robinson

attended


Good Clinical Practice (GCP) Refresher:  
A practical guide to ethical and scientific  
quality standards in clinical research

on 17/06/2014

Sessions include:  
GCP: the standards and why we have them  
Study overview  
Informed consent  
Essential documents  
GCP recent changes



**Emma Lowe**  
NIHR CRN Workforce Development Manager



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## Appendix L: Participant documentation for pre and post cohort study (Chapter Six)

### Invitation Letter



Day Rehabilitation Service  
North Rd  
Retford  
Notts  
DN22 7XF  
Tel: 01777 274400  
Fax: 01777 710535

Date: 24/06/15

#### **Chair Based Exercise Proof of Concept Study- Invitation to Take Part**

You are being invited to take part in a research study run in the Day Rehabilitation Service. You are being invited as you have previously attended the Age Well group programme run by the service. The study is looking at a chair based exercise programme and whether it can improve muscle strength and mobility. The study is also forming part of a PhD project in the Division of Rehabilitation and Ageing at the University of Nottingham.

The study involves taking part in a 12 week exercise programme run by a physiotherapist in the Day Rehabilitation service. Measures of your muscle strength, walking and well-being would be taken before and after the exercise programme.

At the end of the programme you would then be invited to take part in a group discussion about your experience and thoughts on the exercise programme.

More information about what is involved is in the enclosed leaflet.

A member of the Day Rehabilitation Service will be contacting you by telephone to discuss the study further.

Kind Regards

Physiotherapist  
Day Rehabilitation Service

CBE- Participant Invitation Letter

Version 1.0 03.02.15

Bassetlaw Health Partnerships, Hawthorn House, Ransom Wood Business Park, Southwell  
Road West, Rainworth, NG21 0HJ  
Chair: Dean Fathers, Chief Executive: Ruth Hawkins



## **Participation Information Sheet**

Participant Information Sheet  
Final version 1.3 16.04.15

**Title of Study: Developing a Chair Based Exercise Programme for Older People: A Proof of Concept Study**

**Name of Researcher(s): Professor Pip Logan  
Katie Robinson (Research Physiotherapist and PhD Student)**

We would like to invite you to take part in our research study. Before you decide we would like you to understand why the research is being done and what it would involve for you. One of our team will go through the information sheet with you and answer any questions you have. Talk to others about the study if you wish. Ask us if there is anything that is not clear.

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

We are trying to find the most effective chair based exercise programme for older people who have difficulty standing for long periods and who may not feel confident to exercise whilst standing. There are many examples of chair based exercise programmes. They vary in content and format. They deliver differing health benefits. We have already asked clinical experts and some older people to share their opinions on the chair based exercises they have experienced and have developed a programme based on their views and the best evidence. We now want to test if this programme can be delivered and if it shows any changes in muscle strength and walking after the exercise programme.

### **Why have I been invited?**

You are being invited to take part because you have previously attended the Age Well group programme run by the Day Rehabilitation Service. The Age Well programme includes some chair based exercises. We are inviting 20 people like you to take part.

### **Do I have to take part?**

It is up to you to decide whether or not to take part. If you do decide to take part you will be given this information sheet to keep and be asked to sign a consent form. If you decide to take part you are still free to withdraw at any time and without giving a reason. This would not affect your legal rights.

### **What will happen to me if I take part?**

If you do decide to take part you will be asked to undertake a 12 week exercise programme run by the Day Rehabilitation team. Measures of your muscle strength and walking and well-being will be taken before the exercise programme starts and then again after you have completed the exercise programme.

There will be two exercise sessions a week supervised by a physiotherapist (either in a group or at home) and one session where you will be asked to do the exercises at home on your own. The exercises will be carried out while you are sitting in a chair and with you standing using a chair for support. The exercises can be done in a group or at home.

Here is an example of the exercise you will be undertaking:



After the exercise programme has been completed you will be invited to take part in a focus group to discuss your views on the programme and research study. A focus group is a group discussion and with your consent the group will be digitally recorded. The focus group will last no longer than 1 ½ hours and will take place in the Day Rehabilitation Service. The purpose of the focus group is to explore your views on the exercise programme, any comments for improvement, any health benefits you have noticed or any limitations with the programme.

#### **Expenses and payments**

Transport will be provided by the Day Rehabilitation service for any visits incurred as a result of participation (if required).

#### **What are the possible disadvantages and risks of taking part?**

The possible disadvantages of taking part are you giving up your time to take part in the research study. As with every exercise programme there is a small risk of injury however the sessions will be run by a physiotherapist who will advise you on appropriate exercises for you in order to minimise this risk.

**What are the possible benefits of taking Nottinghamshire Healthcare part?**



NHS Foundation Trust

We cannot promise the study will help you but the information we get from this study may help to improve seated exercise programmes for older people in the future.

**What happens when the research study stops?**

When the research stops you will stop attending the exercise sessions and will no longer be a patient in the Day Rehabilitation Service. Should you have any problems in the future you are free to contact the Day Rehabilitation Service and refer yourself back into the service.

**What if there is a problem?**

If you have a concern about any aspect of this study, you should ask to speak to the researchers who will do their best to answer your questions. The researchers contact details are given at the end of this information sheet. If you remain unhappy and wish to complain formally, you can do this by contacting the Patient Advice and Liaison Service (PALS) for Bassetlaw Health Partnership on 01623 673849.

**Will my taking part in the study be kept confidential?**

We will follow ethical and legal practice and all information about you will be handled in confidence.

If you join the study, some parts of your medical records and the data collected for the study will be looked at by authorised persons from the University of Nottingham who are organising the research. They may also be looked at by authorised people to check that the study is being carried out correctly. All will have a duty of confidentiality to you as a research participant and we will do our best to meet this duty.

All information which is collected about you during the course of the research will be kept **strictly confidential**, stored in a secure and locked office, and on a password protected database. Any information about you which leaves the hospital will have your name and address removed (anonymised) and a unique code will be used so that you cannot be recognised from it.

Your personal data (address, telephone number) will be kept for 6 months after the end of the study so that we are able to contact you about the findings of the study. All other data (research data) will be kept securely for 7 years. After this time your data will be disposed of securely. During this time all precautions will be taken by all those involved to maintain your confidentiality, only members of the research team will have access to your personal data.

Although what you say in the focus group is confidential, should you disclose anything to us which we feel puts you or anyone else at any risk, we may feel it necessary to report this to the appropriate persons.

**What will happen if I don't want to carry on with the study?**

Your participation is voluntary and you are free to withdraw at any time, without giving any reason, and without your legal rights being affected. If you withdraw then the information collected so far cannot be erased and this information may still be used in the project analysis.

**Involvement of the General Practitioner/Family doctor (GP)**

Your GP or health professional will only be contacted to confirm your past medical history to ensure you are eligible to take part in the study.

**What will happen to the results of the research study?**

The results of the study will be published in academic journals such as Physiotherapy. A one page summary of the results will be available to all participants. The findings will be shared in clinical groups with Nottinghamshire Healthcare Trust. The study will also be included in a PhD Thesis. No personal identifiable information will be used in any published reports. Direct quotes from the focus group may be used in reports and these quotes will be anonymised.

**Who is organising and funding the research?**

This research is being organised by the University of Nottingham and is being funded by Nottingham University Hospitals Charitable Trust.

**Who has reviewed the study?**

All research in the NHS is looked at by independent group of people, called a Research Ethics Committee, to protect your interests. This study has been reviewed and given favourable opinion by Lancaster- North West Research Ethics Committee.

**Further information and contact details**

Professor Pip Logan- 0115 823023/[pip.logan@nottingham.ac.uk](mailto:pip.logan@nottingham.ac.uk)

Katie Robinson - 0115 8230470/[katie.robinson@nottingham.ac.uk](mailto:katie.robinson@nottingham.ac.uk)

Day Rehabilitation Service – 01777 862374

## Appendix M: Exercise descriptions (Chapter Six)

Stage	Detail
Posture check	To ensure good posture throughout the programme. Participants reminded not to hold their breath during the programme to ensure safety.
Warm Up	To mobilise joints and warm up major muscle groups involved in the session. The warm up included aerobic exercises (e.g. seated marching), static stretching and range of movement exercises.
Cardiovascular exercises	To increase cardiovascular fitness, performed in intervals as recommended by expert consensus. Participants advised to work at moderate intensity where they could still hold a conversation. Exercises included seated marching, seated lunges, side taps and sit-to-stand. Progression was achieved through increased duration and speed. Intensity was progressed by moving to supported standing.
Resistance and endurance training	Progressive resistance training in line with the principles for older people starting at a low intensity for older people beginning to exercise. One repetition max was not used to determine intensity due to the co-morbidities and difficulties with testing in this population. The OPERA trial conducted in care home residents suggested chair based exercise participants should begin with 0.5kg or 1kg ankle weights reflective of participant's functional ability. A 0.5kg or 1kg weight or a yellow or red resistance band was therefore used to start resistance training based on clinical reasoning and participant preferences. Use of resistance band or weight dependent on preference and technique. The strength training protocol adhered to current evidence and other exercise programmes with progressing the repetitions, sets and resistance as appropriate to the individual. When participants could perform 3 sets of 12 reps with good technique the resistance was increased and the sets and repetitions reduced. 3 sets was chosen in line with other evidence based exercise programmes and the ACSM guidelines which a maximum of 3 sets. Sessions were 48 hours apart in line with recommended guidance
Flexibility	Stretches to upper and lower limb based on current guidelines Stretches held for 10-20 seconds, repeated twice. Duration and reps built up to 30-60 seconds and 4 reps.
Cool Down	Gradual reduction in effort and included flexibility exercises in line with recommendations from ACSM. Participants were also monitored for 30 minutes after the exercise programme to ensure safety.
Description of exercises	
Seated marching	Sit tall on first third of chair. Legs hip width and feet right angle. Neutral spine. March with toe >> heel strike.
Supported standing marching	Stand tall and use the chair for support. Slowly lift alternate legs. Progress to using ankle weights.
Shoulder lifts	Sit tall on first third of chair. Arms loose by side of hips. Lift shoulders to ears.
Shoulder circles	Sit tall on first third of chair. Arms loose by side of hips.

	Neutral spine. Move shoulders forward > up > back > down.
Side bends	Sit tall on first third of chair. Arms loose by side of hips. Neutral spine with equal weight distribution. Slide arm down side of hip
Trunk twists	Sit tall on first third of chair. Place hand on knee. Turn head and trunk to opposite side
Ankle mobilisers	Sit tall on first third of chair. Knees at right angles with feet flat. Lift heel and place on spot directly in front .Lift knee again and place heel on same spot.
Gastrocnemius and Soleus Stretch	Sit tall on first third of chair with neutral spine and knees at right angles. Straighten one leg with foot pulled towards shin.
Triceps and Latissimus Dorsi stretch	Sit tall on first third of chair with neutral spine. Legs at hip width apart and knees at right angles. One hand on shoulder. Opposite hand eases elbow toward ceiling.
Adductor stretch	Sit tall on first third of chair with neutral spine. Feet placed as wide as possible. Place hands on inner thighs and press open.
Hamstrings stretch	Sit tall on first third of chair with neutral spine. Straighten leg with foot relaxed. Hands on thigh just above knee and lean forwards whilst maintaining neutral spine position.
Pectoralis Major stretch	Sit tall on first third of chair with neutral spine. Hold onto the back of the chair. Lift chest without losing spinal neutral. Pull shoulders together.
Upwards side stretch	Arm bent to shoulder. Opposite hand assists arm to raise above shoulder.
Wide based sway	Sit tall on first third of chair with neutral spine. Feet shoulder width apart. Start to sway to each side building up a rhythm. Progress to include arms and then incorporate arms raised and then high and side claps.
Sit-Stand for cardiovascular endurance	Sit to stands as quickly as possible but with good technique
Lunges	Sit tall on first third of chair with neutral spine. Feet shoulder width apart. First footsteps half step in front while head leans forwards so that the 'nose is over the toes' and then returns. Change leg. Build to a rhythm
Leg press resistance training	Sit tall on first third of chair with neutral spine. Lift leg approximately 1inch and pull Resistance band up. Straighten knee. Or using ankle weight- seated knee extensions.
Hip flexor strengthening	With ankle weight lift knee and hold. Slowly return.
Rhomboids and Trapezius resistance training	Resistance band on lap, scoop up with fist width between. Pull apart
Abductors resistance and endurance training	Wrap Resistance band around thigh. Pull knees apart
Biceps resistance and endurance training	Resistance band on draped on floor with feet on the band. Arm by side at 90 degrees. Band held with tail at top of hand. Thumb facing up and wrist straight. Bend arm up. Or using hand weight lift hand to shoulder and return.
Triceps resistance and endurance training	Resistance band draped on floor. Hold band tail at back of hand.

	Arm slightly bent and wrist straight throughout. Stretch band backwards Or using hand weight- lower arm behind head.
Chest press resistance and endurance training	Resistance band at back of chair. Tails at top of hand with straight wrists.
Wrist twist resistance and endurance training	Resistance band. Place on hand above the other. Second, draw the elbows away from the body and then squeeze the band while drawing the elbows toward the body.
Adductors resistance and endurance training	Place a large soft ball or rolled towel between the legs.
Sit- stand for strength training and endurance	Slowly stand and sit down- if able do not use hand. Progress to using ankle weights with sit-stand.
Heel Raises in supported standing	Using the back of the chair for support raise both heels off the ground and slowly lower back to the floor.
Weight transfers in supported standing	Using the back of the chair for support step one foot out to the side and shift weight over that hip. Return to centre and repeat with other foot. Progress to using ankle weights.
Toe Raises in supported standing	Using the back of the chair for support raise toes off the ground and slowly lower back to the floor.
Squats in supported standing	Using the back of the chair for support slowly bend knees and return to upright position. Progress to using ankle weights.

**Some exercise descriptions have been modified with permission from LaterLife Training.**

## Appendix N: Health assessment form (Chapter Six)

### Health Questionnaire

Date of completing Questionnaire:		GP Details	
Name:		Emergency contact	

**If the answer is YES to any questions please give some details including dates where possible.**

Have you any history of heart trouble? (such as heart attack, angina, valve disease, palpitations, pains in chest, dizzy spells, high blood pressure)	
Have you any history of problems with blood vessels? (such as DVT, thrombosis, embolus, claudication, aneurysm, dizzy spells, stroke, blood clots)	
Have you any history of chest problems? (such as bronchitis, asthma or wheezy chest)	
Do you suffer from diabetes? (if YES please state if insulin dependent)	
Do you suffer from Parkinson's Disease? (if YES please state any medication taken)	
Have you been diagnosed with Alzheimer's Disease or Dementia? (If YES please state any medication taken)	
Have you any history of emotional or psychiatric problems? (such as depression, anxiety or psychiatric illness)	
Do you suffer from osteoarthritis or rheumatoid arthritis? (if YES please state joints affected and indicate mild, moderate or severe and any medication regularly taken)	
Have you broken or fractured any bones? (If so, which bones and when?)	
Do you have any problems with your bones? (such as diagnosed osteoporosis, loss of height)	
Have you any history of back problems? (If YES, please give further information)	
Have you had any surgery on your joints? (If YES, please state what surgery and when)	
Have you been in hospital in the last 5 years? (If YES, please state what for and for how long)	
Do you use a walking aid? (If YES, please state what aid)	
Do you have any physical disabilities? (such as vision/hearing problems)	
Have you ever smoked? (if YES please state whether current or ex-smoker)	
Is there any other illness or condition that affects your general health or interferes with your mobility? (such as cancers, multiple sclerosis etc.)	
Please state any prescribed medication regularly taken for any condition.	
How many times have you fallen in the past year (approximately)?	

## Appendix O: Data checking form (Chapter 6)

CBE Proof of Concept Study Data Checking Form

Participant ID:

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### Section One: Enclosed documents

Are all the documents stated enclosed?	Yes/No
--	--------

If No please list documents not enclosed

\_\_\_\_\_

## Section Two: CRF Compliance

	Yes/No	If No please provide page number for missing information
ID and Initials on every page		
Errors marked through and initialled		
Completed in black pen		
All sections completed or N/A used		
Blank Pages stated		

### Section Three: Database Outcomes

	Correct- Yes/No	Please record error and amend error in red on database
ID		
Gender		
Pre TUG		
Post TUG		
Pre EQ5D		
Post EQ5D		
Pre 6mw		
Post 6mw		
Pre Grip Strength		
Post Grip Strength		
Pre Quads Strength		
Post Quads Strength		

### Section Four: Database Exercise Programme

		Please record error and amend error in red on database
Stated whether started exercise programme?	Yes/No	
Number of sessions attended accurate?	Yes/No	
Reasons for non-attendance recorded and accurate?	Yes/No	

Date Checked

Name:

Signature:

Date reviewed by researcher :

Action Plan:

Name:

Signature:

**Appendix P: EQ-5D-5L questionnaire (Chapter Six)**



**Health Questionnaire**

**English version for the UK**

Under each heading, please tick the ONE box that best describes your health TODAY.

**MOBILITY**

- I have no problems in walking about ☐
- I have slight problems in walking about ☐
- I have moderate problems in walking about ☐
- I have severe problems in walking about ☐
- I am unable to walk about ☐

**SELF-CARE**

- I have no problems washing or dressing myself ☐
- I have slight problems washing or dressing myself ☐
- I have moderate problems washing or dressing myself ☐
- I have severe problems washing or dressing myself ☐
- I am unable to wash or dress myself ☐

**USUAL ACTIVITIES** (e.g. work, study, housework, family or leisure activities)

- I have no problems doing my usual activities ☐
- I have slight problems doing my usual activities ☐
- I have moderate problems doing my usual activities ☐
- I have severe problems doing my usual activities ☐
- I am unable to do my usual activities ☐

**PAIN / DISCOMFORT**

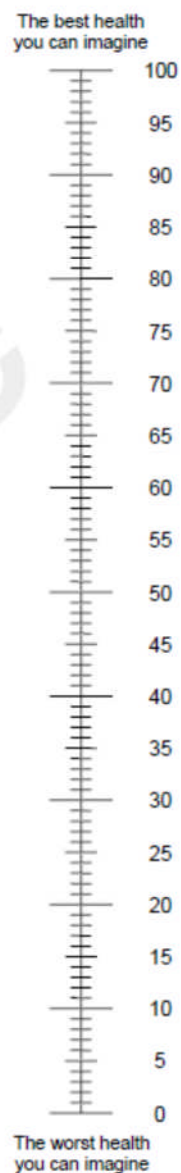
- I have no pain or discomfort ☐
- I have slight pain or discomfort ☐
- I have moderate pain or discomfort ☐
- I have severe pain or discomfort ☐
- I have extreme pain or discomfort ☐

**ANXIETY / DEPRESSION**

- I am not anxious or depressed ☐
- I am slightly anxious or depressed ☐
- I am moderately anxious or depressed ☐
- I am severely anxious or depressed ☐
- I am extremely anxious or depressed ☐

- We would like to know how good or bad your health is TODAY.
- This scale is numbered from 0 to 100.
- 100 means the best health you can imagine.  
0 means the worst health you can imagine.
- Mark an X on the scale to indicate how your health is TODAY.
- Now, please write the number you marked on the scale in the box below.

YOUR HEALTH TODAY =



## **Appendix Q: Focus group schedule (Chapter Six)**

### **Focus Group Instructions**

1. Please respect each other and allow each person to have their say
2. Please try to keep the discussion of the group confidential
3. The aim of the group is to hear your thoughts as a group so please be as open as possible
4. The discussions will be tape recorded and summarised on flip chart paper
5. I am acting as a facilitator and will ask questions but will not be joining in with the discussions

### **Questions**

1. What are the benefits to yourself you have noticed from attending the exercise programme?  
(Prompts re: physical and mental health benefits)
2. What are the negatives to yourself you have noticed from attending the exercise programme?  
(Prompts re: pain, risk of harm)
3. What are your thoughts on the number of sessions in the programme?
4. What are your thoughts on the duration of the sessions in the programme?
5. What are your thoughts on the intensity of the exercises in the programme?
6. What are thoughts on the types of exercises used in the programme?  
(Prompts: strength, aerobic, standing using the chair)
7. What were your reasons for wanting to attend the exercise programme?  
(Prompts: group/home)
8. Were there any barriers and how did these affect you attending the programme?
9. How did you keep motivated to attend the exercise programme?
10. How could the exercise programme be improved or developed further?

## Appendix R: Histogram plots for all variables (Chapter six)

### Baseline data

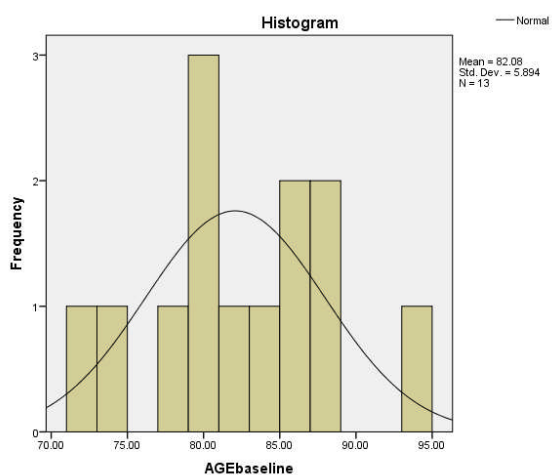


Figure 1: Histogram for age at baseline

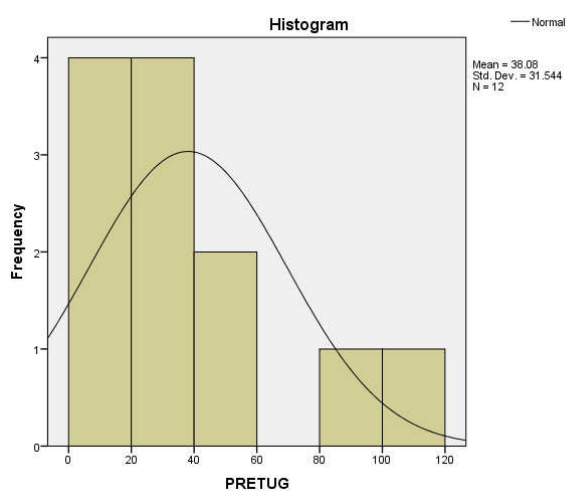
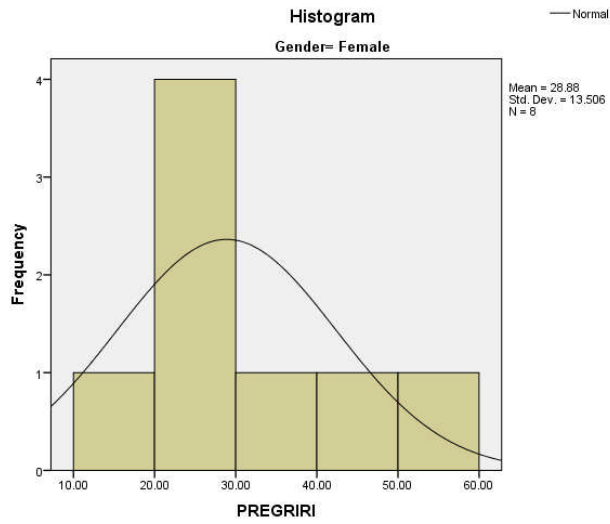
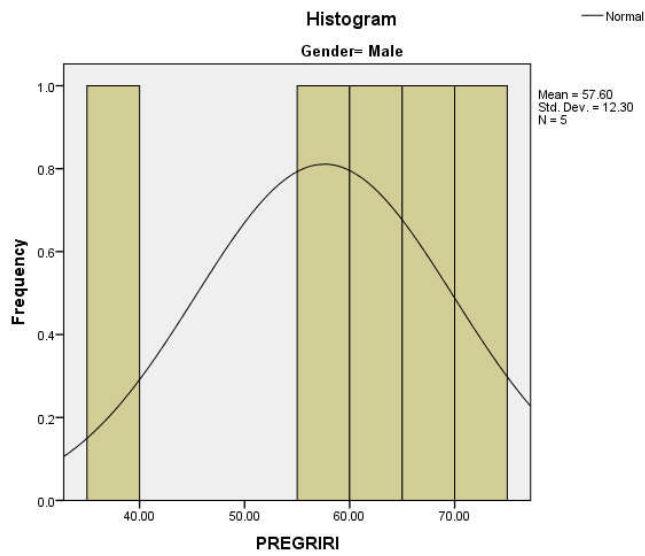


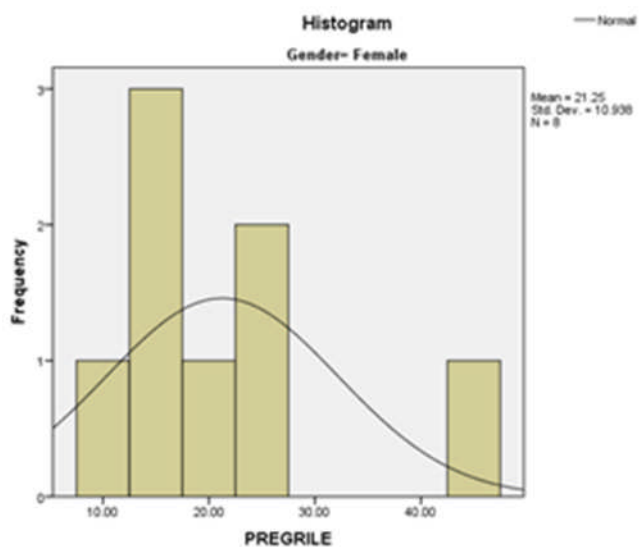
Figure 2: Histogram for Timed Up and Go Test at baseline



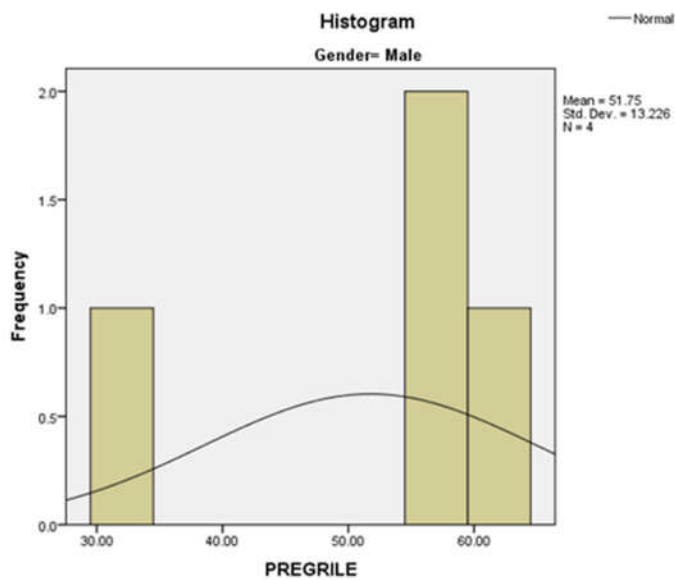
**Figure 3: Histogram for right grip strength for females at baseline**



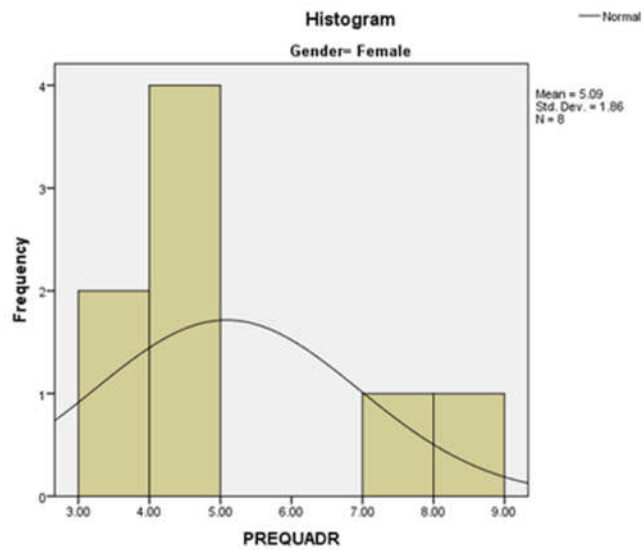
**Figure 4: Histogram for right grip strength for males at baseline**



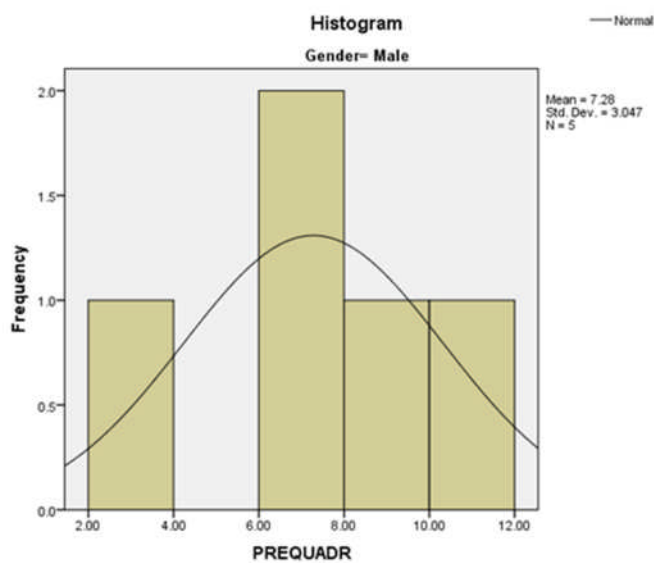
**Figure 5: Histogram of left grip strength for females at baseline**



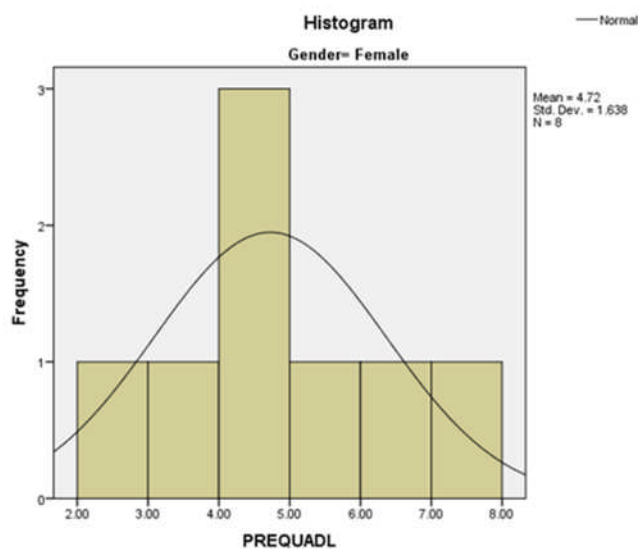
**Figure 6: Histogram of left grip strength for males at baseline**



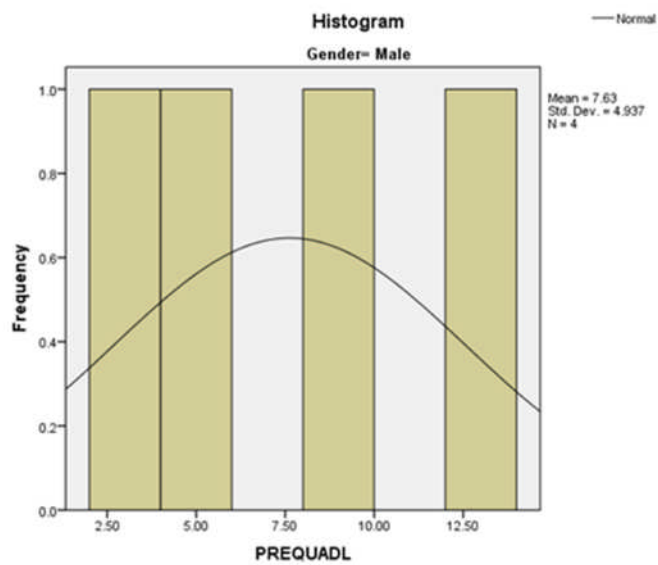
**Figure 7: Histogram of right quadriceps strength for females at baseline**



**Figure 8: Histogram of right quadriceps strength for males at baseline**

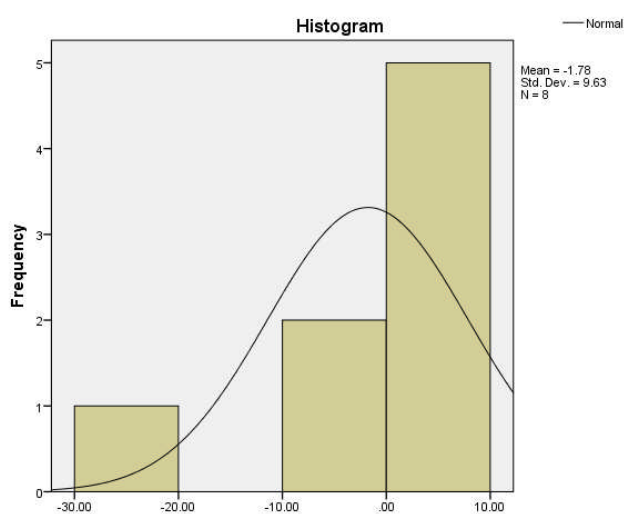


**Figure 9: Histogram for left quadriceps strength for females at baseline**

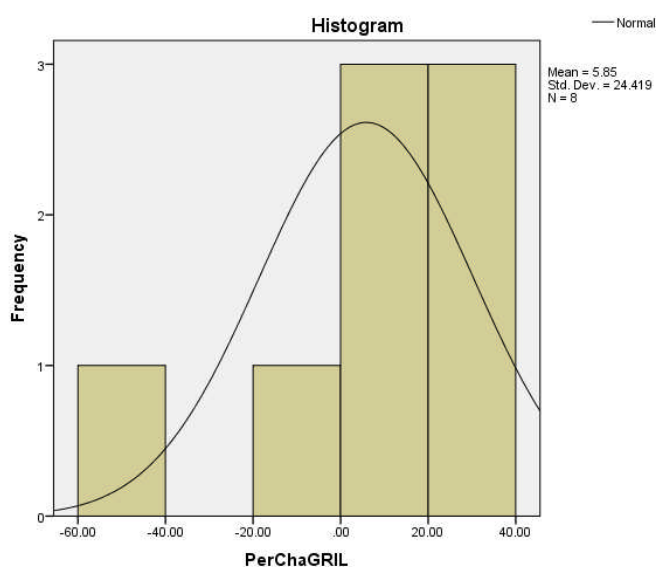


**Figure 10: Histogram for left quadriceps strength for males at baseline**

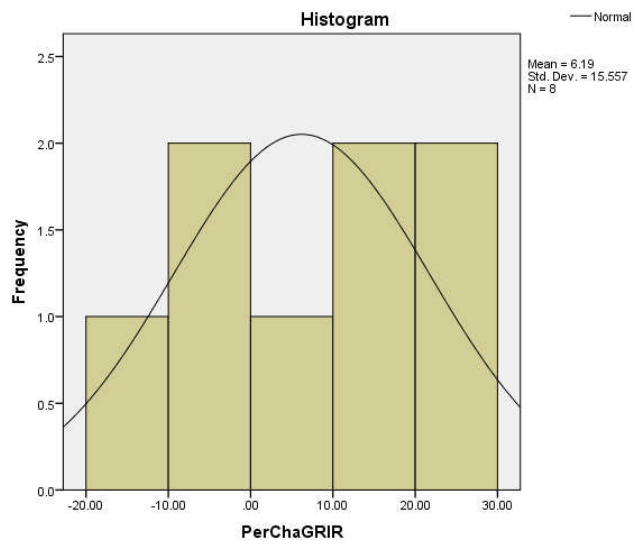
## Percentage Changes



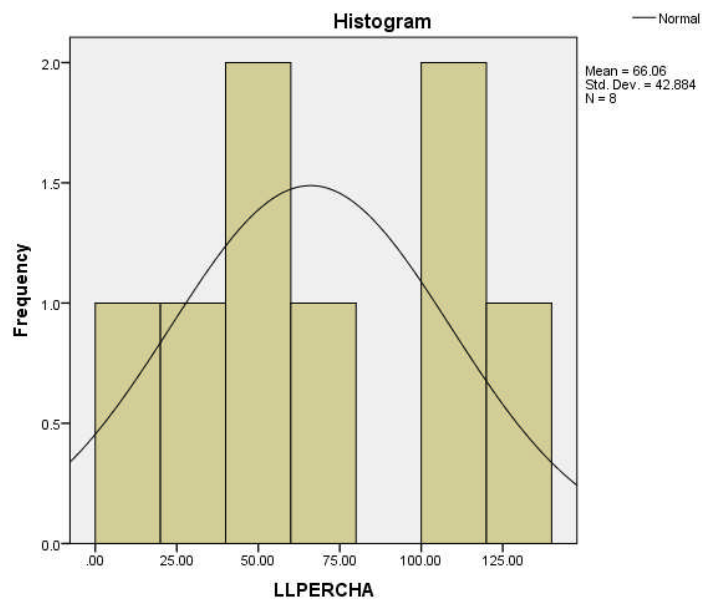
**Figure 11: Histogram for the percentage change in Timed Up and Go Test times**



**Figure 12: Histogram for the percentage change in left grip strength scores**

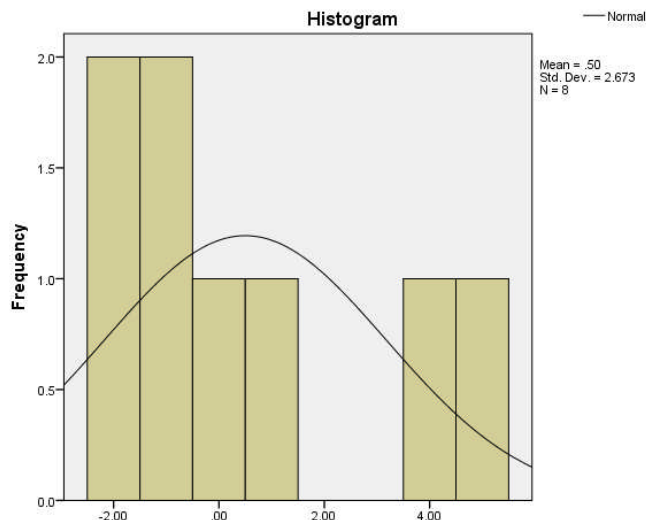


**Figure 13: Histogram for the percentage change in right grip strength scores**

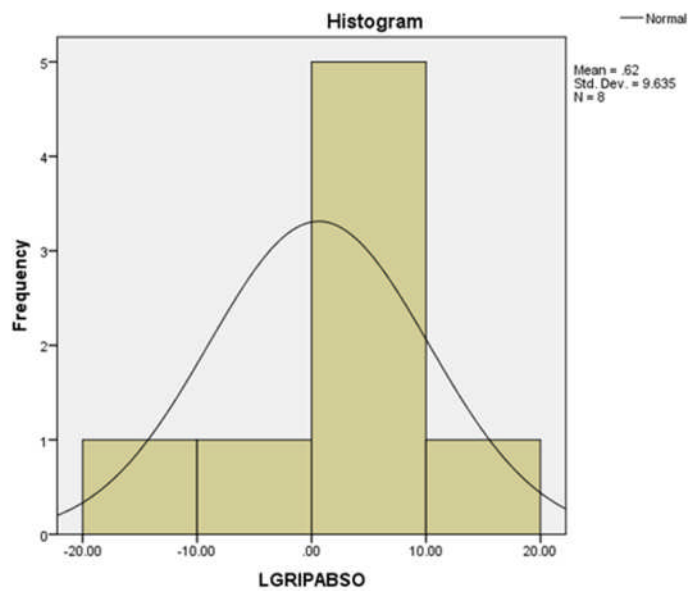


**Figure 14: Histogram for the percentage change in quadriceps strength scores**

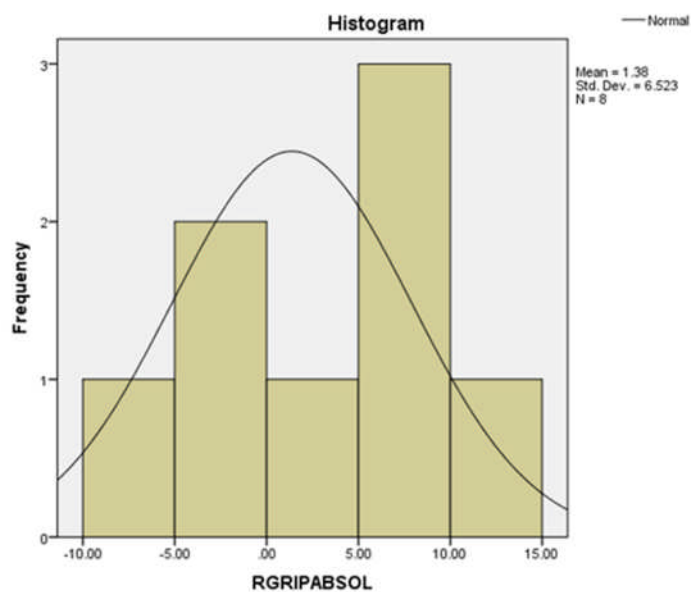
## Absolute Changes



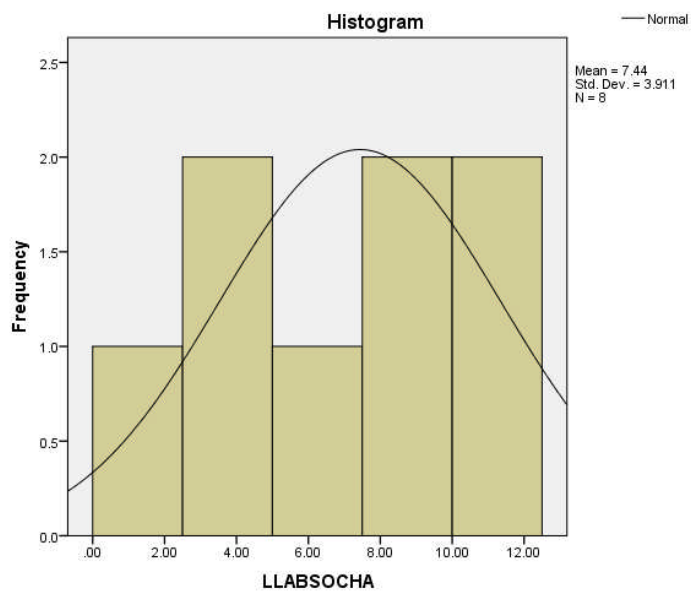
**Figure 16: Histogram for the absolute change in Timed Up and Go Test scores**



**Figure 17: Histogram for the absolute change in left grip strength scores**



**Figure 18: Histogram for the absolute change in right grip strength scores**



**Figure 19: Histogram for the absolute change in quadriceps strength scores**

## Appendix S: Initial framework (Chapter Six)

Theme 1. Defining	Sub themes					
	1.1 Range of exercise for older people	1.2 Used flexibly based on needs	1.3 the chair provides stability	1.4 Progression to standing programmes	1.5 Primarily seated	1.6 Other

Theme 2. Intended users	Sub-themes						
	2.1 Related to falls	2.2 Barriers to other forms of exercise	2.3 Reasons unable to take part in other forms of exercise	2.4 Medical problems	2.5 Reduced mobility	2.6 Age	2.7 Other

Theme 3. Benefits	Sub-themes							
	3.1 Mood/well-being	3.2 Social interaction	3.3 Muscle strength	3.4 Activities of daily living	3.5 Mobility around joints	3.6 Walking	3.7 Co-ordination	3.8 Other

Theme 4. Structure	Sub-themes								
	4.1 Tailored to individuals	4.2 Preferences for strength equipment	4.3 Challenging intensity	4.4 Progressively challenging strength training	4.5 CV training	4.6 Supported standing programmes	4.7 Standing Programmes	4.8 Music	4.9 Other

Theme 5. Format	Sub-themes							
	5.1 Rolling programmes	5.2 Length of session	5.3 Barriers to more sessions	5.4 Preferences for number of sessions	5.5 Tailored to individual neds	5.6 Preferences for group/1:1	5.7 Home exercise programme	5.8 Other

Theme 6. Risk management	Sub-themes							
	6.1 Skilled instructors	6.2 Qualifications	6.3 Health assessments	6.4 Healthcare professionals	6.5 Participant responsibility	6.6 Monitoring	6.7 Pain	6.8 Other

Theme 7. Barriers /Motivators	Sub-themes					
	7.1 Access	7.2 Location	7.3 Transport	7.4 Clearly defined goals	7.5 Perceived benefits	7.6 Other

## **Appendix T: Transcription protocol (Chapter Six)**

- Leader to be referred to as Facilitator.
- First letter of name to be used if names used throughout
- ID numbers to be assigned to participants
- Nonverbal communication recorded in brackets e.g. (group laughter)
- Transcribed verbatim even if words mispronounced
- If a word or phrase is inaudible to be recorded in square brackets e.g. [inaudible]
- Separate line for each person speaking
- Underlined if participant is talking at the same time

## Appendix U: Example of initial coding (Chapter Six)

	3.1 Mood/Well-being	3.2 Social Interaction	3.3 Muscle Strength	3.4 Activities of Daily Living s	3.5 Mobility around joints	3.6 Walking	3.7 Co-ordination	3.8 - Other- Confidence	3.8 Other- Discipline	3.8 Other - Family Observations
FG1	Yes mind active yeah yeah	Well it was nice meeting with the group.  Erm the commaradery of the group. Once they get to know one another better they work together don't they  Sociable	You know K, this leg, this leg is [inaudible]. And now I can pick it up			I can walk better		But I got a confidence that is the main thing.  But still I got quite a lot of confidence in me.	have a discipline  My main problem was disciplining myself to actually do it you know on a regular basis	he youngest daughter thinks I have improved a lot but Christine the one I spend most time with is not too sure (laughs)
FG2	General wellbeing  And then when you get home you are full of beans and you are telling your family what you have been doing and what you haven't been doing  I think it makes you look forward to these sessions as something  you get yourself washed and nicely smelling and you know you put a little bit of effort in your appearance  Because I brought a new t-shirt and thought that will be nice to go the group in you know. When I used to do it	Just meeting people you know  the more company you move into that must get better really the fact that you know you are aware of that and people don  Well you are meeting people, company aren't you  Talking to other people. When you are talking to yourself all day long you don't err. You lose yourself  Nice to talk to you and talk to you You get in a group and you are talking to anyone  It was like going out.  Meeting people Which a lot of us don't do much of really, hardly ever go out.	Yes I did, I noticed my legs were getting a bit stronger  Well my legs have felt a bit stronger and my hands have been a bit stronger  Strengthening your legs and arms  It makes your legs stronger  The strength, all them exercise were exactly what I needed to keep me legs reasonably okay and me arms as well  Strengthening your body and that sort of thing			Walking better  about walking, not being so scared of people judging you when you were walking.		I was [inaudible]. It made me not so scared you know  You've got more confidence  You've got more confidence  Yeah it can build your confidence up  Used to give me as you've just said confidence  Erm it gives me more confidence  and you are not scared of talking to you. At one time of day I would have been scared stiff, scared stiff of talking to anybody but now Its confidence building  That is the biggest thing  Confidence main thing	Well I have felt happier when I have got home from a lecture, I feel as though someone is doing something for me	And then when you get home you are full of beans and you are telling your family what you have been doing and what you haven't been doing  I think it makes you look forward to these sessions as something  you get yourself washed and nicely smelling and you know you put a little bit of effort in your appearance  Because I brought a new t-shirt and thought that will be nice to go the group in you know. When I used to do

## **Appendix V: Health condition categories (Chapter Six)**

### **Medical Conditions Categorisation**

- 1= Angina
- 2= Diabetes
- 3= Osteoarthritis
- 4= Rheumatoid arthritis
- 5= COPD
- 6= Heart failure
- 7= Asthma
- 8= Previous MI
- 9= Hypertension
- 10= Stroke
- 11= LBP
- 12= Joint replacement
- 13= Parkinson's
- 14- Osteoporosis
- 15= Cellulitis
- 16= Cancer
- 17= Epilepsy

## Appendix W: Event reporting (Chapter Six)

Time reported	During delivery of exercise programme	Category	Details	Outcome
Prior to exercise programme commencing	No	S- Surgery	Elective shoulder replacement	Withdrawn from study
Prior to exercise programme commencing	N/A	H- Hospital Admission	Stroke	Withdrawn from study
Prior to exercise programme commencing	N/A	F- Fall	Fall with no injury	No effect on study
Prior to exercise programme commencing	N/A	O -SOB	SOB at rest observed and therapist advised GP review.	Withdrawn from exercise component
1 week into exercise programme	No	T- Tiredness	Declined session as too tired	Missed one exercise session
1 week into exercise programme	No	O- swelling	Lower limb swelling therefore no lower body exercise due to use of weights and bands	Modified delivery of exercise programme for 1 session
2 weeks into exercise programme	No	O- sickness	Reported upset stomach	Missed one exercise session
2 weeks into exercise programme	No	O- Dizziness	Reported episode of dizziness due to inner ear	No effect on exercise programme
2 weeks into exercise programme	No	P-Pain	Reported ongoing left knee pain on mobilising. No increase since start of programme	No effect on exercise programme
3 weeks into exercise programme	Yes	P-pain	Dull ache in left ankle on arrival to group, resolved by next session	Modified delivery of exercise programme for 1 session
3 weeks into exercise programme	No	T- Tiredness	Tired after visits out this week	Missed one exercise session
4 weeks into exercise programme	No	H- Hospital Admission	Exacerbation of heart failure	Missed remaining exercise sessions
4 weeks into exercise programme	No	P- Pain	Pain in left side at start of session, recurring problem that was not related to the programme	Modified delivery of exercise programme for 1 session
4 weeks into exercise programme	No	C- cough	Declined exercise programme due to cough	Missed one exercise session

Time reported	During delivery of exercise programme	Category	Details	Outcome
4 weeks into exercise programme	No	C- cough	Declined exercise programme due to cough	Missed one exercise session
6 weeks into exercise programme	No	C- cough	Declined exercise programme due to cough	Missed one exercise session
6 weeks into exercise programme	No	C- cough	Dry cough observed in exercise group	No effect on exercise programme
6 weeks into exercise programme	Yes	T- Tiredness	Observed tiredness in session	No effect on exercise programme
6 weeks into exercise programme	No	P-Pain	Lower back pain reported prior to session and walking aid height reviewed, resolved with change in walking aid	Modified delivery of exercise programme for 1 session
6 weeks into exercise programme	No	A- Accident	Bandage to left foot as hit on door	Modified exercise to not use resistance band on left foot due to bandage
7 weeks into exercise programme	No	O- sickness	Sick from 'something she ate'	Missed one exercise session
7 weeks into exercise programme	Yes	A- Accident	Hit in face with resistance band when going HEP. No injury	Advised not to carry out resistance band exercises independently
8 weeks into exercise programme	No	P-Pain	Reported ongoing left knee pain on mobilising, no change since start of programme	No effect on exercise programme
9 weeks into exercise programme	No	P- Pain	Pain in left shoulder following cleaning floor after flood.	Modified delivery of exercise programme for 1 session
4 weeks into exercise programme	No	P- Pain	Pain in left hip following travel on/off minibus, resolved by next session	Missed one exercise session
10 weeks into exercise programme	No	C- cough	Declined exercise programme due to cough	Missed one exercise session
10 weeks into exercise programme	No	C- cough	Declined exercise programme due to cough	Missed one exercise session
10 weeks into exercise programme	No	O- exacerbation of COPD	Reported exacerbation of COPD due to hot weather and GP prescribed steroids	Missed two exercise sessions

Time reported	During delivery of exercise programme	Category	Details	Outcome
10 weeks into exercise programme	Yes	T- Tiredness	Observed tiredness in session. Participant reported no change in fatigue levels	No effect on exercise programme
10 weeks into exercise programme	Yes	T- Tiredness	Observed tiredness in session	No effect on exercise programme
10 weeks into exercise programme	Yes	T- Tiredness	Observed tiredness in session	No effect on exercise programme
10 weeks into exercise programme	Yes	P- Pain	2/10 discomfort in left hip	No hip flex exercise for that session
10 weeks into exercise programme	No	P-Pain	Reported discomfort in left side after trip to supermarket. No residual pain or pain when doing exercises or mobilising.	No effect on study
10 weeks into exercise programme	No	T- Tiredness	Reported feeling tired after going out with family	Modified delivery of exercise programme for 1 session
11 weeks into exercise programme	Yes	T- Tiredness	Observed tiredness in session.	Reduced reps and sets of exercise programme
11 weeks into exercise programme	Yes	P- Pain F- Fall	Pain reported completing exercises due to fall 2 days previously. Fall due to environmental factors	Modified delivery of exercise programme for 1 session
11 weeks into exercise programme	No	F- Fall	Fall due to dizziness from inner ear problem	Missed one exercise session
1 week after exercise programme	No	F- Fall	Reported lost balance and fell to side. No injury reported	End of exercise sessions therefore no effect on exercise programme
2 weeks after exercise programme	No	I- Infection	Chest infection	Unable to attend focus group
4 weeks after exercise programme	No	I- Infection	Shingles infection	Unable to attend first focus group

## Appendix X: Barrier and facilitator codes (Chapter Six)

Facilitators		
Theme	Definition	Codes
Seeing a benefit (29)	Feeling and seeing benefits from participating	see improvement progression feeling it working reducing pain feel better
Enjoyment (27)	Enjoying participating	enjoyment positive outlook think they are good
Challenging level (11)	The level of exercise is appropriately challenging to know you have worked	just right gradual challenging feeling you have worked
Group support (10)	Relating to the group context and interaction of participants supporting each other	group rapport camaraderie motivation between participants social interaction group cohesion
Understanding the purpose (7)	Understanding the purpose of the exercises	explanation and understanding time to explain increased knowledge purpose
Influence of family and friends (5)	Related to any influence of family members over participation	family observation and encouragement telling friends telling family
Skills of the therapist (7)	Interaction between therapist, staff and participants	staff behaviour rapport with therapist background knowledge of therapist tailor to individuals conversation with therapist
Independence with programme (4)	Being able to the exercises on your own	do on your own do on your own at home no special equipment familiarisation self-monitoring
Reason to improve (3)	Clear reason for wanting to attend	reason to improve goal
Preparation (2)	Preparation for each session	preparation
Previously exercised (1)	Previous exercise behaviour positively impacts on attending the programme	used to exercise
Seeing others doing it (1)	Seeing other people outside of the study group carrying out the exercise (e.g. sports people, family and friends)	Seeing others doing it

Barriers		
Theme	Definition	Codes
Medical conditions (30)	Medical conditions that limited participation	medical conditions
		illness
		postural imbalance
Close Monitoring (16)	Requiring to monitor participants which limits carrying out the programme independently	poor technique
		needs supervision
		need monitoring
		slowing people down
Fatigue (12)	Fatigue during sessions that limited participation or progression	fatigue
		tired
		too much exercise
Not Challenging (9)	The level of the programme is not challenging enough	not challenging
Pain (8)	Pain or ache limiting participation	pain
		ache
Professional responsibility (8)	Constraints over professional and contextual boundaries	therapist responsibility
		NHS policy
		responsibility of participant
		individual responsibility
Variation in abilities (6)	Different levels of ability between participations and with individual participants in each session	varying abilities
		fluctuating abilities
Memory difficulties (5)	Related to difficulties in remembering session times and dates as well as completion of the individual exercises	forgot
Weather (4)	The influence of the weather (too hot, ice) on participation and delivery	weather
Comparing abilities 4)	Participants comparing themselves with other participants	competition (negative)
		perception of each other's abilities
Anxiety (4)	Anxiety of participants during attendance to the programme	anxiety
Transport disruptions (4)	Disruptions to sessions related to transport	transport negative
		lack of time due to transport
Unexpected Events (3)	Any event that was not anticipated by the participant	fall
		accident
Lack of perceived benefit (2)	Not able to feel a benefit from participating	unable to feel it working
		no perceived benefit
Unrealistic Outcomes (2)	Participants reporting anticipated outcomes that were considered unrealistic or unachievable	not able to achieve anticipated outcomes
Previous experiences (1)	Negative experiences of previous therapy or exercise programmes	previous experiences (negative)
No specific goal (1)	Where no goal was identified for attending	no specific goal

## Appendix Y Strength variables converted (Chapter Six)

**Table 1: Pre and post scores for right grip strength converted to kilograms**

Pre-test score (kg)	Post test score (kg)	Absolute change (kg)	Percentage change	MCID
14.52	13.61	-0.91	-6.25	No
24.95	22.68	-2.27	-9.09	No
11.34	13.61	2.27	20.0	No
29.50	31.75	2.27	7.69	No
9.07	11.34	2.27	25.00	No
9.98	11.34	1.36	13.64	No
24.95	20.413	-4.54	-18.18	No
27.22	31.75	4.54	16.67	No
<b>Mean Change (SD)</b>		0.63 ±2.96	6.19 ±15.56	
<b>95 % Confidence Interval</b>		-1.85 to 3.10	-6.81% to 19.19%.	

**Table 2: Pre and post scores for left grip strength converted to kilograms (kg)**

Pre-test score (kg)	Post test score (kg)	Absolute change (kg)	Percentage change	MCID
11.34	12.70	1.36	12.00	No
26.31	24.49	-1.81	-6.90	No
9.07	11.34	2.27	25.00	No
27.22	28.58	1.36	5.00	No
6.80	9.07	2.27	33.33	No
11.34	11.34	0	0	No
20.41	11.34	-9.07	-44.44	No
25.85	31.75	5.90	22.81	Yes
<b>Mean Change (SD)</b>		0.29 (4.37)	5.85 (24.42)	
<b>95 % Confidence Interval</b>		-3.37 to 3.94	-14.56 to 26.26	

**Table 3: Pre and post test scores for quadriceps strength converted to newtons (N)**

Pre-test score (N)	Post test score (N)	Absolute change (N)	Percentage change	MCID
92.308	187.562	95.25	103.19	Yes
232.73	328.97	96.24	41.35	No (Approaching)
143.37	162.03	18.65	13.01	No
190.51	230.77	40.26	21.13	No
96.24	217.022	120.79	125.51	Yes
87.40	126.678	39.28	44.94	Yes
88.29	148.282	59.99	67.78	Yes
190.51	216.04	113.91	111.53	Yes
<b>Mean Change</b>		73.04 ±38.41	66.10 ±42.88	
<b>95 % Confidence Interval</b>		40.95-105.17	17.98%-139.06%	

## **Appendix Z: Focus group reflection (Chapter Six)**

### **Focus Group Reflections**

- 4 participants, 3 had completed the programme and 1 had started the programme

#### **Start of the Group**

*Felt it was difficult to generate conversation at the start of the group with participants looking at me for direction and to start the discussion. Once the discussion started things improved and I felt I was asking questions to facilitate discussion and using the prompt sheet to maintain momentum. I felt at the start I perhaps made the discussions more stilted as I asked too many questions rather than allowing time for discussion and interaction.*

#### **Questions**

*I had my questions sheet and prompts and had practiced questions with my peers so felt prepared. I also felt as a clinician who had run therapy groups that I was used to asking open questions and facilitating discussion. On listening to the recording and reading the transcripts I was surprised by my question style and felt I had asked too many closed questions and occasionally leading questions. I was aware of the issues with leading questions and felt that I had consciously avoided them but on reflection I had asked questions in a certain way which may have framed the responses. Potentially in my practice as a physio I was more used to structured assessments with specific questions and this made me reflect on whether I was using open questions effectively in a clinical setting. I had felt prepared with my questions and had undertaken training through the*

graduate school however on reflecting I felt that my question style with clinical research could be improved and this would take more experience and practice.

### Facilitator and delivery of programme

I was concerned about the discussion being hampered as I had delivered the exercise programme and participants may be overly positive. I actually felt during the discussions that my rapport with the participants helped to generate discussion and that they were comfortable with me. I also felt I was able to direct the discussion as I understood the context as I had delivered the programme.

### Clinical Role

My role as a physiotherapist proved challenging when participants asked direct questions related to their condition or health needs. I was able to park the questions and then discuss why I had not answered them with the participants after the group.

### Action points

- Have the confidence to leave silence and allow discussions and interactions to develop slowly
- Having prompts for questions was useful
- Make participants aware at the beginning of the group about my role and the differences between my clinical role
- Allow time for my questions to ensure better wording