Characteristics of effective home-based resistance training exercise in patients with chronic disease: a scoping review protocol

Thomas J Wilkinson [1], Roseanne Billany [1,2], Courtney J Lightfoot [1], Matthew Graham-Brown [3], Alice C Smith [1]

[1] Leicester Kidney Lifestyle Team, Department of Health Sciences, University of Leicester, Leicester, UK, LE17RH

[2] School of Sport, Exercise and Health Sciences, Loughborough University, Loughborough, UK, LE11 3TU

[3] Department of Cardiovascular Science, University of Leicester, Leicester, UK, LE17RH

Corresponding author:

Dr TJ Wilkinson. Leicester Kidney Lifestyle Team, Department of Health Sciences, University of Leicester, Leicester, UK, LE17RH. Email: t.j.wilkinson@le.ac.uk

Abstract

Regular exercise, principally resistance training, is an effective method to promote muscle hypertrophy and attenuate muscle atrophy during various atrophic conditions. There is growing interest in the evaluation of home-based resistance training programmes. These programmes have the potential to overcome common barriers to participation, such as accessibility and affordability. The objective of the scoping review is to map the available evidence to provide an overview of what characteristics, principles, and components are required for an effective home-based resistance training programme in patients with chronic disease. The four specific objectives of the scoping review will be to: 1) conduct a systematic search of the published and grey literature for studies reporting on home-based resistance training in patients with chronic disease; 2) map out the characteristics and range of methodologies (including exercise protocols and outcome measures) used in effective home-based resistance training; 3) examine reported challenges and limitations of home-based resistance training; and 4) propose recommendations for optimizing home-based resistance training protocols in this population.

Key words

Resistance training; home-based; strength training; exercise; chronic disease

Introduction

Rationale

Accountable for 71% of worldwide deaths, noncommunicable, often termed 'chronic', diseases (NCDs) are the most common causes of death and morbidity and have an enormous socio-economic burden.[1,2] Four NCDs (cardiovascular disease, cancer, diabetes, and chronic respiratory disease) are prioritized in the World Health Organization's (WHO) 'Global Action Plan (GAP) For Prevention and Control of Noncommunicable Diseases 2013-2020'[3] because they share key behavioural risk factors amenable to public health action and together contribute to a major portion of global NCD burden.[4] Although not currently identified as a separate target, there is undeniable evidence that kidney disease is a key determinant of the poor health outcomes of diabetes and cardiovascular disease (including hypertension).[4] Indeed, the WHO 'Global Action Plan' recognizes kidney disease as an important factor in major NCD burden.[3]

Along with increased mortality and morbidity, skeletal muscle atrophy and skeletal muscle dysfunction are well-documented consequences of these conditions. Driven by a complex torrent of factors such as inflammation, disuse, ageing, and malnutrition, loss of skeletal muscle has been observed in cardiovascular disease including chronic heart failure (CHF)[5] and cancer[6,7] – often termed 'cardiac' and 'cancer' cachexia; diabetes[8]; chronic respiratory disease such as chronic obstructive pulmonary disease (COPD)[9,10]; and chronic kidney disease (CKD).[11]

Disease-related muscle atrophy is an important clinical problem because loss of muscle mass and therefore acquired skeletal muscle weakness can result in exercise and functional limitations, and contribute to a poor quality of life (QoL). Importantly, and somewhat under-recognized, muscle also plays a central role in whole-body protein metabolism, which is particularly important in the response to stress. In particular, skeletal muscle serves as the principal reservoir for amino acids to maintain protein synthesis in vital tissues and organs in the absence of amino acid absorption from the gut and by providing hepatic gluconeogenic precursors [7]. It is unsurprising therefore that studies have shown that skeletal muscle atrophy is independently associated with increased mortality of patients with cardiovascular disease including CHF[12]; cancer[6]; chronic respiratory disease such as COPD[13]; and CKD.[14]

Regular exercise, principally resistance training, is an effective method to promote muscle hypertrophy and attenuate muscle atrophy during various atrophic conditions[7,15-23], and resistance training is now supported in international[24] and national clinical practice[25-27] and public health guidelines.[28] The increase in muscle tissue through exercise has a range of diverse physiological and metabolic effects in patients with chronic disease including: attenuating the decrease in muscle mass[18,19]; increasing strength and physical performance[16,17,22]; accelerating the synthesis of acute-phase proteins in the liver and the synthesis of proteins involved in immune function[7], consequently improving the state of chronic low-grade inflammation[21]; betterment of lipid profile[22]; improved glucose homeostasis[29]; decreased systolic and diastolic arterial pressure; greater insulin sensitivity[22,27]; and positively affecting osteo-muscular parameters.[21]

Resistance training can involve a variety of training modalities, including free weights, weight machines, medicine balls, elastic tubing devices, and an individual's body weight[23]. However, despite this wealth of evidence supporting the essential role of resistance training chronic disease, few people participate in resistance training[23] and the prevalence of participation in resistance training in nationally representative samples is low, ranging from 10%[30] to 30%.[31] In patients with chronic disease, this number is likely to be much lower.

The majority of resistance training studies have involved supervised programmes held in clinics or gymnasiums overseen by exercise health professionals or researchers. These sessions are frequently subsidized or provided free as part of a rehabilitation or research programme, and once access and supervision is removed, continued participation is often reduced. Traditional resistance training in a gym setting might not be a viable option for some patients, and lack of access to traditional resistance equipment or facilities as a result of economic or physical constraints impairs some individuals from carrying out resistance training[32,33]. Additionally, a lack of knowledge of the benefits of exercise and how to exercise can be a major deterrent for some[33,34]. Consequently, there is growing interest in the evaluation of home-based resistance training programmes. These programmes have the potential to overcome common barriers to participation, such as accessibility and affordability[23].

A review by Thiebaud et al.[32] in older adults found that typical resistance exercises carried out at home often utilize bodyweight, ankle weights, and elastic bands. However, given the diversity of the home-based programs reviewed, the effectiveness of resistance training was not well established in terms of increasing both strength and functional ability. Large homogeneity in other home-based resistance training protocols have been observed in patients with COPD[35], diabetes[36], and kidney disease.[37] A key explanation for this is likely the lack of progression and intensity achievable in a home-setting, and whilst manipulating set and repetition quantities outside conventional ranges may mitigate this[32], further research in optimising home-based resistance exercise is needed.

A scoping review is proposed to identify and map the current extent and types of research and peer-reviewed expert opinion relating to home-based resistance training in these populations, specifically what training principles and characteristics of previous studies have been shown to be effective, safe, and achievable in these patients. The results of this review will be used to highlight areas in need of further research, and to inform future studies by identifying what potential training strategies and outcomes should be used.

Objectives

The objective of the scoping review is to map the available evidence to provide an overview of what characteristics, principles, and components are required for an effective home-based resistance training programme in patients with chronic disease. The four specific objectives of the scoping review will be to: 1) conduct a systematic search of the published and grey literature for studies reporting on home-based resistance training in patients with chronic disease; 2) map out the characteristics and range of methodologies (including exercise protocols and outcome measures) used in effective home-based resistance training; 3) examine reported challenges and limitations of home-based resistance training; and 4) propose recommendations for optimizing home-based resistance training protocols in this population.

A preliminary search (March 2019) for existing reviews on home-based resistance exercise in patients with chronic disease was carried out using the following databases: JBI Database of Systematic Reviews and Implementation Reports, PROSPERO, Cochrane Database of Systematic Reviews (CDSR), and MEDLINE (Ovid). A systematic review[38], from Taiwan, of home-based aerobic exercise with or without resistance exercise was identified, although this was restricted to only people with CHF. Consequently, no existing reviews similar to the proposed scoping review were found.

Inclusion criteria

Participants

This review will focus on the effect of home-based resistance training in patients with noncommunicable (chronic) disease. Noncommunicable diseases will be defined as: cancer; cardiovascular disease; diabetes mellitus (type 1 and type 2); CKD (including patients treated with dialysis); and chronic respiratory disease (asthma, COPD, pulmonary hypertension). There will be no restriction on age or sex in order to describe the full extent of the evidence related to the topic. Studies exclusively investigating home-based resistance training in older adults will be excluded given a previous review by Thiebaud et al.[32]

Concept

The concept being considered in this review is characterizing what components define an effective home-based resistance exercise programme. 'Effective' will be defined as improvements in the outcomes reported and, although these are likely to differ between individual studies, will likely include features of body composition such as muscle mass and/or quality and physical fitness including muscle strength and physical performance. The core 'components' of the home-based resistance exercise programme reported will be identified using the well-established S.P.O.R.T. principles of exercise training:[39,40]

1) Specificity (i.e. are the exercises personalized to the individual needs);
2) Progression (i.e. how is training progressed in a home-setting);
3) Overload (i.e. how is adequate intensity ensured – this relates to the F.I.T.T. principles: i) *Frequency* (duration (weeks/months/years) and sessions per week) required for effective adaptations; ii) *Intensity* (repetition and set ranges, time under tension, workload relative to maximum); iii) *Time* (what is the duration of exercise; what rest periods are utilized between sets and sessions;); and iv) *Type* (what type of exercises are being employed, what muscle groups are being worked, what equipment is being used);
4) Reversibility (i.e. utilising follow up to assess possible reverse in outcomes following termination of exercise); and
5) Tedium (i.e. how is variety ensured across the programme).

The review will also explore the safety and adherence rates of home-based resistance training and reasons for this. Whilst studies that utilize mixed training components (aerobic/balance training plus resistance training) will be included, only evidence and principles pertaining to resistance training will be reported. Given the small but beneficial gains following resistance training in older adults of adequate nutrition, such as protein[41] or Vitamin D[42], studies containing a combination of home-based resistance training and nutritional intervention will be included.

Context

Home-based resistance training information and advice may be provided in a variety of settings including online sources or may be internally provided by healthcare or rehabilitation services. These may be unsubstantiated and are often not supported by scientific evidence. Consequently, evidence for inclusion in this review will only come from peer-reviewed scientific publications or expert consensus guidelines (described below). Evidence for inclusion in this review will not be restricted by country or date to enable the full extent of available evidence to be mapped.

Types of studies

This scoping review will consider all types of quantitative and qualitative (if appropriate) study designs and reviews (including narrative reviews and expert opinion articles termed as reviews). Quantitative studies include experimental designs (randomised and non-randomised controlled trials and quasi-experimental studies) and observational designs (cohort studies, case-control studies, cross-sectional studies, case studies and descriptive studies). Guidelines and documents disseminated by relevant associations/societies/institutions, such as international and national disease associations, will be excluded as these are not usually peer-reviewed publications or research. If peer-reviewed publications of consensus guidelines are identified, these will be included. Peer-reviewed papers will be included if they are written in English and involve human participants with noncommunicable disease. Papers will be excluded if they did not fit the conceptual framework for the study. Patients with communicable and infectious diseases, or those defined exclusively as 'older adults' were excluded.

Methods

This protocol was drafted using the Preferred Reporting Items for Systematic Reviews and Meta-analysis Protocols (PRISMA-SCr)[43] and Joanna Briggs Institute (JBI) systematic scoping review methodological guidance[44]. An overview of the review process is shown in **Appendix I**.

Search strategy

The search strategy aims to find published and unpublished studies, expert opinion, and review articles. A three-step search strategy will be used in line with guidance from the JBI[44]. An initial limited search, by T.J.W, of MEDLINE (Ovid) has been undertaken followed by analysis of the text words contained in the title and abstract, and of the index terms used to describe articles. This informed the development of a search strategy which will be tailored for each information source. The full search strategy for MEDLINE (Ovid) is detailed in **Appendix II**. This meets the criteria for a draft search strategy for at least one database, required in the PRISMA-ScR checklist[43] and by the JBI[44]. Reference lists of articles selected for inclusion will be screened for additional relevant articles and subject experts will be contacted to check for completeness in the list of articles identified by the reviewers for inclusion.

Information sources

The databases to be searched include: MEDLINE and Embase via Ovid; AMED and CINAHL Plus via EBSCO; Web of Science; CDSR; and the JBI Database of Systematic Reviews and Implementation Reports. Trial registers to be searched include: ISRCTN Registry; ClinicalTrials.gov; WHO International Clinical Trials Registry Platform (ICTRP); and the Cochrane Central Register of Controlled Trials. The search for 'grey literature' and unpublished studies will include: OpenGrey and Google Scholar. As per recommendations by Haddaway et al., the first 300 results of Google Scholar will be searched. In addition, only 'title' level searches will be performed as these return more conference proceedings, theses, and 'other' grey literature[45]. All databases will be searched from date of inception.

Study selection

Following the search, all identified citations will be collated and uploaded into EndNote X7.3.1 (Clarivate Analytics, USA). After duplicates are removed, the titles and abstracts will be screened by two independent reviewers for assessment against the review inclusion/exclusion criteria. Articles that may meet the inclusion criteria, and no exclusion criteria, will be retrieved in full. The full text of selected articles will be assessed in detail by two independent reviewers. Full text articles that do not meet the criteria for inclusion will be excluded and reasons for exclusion will be provided in an appendix in the final review. The search results will be reported in full in the final review manuscript and presented as a PRISMA flow diagram[46]. Disagreements between the reviewers will be resolved through discussion or with a third reviewer – author T.J.W will have final say on inclusion.

Data extraction

Data from articles will be extracted into a charting form by two independent reviewers (as described above). The data charted will include specific details about the author/s, date and type of publication, country of origin, type of evidence and study design (if applicable), population, training principles (based on the S.P.O.R.T. and F.I.T.T. principles[39]), adverse events, outcomes assessed, setting, and key findings or recommendations. Reviewers will be asked to critically appraise the reasons given by article authors for their findings.

A draft charting form has been developed to ensure that appropriate data is extracted to enable the review questions to be answered (**Appendix III**). This charting form will be initially tested by two independent reviewers on two articles to check that all relevant information relating to the review questions is extracted. If required, the form will continually be adapted during the review process and the final version will be included in the final scoping review. Authors of included articles will be contacted for clarification of information when necessary.

Calibration exercises

To prevent errors and ensure high inter-rater agreement, two 'calibration exercises' as recommended by the PRISMA-ScR[43] will be performed. Firstly for the study selection process, the entire reviewer team will examine 50 citations for initial title and abstract screening. Discrepancies in inclusion between reviewers will be calculated and a roundtable discussion will be held to clarify any issues. Refinements to the form will be made as required. A second exercise will be done if agreement <80%[43]. Following a training workshop on use of the detailed charting form, a second calibration exercise will be done for full-text screening of two random articles.

Data presentation

Results will be presented in a tabular format according to: 1) study design (e.g., randomised controlled trial (RCT), cohort study); or 2) article type (e.g., expert opinion). A draft results table is included in **Appendix IV**, although this table will be adapted as required. A diagrammatic map will be produced to highlight the variety or consistency across training components. A narrative summary will synthesize the findings to provide a description of the evidence identified in relation to the review questions. Published in a peer-reviewed journal, the final report will conform to the PRISMA-SCr[43] and JBI[44] guidance. Items 22 ('Risk of bias across studies') and 23 ('Additional analysis') on the PRISMA-ScR will not be included as they are not applicable for inclusion in scoping reviews.

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Conflicts of interest

The authors declare no conflict of interest.

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Appendix I: Overview of screening and data extraction process

1. Initial search of MEDLINE (Ovid) (strategy shown in Appendix II) – **COMPLETE**
2. Compete database(s) search
3. All identified citations uploaded to citation manager (EndNote X7.3)
4. Duplicates removed
5. Calibration exercise 1 - entire reviewer team will examine 50 citations for initial title and abstract screening
6. All remaining titles and abstracts reviewed by two independent reviewers
7. Articles not meeting inclusion criteria will be removed
8. Full text sources will be obtained for remaining citations
9. Charting form checked for purpose by two reviewers on one random article
10. Training workshop (on use of the detailed charting form) and calibration exercise 2 – entire reviewer team will perform a full-text screening of two random articles
11. Full texts reviewed by two independent reviewers, with articles not meeting the criteria for inclusion excluded
12. Data from articles will be extracted into a charting form (draft version found in Appendix III) by two independent reviewers
13. Results presented in tabular format and diagrammatic map as appropriate
14. Review published in a peer-reviewed journal

Appendix II: Search strategy for MEDLINE (Ovid)

1	home adj based.ti,ab	
2	Resistance Training/.ti	
3	strength training.ti,ab	*Resistance training component of search*
4	weight training.ti,ab	
5	**1 AND 2** (home based AND Resistance Training)	
6	**1 AND 3** (home based AND strength training)	
7	**1 AND 4** (home based AND weight training)	
8	**5 OR 6 OR 7 OR 8**	
9	exp Neoplasm$/	
10	Cardiovascular Disease$/	
11	exp Heart Disease$/	
12	Diabetes Mellitus/	
13	exp Renal Insufficiency/	
14	Dialysis/	
15	Exp Kidney Disease$/	*Condition component of search*
16	Lung Disease$/	
17	Kidney Transplantation/	
18	Asthma/	
19	exp Chronic Obstructive Pulmonary Disease/	
20	Hypertension Pulmonary/	
21	**9 OR 10 OR 11 OR 12 OR 13 OR 14 OR 15 OR 16 OR 17 OR 18 OR 19 OR 20**	
22	**8 AND 21**	

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Appendix III: Draft charting form

<table>
<tr><th colspan="2">Reviewer name</th><th>Date</th></tr>
<tr><td colspan="3">First author of paper</td></tr>
<tr><td colspan="2">Year of publication</td><td>Record number (assigned per full text)</td></tr>
<tr><td colspan="3">Journal</td></tr>
<tr><td colspan="3">Country of origin*</td></tr>
<tr><th colspan="3">Population and study design</th></tr>
<tr><td colspan="3">Primary condition being investigated</td></tr>
<tr><td colspan="3">Age and sex characteristics</td></tr>
<tr><td colspan="3">Other participant characteristics</td></tr>
<tr><td colspan="3">Sample size</td></tr>
<tr><td colspan="3">Study design</td></tr>
<tr><td colspan="3">Number and summary of groups used</td></tr>
<tr><td colspan="3">Any other comment of methods</td></tr>
<tr><th colspan="3">Training principles</th></tr>
<tr><td colspan="3">Specificity (i.e. are the exercises personalized to the individual needs)</td></tr>
<tr><td colspan="3">Progression (i.e. how is training progressed in a home-setting)</td></tr>
<tr><td rowspan="4">Overload (i.e. how is adequate intensity ensured)</td><td colspan="2">i) Frequency (duration (weeks/months/years) and sessions per week) required for effective adaptations</td></tr>
<tr><td colspan="2">ii) Intensity (repetition and set ranges, time under tension, workload relative to maximum)</td></tr>
<tr><td colspan="2">iii) Time (what is the duration of exercise; what rest periods are utilized between sets and sessions)</td></tr>
<tr><td colspan="2">iv) Type (what type of exercises are being employed, what muscle groups are being worked, what equipment is being used)</td></tr>
<tr><td colspan="3">Reversibility (i.e. utilising follow up to assess possible reverse in outcomes following termination of exercise)</td></tr>
<tr><td colspan="3">Tedium (i.e. how is variety ensured across the programme)</td></tr>
<tr><th colspan="3">Outcomes</th></tr>
<tr><td colspan="3">Primary outcome and associated changes</td></tr>
<tr><td colspan="3">Secondary outcome and associated changes</td></tr>
<tr><td colspan="3">Critically appraisal of findings and reasons for change(s)</td></tr>
<tr><td colspan="3">Other comments</td></tr>
</table>

*where was study conducted

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Appendix IV: Draft table of results with example

Reference	**Population**	**Study design**		**Training principles**						
Citation **Year**	**Condition** **Age** **Sex** **Other**	**Design** **Groups used**	**Sample size**	**Specificity**	**Progression**	**Overload (F.I.T.T)**	**Reversibility and tedium**	**Key findings**	**Adverse events**	**Other comments**
Uchiyama et al. 2019 [37]	Peritoneal dialysis Usual care group: 63.2 (±9.5) yrs, 70% male vs. Exercise group: 64.9 (±9.2) yrs, 79% male	Randomized controlled trial; two groups – usual care vs. home-based aerobic and resistance training	Exercise: n=24 Usual care: n=23	Exercise set to 70% of one repetition max	One repetition max assessed monthly and program adjusted accordingly	*Frequency:* 2x week for 12 weeks *Intensity:* 70% of one repetition max, 1 set of 10 repetitions *Time:* Not reported *Type:* Upper and lower (e.g., latissimus, deltoid, biceps, quadriceps) using Theraband	Not reported	Distance walked on incremental shuttle walk increased; Kidney Disease Quality of Life-Short Form questionnaire increased; serum albumin maintained; No change in quadriceps or handgrip strength; No change in pulse wave velocity; No change in skeletal muscle index	No adverse events reported	Combination of both aerobic and resistance training; adherence measured by weekly postcard. Adherence was moderate to resistance training (76%)

