

REVIEW

Interventions to prevent or reduce the level of frailty in community-dwelling older adults: a scoping review of the literature and international policies

MARTINE T. E PUTS¹, SAMAR TOUBASI¹, MELISSA K. ANDREW², MAUREEN C. ASHE^{3,4}, JENNY PLOEG⁵, ESTHER ATKINSON⁶, ANA PATRICIA AYALA⁷, ANGELIQUE ROY⁸, MIRIAM RODRÍGUEZ MONFORTE¹, HOWARD BERGMAN⁹, KATHY MCGILTON⁸

¹University of Toronto—Lawrence S. Bloomberg Faculty of Nursing, Toronto, Ontario, Canada

²Dalhousie University—Division of Geriatric Medicine, Halifax, Nova Scotia, Canada

³University of British Columbia—Family Practice, Vancouver, British Columbia V5Z 1M9, Canada

⁴University of British Columbia—Centre for Hip Health and Mobility -7 F-2635 Laurel St., Vancouver, British Columbia V5Z 1M9, Canada

⁵McMaster University—School of Nursing, Hamilton, Ontario, Canada

⁶University of Toronto—Gerstein Information Science, Toronto, Ontario, Canada

⁷University of Toronto—Gerstein Information Science Centre, Toronto, Ontario, Canada

⁸University Health Network—Toronto Rehabilitation Institute, Toronto, Ontario, Canada

⁹Department of Family Medicine, McGill University—Geriatric Medicine, Montréal, Canada

Address correspondence to: M. T. E. Puts. Tel: (+1) 416 978 6059; Fax: (+1) 416 978 8200. Email: martine.puts@utoronto.ca, martineputs@hotmail.com

Abstract

Background: frailty impacts older adults' ability to recover from an acute illness, injuries and other stresses. Currently, a systematic synthesis of available interventions to prevent or reduce frailty does not exist. Therefore, we conducted a scoping review of interventions and international policies designed to prevent or reduce the level of frailty in community-dwelling older adults.

Methods and analysis: we conducted a scoping review using the framework of Arksey and O'Malley. We systematically searched articles and grey literature to identify interventions and policies that aimed to prevent or reduce the level of frailty.

Results: fourteen studies were included: 12 randomised controlled trials and 2 cohort studies (mean number of participants 260 (range 51–610)), with most research conducted in USA and Japan. The study quality was moderate to good. The interventions included physical activity; physical activity combined with nutrition; physical activity plus nutrition plus memory training; home modifications; prehabilitation (physical therapy plus exercise plus home modifications) and comprehensive geriatric assessment (CGA). Our review showed that the interventions that significantly reduced the number of frailty markers present or the prevalence of frailty included the physical activity interventions (all types and combinations), and prehabilitation. The CGA studies had mixed findings.

Conclusion: nine of the 14 studies reported that the intervention reduced the level of frailty. The results need to be interpreted with caution, as only 14 studies using 6 different definitions of frailty were retained. Future research could combine interventions targeting more frailty markers including cognitive or psychosocial well-being.

Keywords: *scoping review, frail elderly, interventions, physical activity, nutrition, older people*

Introduction

With increasing age the risk of frailty increases. While there are several definitions of frailty, it is seen as a multidimensional concept with various indicators such as weight loss, lack of physical activity and lack of strength [1, 2]. A systematic review showed that the weighted prevalence of frailty in community-dwelling older adults was 10.7% (ranging between 4.0 and 59.1) [3].

Previous research has shown that frail older adults are more at risk for adverse health outcomes, such as falls, mobility decline, hospitalisation, institutionalisation and increased risk of death [4]. Research highlights that frailty is potentially reversible [5]. Therefore, it is important to identify frailty to prevent, reduce and postpone adverse health consequences for older adults and their caregivers. There have been many studies examining the prevalence of frailty and validity of several frailty models. However, there has not been a comprehensive review of interventions and/or policies that can prevent or reduce the level of frailty in community-dwelling older adults. Ideally, these interventions could be implemented by primary healthcare providers and/or older adults and/or their families/caregivers, and would focus on improving outcomes that are important to older adults [6]. A comprehensive review of interventions to prevent and reduce frailty is also important for healthcare professionals who will want to ensure that they are well equipped to assist community-dwelling older adults and their families/caregivers once frailty is identified.

Therefore, in this scoping review, our aim was to identify relevant peer-reviewed and grey literature on interventions and policies to prevent and/or delay frailty in community-dwelling older adults. Our research question was: Which interventions and policies focused on reducing frailty exist and to what extent are these interventions effective? We have chosen the scoping review methodology as it allows for inclusion of quantitative and qualitative studies, grey literature and includes a stakeholder consultation which we considered important for future intervention development and uptake.

Methods

The scoping review methodology protocol has been published [7] but we describe it briefly below.

Review methodology

We used the scoping review methodological framework as described by Arksey and O'Malley [8] with the modifications recommended [9, 10]. Our six-stage scoping review model included: (i) identifying the research question; (ii) identifying relevant studies; (iii) selecting studies; (iv) charting data; (v) summarising and reporting the results and (vi) consulting with stakeholders. We followed the reporting guidelines for PRISMA statement [11].

Search methods

Our inclusion criteria were: original publications of an intervention to prevent or to reduce the level of frailty in

community-dwelling older adults aged ≥ 65 years; and/or studies that included a wider age range were eligible if the mean/median age of the study population was aged 65 years and over and/or if they had included a subgroup analysis for the population aged >65 years. Included studies needed to provide a measure of frailty before and after the intervention. Grey literature that had information on the effect of the interventions or policies to prevent or reduce frailty were eligible.

We searched for publications dated between January 2000 and February 2016 using key words and Medical Subject Headings terms such as frail elderly or frailty AND interventions or evaluation study randomised trial AND Aged or 65 and over or senior. Searches (including grey literature) were performed with no language restrictions and carried out by three librarians on our team. See Appendix A for the Medline search strategy used.

We searched the Cochrane Central Register of Controlled Trials (CENTRAL), Cochrane Effective Practice and Organisation of Care Group (EPCC), MEDLINE, EMBASE, Cumulative Index to Nursing and Allied Health (CINAHL), Allied and Complementary Medicine (AMED), Psych INFO, Ageline, Sociological Abstracts, Web of Science, Applied Social Sciences Index and Abstracts (ASSIA), Database of Abstracts of Reviews of Effects (DARE), Health Technology Assessment (Canadian Search Interface) databases and reference lists of included studies. We searched trial registries for potential studies in progress.

Study selection

We included studies through a two-step process (see Figure 1 PRISMA flow chart). First, abstracts were screened by two independent reviewers. Then, all potentially relevant full articles were reviewed for study inclusion by two reviewers. The grey literature was searched by the librarians and reviewed by two reviewers.

Data abstraction

We used standardised data collection forms developed by the research team. Data were abstracted by two reviewers independently and compared. The information abstracted included: characteristics of the study population, study design details, frailty assessment used and levels of frailty of study participants, intervention details and outcomes, analyses used.

Quality assessment

We assessed the quality of the included studies using the Mixed Methods Appraisal Tool (MMAT) [12]. The MMAT is a quality assessment tool that is useful to assess qualitative, quantitative and mixed method studies. Incomplete reporting, preventing reproducibility and transparency in the methods, and factors that can lead to selection bias such as low response rates ($<60\%$), contamination in trials, measurement error, etc. can all lead to lower quality ratings. By using the MMAT it allowed us to use one quality assessment tool to review all studies. We used the MMAT to review study quality but we did not exclude any study based on the score.

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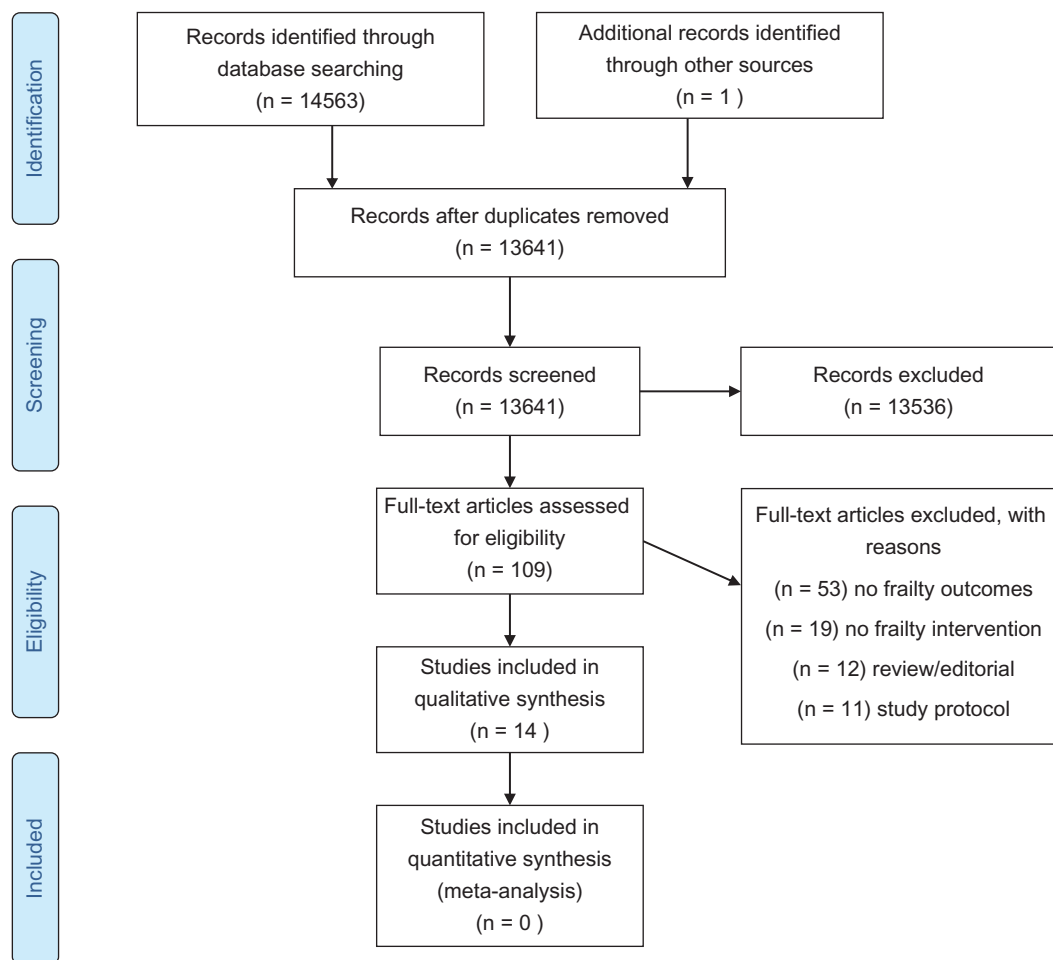


Figure 1. PRISMA FLOW CHART of the selection of included studies in the review.

Data analysis

We summarised the results using a narrative descriptive synthesising approach. There was heterogeneity in study inclusion criteria, interventions, frailty assessment tools and outcomes, thus a pooled analysis was not appropriate.

Consultation

We organised a stakeholder consultation (step 6 of the framework) on 19 May 2016 including older adults, family caregivers, representatives of provincial and national community organisations, senior organisations and primary care organisations to provide feedback on the findings and to develop next steps in research and practice. An older adult and caregiver reviewed the results for accuracy. We summarised their feedback and present it below.

Results

Characteristics of included studies

In this review, 14,563 abstracts were retrieved, and after deduplication 13,641 abstracts were reviewed by two independent reviewers. One hundred and nine articles were selected for full

text review and 14 studies were included in this review. Twelve studies were randomised controlled trials (RCTs) [13–23] and two studies were part of larger cohort studies [24, 25] (see Supplementary data, Tables A and B, available at *Age and Ageing* online). Seven studies were conducted in Asia [5, 17–19, 21, 24, 25], 3 in Europe [16, 20, 23], 3 in USA [13–15] and 1 in Australia [22]. Sample sizes varied from 51 to 610 with a mean of 260 participants and a total of 3,632 participants. The total and the mean number of participants for RCTs were 2,475 and 206. The study mean age ranged from 70 [5] to 86 years [23]. The percentage women in the study ranged from 48% [21] to 100% [18, 19].

Quality of the included studies

The quality assessment results are presented in Supplementary data, Table C, available at *Age and Ageing* online. The quality was moderate to good for most studies. The response rate was not reported for the two cohort studies [24, 25] and for the RCTs it varied between 39% [18] and 100% [20]. The randomisation, allocation concealment and the level of blinding were not always described [5, 14, 16, 20, 21]. For four studies it was not reported whether the analysis was intent-to-treat [14, 16, 18, 19]. Two studies had

a drop-out rate greater than 20% and thus selection bias may be present [14, 16].

Interventions studied

The interventions included physical activity compared to control (four studies) [13, 14, 16, 24]; physical activity combined with nutrition compared to control (four studies) [17–20]; physical activity plus nutrition plus memory training compared to control (one study) [5]; home modifications (one study); prehabilitation physical therapy (PT; plus exercise plus home modifications) (one study) [15] and geriatric assessment (three studies) [21–23] (Table 1 and Supplementary data, Table D, available at *Age and Ageing* online).

The physical activity interventions included group classes in all nine studies [5, 13, 14, 16–20, 24] with sessions ranging in frequency from once weekly [19] to 5 days per week [20]. Most included strength, balance, coordination, flexibility and aerobic exercises provided by exercise professionals, which were progressively increased based on the individuals' competency and performance. The studies that examined a nutritional arm included interventions ranging from milk fat supplementation [18], supplementation using multi-fibre formula enriched with iron, folate, vitamin B6, B12, D and calcium [5], education [19, 20] and cooking classes based on healthy nutrition focused on the strengthening of muscles through protein and vitamin D rich ingredients in addition to supplementation of vitamin D [19], and one study combined nutritional consultation with exercise [17].

The prehabilitation intervention included PT assessment, environmental assessment of the home and a progressive competency-based exercise programme. The study by Gustafsson *et al.* had three arms in total including two intervention arms, one group that received a single preventative home visit and one arm that attended 4 weekly educational meetings and a follow-up home visit. The study by Cameron *et al.* [22] evaluated a multifactorial intervention including a comprehensive geriatric assessment and case management. Li *et al.* [21] used a similar intervention to that of Cameron *et al.* The cognitive intervention in the study of Ng *et al.* [5] consisted of a 2-hour weekly training to stimulate short-term memory and improve attention and information processing skills, as well as reasoning and problem-solving capacity for a 12-week period followed by a booster session. The study by Ng *et al.* [5] included a combination of exercise, nutrition and cognitive interventions.

The control groups were given successful/healthy ageing interventions (booklets and/or classes) [13, 15, 17], home low-intensity exercise programme [14], usual care [5, 16, 19–23] or placebo supplements [18].

Effect of interventions on frailty

The frailty definitions used are listed in Table 1 and most studies used the Cardiovascular Health Study frailty phenotype (also known as Fried's phenotype) (10 studies) [5, 13, 16–23],

the Tinetti/Gill criteria (2 studies) [14, 15] or the Japanese Frailty checklist (2 studies) [24, 25].

The studies that compared exercise to control conditions showed a significant reduction in the total number of frailty markers [13], all individual frailty markers studied [14, 16] or reduction in prevalence of frailty [24] (see Table 2 and Supplementary data, Table E, available at *Age and Ageing* online). These findings were significant up to 12 months following the completion of the study. Exercise plus nutrition compared with control identified a significant reduction in the prevalence of frailty [17, 18, 20] and mean Edmonton Frailty Scale score [20]. Kwon *et al.* [19] showed a significant impact on improving grip strength immediately after intervention in the exercise arm compared to control only. Ng *et al.* showed a significant reduction in the prevalence of frailty ranging from 36% to 48% with the highest reduction in the combination intervention (exercise, nutrition and cognition) followed by exercise, cognitive function and nutrition at 12 months.

The studies using geriatric assessment had mixed findings and only Cameron *et al.* showed a significant reduction in the prevalence of frailty and the total number of frailty markers [22]. Mitoku showed non-significant results of home modifications on frailty prevalence [25].

Adherence and adverse events

While not all studies reported adherence rates, those that did report them ranged from 20% to 28% (for the different components of the intervention) [17] to 100% [14]. Tarazona *et al.* [20] reported that 77% of participants in the intervention group had 3–6 h. per week exercise and attendance of 50% was associated with an OR of reduction in frailty of 4.4 (95% confidence interval 1.2–16.0) and a number needed to treat of 3.2 (2.0–4.5).

The adverse event reports were very low for the total of 3,632 participants included in the 14 studies ranging from 0 adverse events [16], [22, 23], to 2 injuries each in the exercise arms of two studies [5, 14]. Two studies [13, 15] reported similar adverse events rates in intervention and control groups.

International policies on frailty

Diverse international policies have been developed aiming to prevent or improve frailty [26–28] (see Supplementary data, Table F, available at *Age and Ageing* online). The European Commission has recently created a key initiative that targets the prevention of functional decline and frailty (European Scaling-up Strategy in Active and Healthy Ageing) [29] that includes an action group focused on the prevention and early diagnoses of frailty and functional decline (both physical and cognitive) [27]. Other European initiatives are the SPRINTT Project (SPRINTT) [28], a large clinical trial with the overall goal of improving frailty care and prevention; and advocates for use of the SHARE-FI, an instrument developed to identify frailty in Primary Care settings [26].

Table I. Characteristics of included participants

First author and publication year	Country of study	% women	Frailty definition used in study	Inclusion criteria	Exclusion criteria	Sample size and mean age of participants
Binder 2002 [14]	USA	CG 53% IG 52%	Frailty based on 3 measures: (i) the PPT, (ii) activities of daily living and (iii) measurement of peak oxygen uptake	<ul style="list-style-type: none"> • ≥ 2 of 3 frailty criteria 	<ul style="list-style-type: none"> • Those who did not meet ≥ 2 frailty criteria • Those unable to exercise 	$N = 119$, mean age 83, SD 4
Cameron 2013 [22]	Australia	68%	The CHS criteria	<ul style="list-style-type: none"> • Aged 70 years and over • ≥ 3 CHS frailty criteria 	<ul style="list-style-type: none"> • Unable to participate in programme due to physical/cognitive health 	$N = 241$, mean age 83.3, SD 6
Cesari 2015 [13]	USA	68.9	The CHS criteria	<ul style="list-style-type: none"> • aged 70–85 years • < 10 on SPBB, • able to walk 400 min in 15 min 	<ul style="list-style-type: none"> • Severe/uncontrolled diabetes/HTN/cardiac issues 	$N = 424$, mean age 76.8, SD 4.2
Chan 2012 [17]	Taiwan	59%	CCSHA_CFS_TV and the CHS frailty criteria	<ul style="list-style-type: none"> • Community-dwelling older adults from 65 to 79 years of age in Toufen Township ($N = 6,828$). • CCHSA-CFS-TV score 3–6 (CHS pre-frail and frail) 	<ul style="list-style-type: none"> • Institutionalised • Not frail • Unable to participate in programme due to physical/cognitive health 	$N = 117$, mean age 71.4, SD 3.7
Gill 2003 [15]	USA	90%	Physically frail which as determined by two tests (rapid gait speed) and single chair stand.	<ul style="list-style-type: none"> • Physically frail community-dwelling people aged 75 years and over in Southern Connecticut 	<ul style="list-style-type: none"> • NH patients • enrolled in wellness programme • Unable to participate in programme due to physical/cognitive health 	$N = 188$, mean age 83, SD 5 years
Gine-Garriga 2010 [16]	Spain	61%	Physical frailty Gill and Tinetti definition or self-reported exhaustion	<ul style="list-style-type: none"> • Aged 80–90 • Registered in a primary healthcare centre in the Barcelona 	<ul style="list-style-type: none"> • Unable to participate in programme due to physical/cognitive health 	$N = 51$, mean age IG 84.1 (SD 3) and control 83.9 (SD 2.8)
Gustafsson 2012 [23]	Sweden	64%	Adjusted CHS criteria	<ul style="list-style-type: none"> • Community-dwelling • Not receiving care • Able to participate 	<ul style="list-style-type: none"> • Unable to participate in programme due to physical/cognitive health 	$N = 459$, mean age control was 86, preventative home visit mean age 86 and senior meetings mean 85
Kim 2015 [18]	Japan	100%	The CHS criteria	<ul style="list-style-type: none"> • Living in the Itabashi Ward of Tokyo, Japan • Women aged > 73 years 	<ul style="list-style-type: none"> • Unable to participate in programme due to physical/cognitive health 	$N = 131$, mean age 81, SD 3 years
Kwon 2015 [19]	Japan	100%	Lowest 20% handgrip strength and lowest quartile walking speed (2 of 5 CHS criteria)	<ul style="list-style-type: none"> • Living in the Itabashi Ward, Tokyo, Japan • Pre-frail women aged ≥ 70 years 	<ul style="list-style-type: none"> • Unable to participate in programme due to physical/cognitive health • Serum albumin > 4.5 mg/dl and/or taking CA/ Vitamin D supplements 	$N = 89$, mean age 76.8 range (70–84)
Li 2010 [21]	Taiwan	48%	The CHS criteria and BI	<ul style="list-style-type: none"> • Living in 2 neighbourhoods in Taipei • Aged ≥ 65 years • Frail or pre-frail 	<ul style="list-style-type: none"> • Unable to participate in programme due to physical/cognitive health 	$N = 310$, mean age IG is 78.4, SD 8.2 and the CG is 79.3 SD 8.5
Ng 2015 [5]	Singapore	61%	The CHS frailty criteria	<ul style="list-style-type: none"> • Pre-frail or frail community-dwelling older adults aged ≥ 65 years • Able to ambulate without personal assistance 	<ul style="list-style-type: none"> • Unable to participate in programme due to physical/cognitive health 	$N = 246$, mean age 70.0, SD 4.7
Tarazona-Santabalbina 2016 [20]	Spain	54%	The CHS and Edmonton Frailty Scale	<ul style="list-style-type: none"> • Frail older adult aged ≥ 70 years 	<ul style="list-style-type: none"> • Unable to participate in programme due to physical/cognitive health • Family member centenarian in past 2 generations • No transportation 	$N = 100$, mean age IG 79.7 (SD 3.6) and control 80.3 (SD 3.7)

Continued

Table 1. Continued

First author and publication year	Country of study	% women	Frailty definition used in study	Inclusion criteria	Exclusion criteria	Sample size and mean age of participants
Mitoku 2014 [25]	Japan	65%	Frailty = a change in of care level	<ul style="list-style-type: none"> • Aged ≥65 years • New recipient of the LTCI programme in Gujo City between 1 April 2003 and 31 December 2004 	<ul style="list-style-type: none"> • Current care recipients 	N = 547, mean age 81.4, SD 7.1
Yamada 2012 [24]	Japan	77%	Frailty score >10 on the frailty checklist items 1–20	<ul style="list-style-type: none"> • ADL independent • Frail person living in 2 geographical areas (Maibura City and Maizuru City, Japan) 	<ul style="list-style-type: none"> • ADL dependent • eligible for LTCI benefits 	N = 610, mean age exercise group 79.7, SD 6.3 and mean age CG 80.3, SD 6.6

PPT, Physical Performance Test; ADL, activity of daily living; SD, standard deviation; CG, control group; IG, intervention group; HTN, hypertension; CCSHA_CFS_TV, Chinese Canadian Study of Health and Aging Clinical Frailty Scale Telephone Version; CHS, Cardiovascular Health Study consisting of 5 frailty markers; SPBB, short physical performance battery; NH, nursing home; LTCI, long-term care insurance; BI, Barthel index.

Stakeholder consultation

Thirty-three stakeholders including persons living with frailty, their caregivers and administrators of healthcare organisations attended our consultation meeting in person or by webinar. A concern expressed by many attenders was that interventions studied so far were focused exclusively on physical function. Stakeholders commented that a broader definition of frailty including cognitive, social and psychological areas was required and so too are then the interventions to modify it. Stakeholders felt the assessment of frailty in these intervention studies would benefit from the inclusion of a more subjective method, such as the perspective of the caregiver. Caregivers spoke of the need to focus on the process of assisting frail elders to actually follow through on physical regimes as prescribed in these studies and the over-reliance on caregivers to assist with delivering the intervention; they felt this potential burden should be considered carefully. Finally, stakeholders spoke about the stigma regarding frailty and suggested it should be addressed as very few people want to be labelled as ‘frail’, which makes inviting them into possible programmes to prevent frailty even more difficult.

Discussion

Our scoping review highlighted that, up until now, only 9 of the 14 studies were effective in preventing or reducing the frailty using the level of frailty as the intervention target. The effective interventions included exercise, nutrition, cognitive training, geriatric assessment and management and prehabilitation. Our review also revealed that most of these interventions were feasible with adherence rates around 70% for most studies. The exercise interventions ranged in duration, frequency, and type of exercises, but all were effective in reducing the level of frailty in pre-frail or frail individuals. The samples were representative of the average community-dwelling older adult: mean ages were in the seventies and eighties, and half to all participants were women.

Recommendations for future research

Future studies should examine interventions to prevent frailty in non-frail patients as all included studies were focused on reducing frailty among pre-frail or frail participants and this is also the trend for the studies in progress (Supplementary Data Table G, available at Age and Ageing online). Furthermore, interventions were focused on only 1–2 frailty markers and seldom on cognitive and psychological well-being. Cameron *et al.*, [22] showed significant findings despite an intervention adherence rate of only 26–50%, by addressing all identified issues including psychosocial health. Ng *et al.*, [5] showed greater benefits in the groups who received all three intervention components including the cognitive memory training. It is highly likely that individuals with less optimal psychosocial well-being are not participating in

Table 2. Measures of frailty and outcomes of study

First author and publication year	Frailty definition used in study	Level of frailty of participants pre-intervention	Impact of intervention on frailty outcome
Binder 2002 [14]	Frailty based on 3 measures: (i) the PPT, (ii) activities of daily living and (iii) measurement of peak oxygen uptake	100% were frail	The IG compared to CG has significantly greater improvements in the modified PPT, significant improvement in VO ₂ max, no change in ADL function
Cameron 2013 [22]	The CHS criteria: presence of 5 FM: ≥3 is considered frail; 1–2 pre-frail and 0 = robust.	At baseline all were frail. In the IG 64% had 3, 28% had 4 and 8% had 5 FM. In the CG 65% had 3, 25% had 4 and 10% had 5 FM	Significant reduction in the prevalence of frailty and the number of FM in the IG $P < 0.05$ at 12 months
Cesari 2015 [13]	The CHS criteria	Mean number of FM at baseline is 1.67 (SD 1.1)	At 12 months the CG group had a prevalence of frailty of 19.1% and the IG group 10.0 % ($P < 0.05$). The mean number of FM in the CG group decreased 0.21 and in the IG group 0.48 at 12 months ($P < 0.05$)
Chan 2012 [17]	CCSHA_CFS_TV and the CHS frailty criteria	At baseline 40% was category 3 (well), 47% category 4 (vulnerable), 11% mildly frail (5) and 2% moderately frail (6). With CHS-PCF 87% were pre-frail and 13% frail at baseline	At 3 months significant difference between EN and non-EN group in the reduction in the number of frail persons
Gill 2003 [15]	Physically frail which as determined by 2 tests (rapid gait speed and single chair stand)	In the IG 64% had moderate frailty and in the CG 60%. The others were severely frail	At 7 and 12 months statistically significant differences between IG and CG (decline in the FM in CG)
Gine-Garriga 2010 [16]	Physical frailty which as determined by 2 tests (rapid gait speed and single chair stand) or self-reported exhaustion	All participants were frail. At baseline in the IG 59% were classified as frail using the CES-D compared to 63–74% in the CG. At baseline the mean gait speed time needed for the IG was 11.73 (SD 0.6), and for the CG 11.87 (SD 0.65). Mean BI at baseline for IG was 73.4 (SD 2.35) and CG 70.8 (SD 2.35) BI scale ranges (0–90). The mean chair stand test at baseline was 19.55 (SD 0.7) for the IG and 17.05 (SD 0.9) for CG	The IG had greater improvements in all physical frailty tests and those results were maintained at week 36 and significant
Gustafsson 2012 [23, 30]	Adjusted CHS criteria	At baseline 70% in the CG was pre-frail (1–2 FM), and 19% frail (>2 FM) and this was 67% and 20% in preventative home visits group and 70% and 16% in senior meetings group	The findings showed a non-significant intervention effect
Kim 2015 [18]	The CHS criteria	At baseline the Ex+ MFGm group 33% had 3, 49% had 4 and 18% had 5 FM, the Ex+ placebo 54% had 3, 30% had 4 and 15% had 5 FM. the MFGM group at baseline 44% had 3, 41% had 4 and 15% had 5. The placebo 51% had 3, 46% had 4 and 3% had 5 FM	The percentage non-frail participants at post-intervention was significantly higher in the Ex+ MFGM group (58%) than in the MFGM group (28%) or placebo (30%) ($P < 0.05$). At 7 month follow-up it was also significantly greater in the Ex+MFGM group (46%), and Ex+placebo (39%) compared to placebo (15%)
Kwon 2015 [19]	Lowest 20% handgrip strength and lowest quartile walking speed	100% were pre-frail	The exercise group compared to the CG had a significant improvement in handgrip strength after the intervention but the effects were reduced at 6 months (NS). No change in walking speed
Li 2010 [21]	CHS frailty criteria and BI	At baseline 17% in the IG and 19.6% in the CG were frail. 83% is pre-frail in the IG and 80.4% in the CG group	The findings showed a non-significant intervention effect
Ng 2015 [5]	The CHS frailty criteria	Mean number of FM in each group at baseline Nutrition (2.1), Cognitive (2.0), physical (2.2), combined (2.1) control (1.8)	Significant reduction in the number of FM across all 4 groups ($P < 0.05$). Significant reduction in prevalence of frailty in all IGs compared to control ($P < 0.05$)

Continued

Table 2. Continued

First author and publication year	Frailty definition used in study	Level of frailty of participants pre-intervention	Impact of intervention on frailty outcome
Tarazona-Santabalbina 2016 [20]	The CHS and Edmonton Frailty Scale	Mean baseline number of frailty criteria in the IG (SD 0.8) compared to CG 3.8 (SD 0.6). The mean Edmonton frail score was 8.6 (SD 2.4) for the IG and 8.5 (SD 1.9) for the CG	The frailty score significantly improved in the IG ($P < 0.001$), 31.4% had a reversal of frailty and none in the CG. Similarly, the Edmonton Frail scale also significantly improved (mean frailty score after IG 7.7 and 9.3 for CG) The results were NS
Mitoku 2014 [25]	Frailty = a change in of care level	Unclear	The total score for exercise group after intervention was 7.1 SD 4.0 and control 8.0 SD 4.8 $P < 0.001$.
Yamada 2012 [24]	Frailty score > 10 on the frailty checklist	CG frailty checklist pre score 7.3 and IG 7.4	During the year, 8% of intervention and 18% in the CG were newly certified for LTCI (considered frail) $P < 0.05$

VO₂ max, maximum volume of oxygen consumption; FM, frailty marker; CSHA_CFS-TV, Chinese Canadian Study of Health and Aging Clinical Frailty Scale Telephone Version; CHS_PCF, cardiovascular health Study Phenotypic Classification of Frailty; EN, Exercise and Nutrition; CES-D, Center for Epidemiological Studies Depression scale; EX+MFGM, exercise and milk fat globule membrane; Ex, Exercise; NS, not significant; P, P-value; HR, hazard ratio.

exercise and nutrition studies if their psychosocial well-being is not addressed. Furthermore, more intervention studies focusing on older adults should include frailty as an outcome and measure it pre- and post-intervention so that the evidence base for preventing and managing frailty grows.

The quality of the reporting of the study details should be enhanced by including randomisation and allocation concealment, response rates, details of statistical analyses and trial registration number, as well as number and type of chronic conditions/comorbidities as this was not clear for all included studies. To enhance the generalisability of the findings, intervention studies should include older adults with cognitive impairment as several studies had quite 'high' levels of cognitive function as cut-off criteria for enrolment in the study. With the ageing of the population and the desire to age in place, it is important that more studies include a cognitive intervention arm as this was only included in one of the studies we identified in the existing literature. Lastly, caregivers should be included in future studies; none of these studies involved caregivers, though they are clearly key partners in interventions and may also themselves benefit from the interventions given the impact of prolonged caregiving on their own health and well-being. Ensuring that caregivers are not overburdened is key to the success of this strategy as noted by our stakeholder group.

The strengths of this scoping review included a comprehensive systematic search of electronic databases and grey literature carried out by librarians. However, the results need to be interpreted with caution. Due to our inclusion criterion that studies needed to have a frailty outcome measure, we have excluded studies that have been focused on frail persons, but did not measure frailty as an intervention outcome; of the over 13,000 abstracts we only identified 14 studies that met the inclusion criteria. Furthermore, the studies were based on six different definitions of frailty, some of which included disability in activities of daily living. As well, the study populations were heterogeneous in their level of baseline frailty.

While the reduction in frailty was statistically significant in nine studies (even though the reductions were small in some studies), currently there is no indication what a clinically meaningful change in frailty is. Several studies showed no impact on activity of daily living (ADL) function or fall rates. In some studies statistical significance was obtained because the intervention group remained stable while the control group deteriorated. Thus, new interventions need to be developed to identify interventions with a larger impact on clinically important outcomes which is in line with the recommendations recently published in the White Book on frailty [6] and as suggested by Fairhall *et al.* [30], such as measures of participation in life roles. Although these measures are relatively unused in research focused on frailty, they align with the description of 'social and cognitive frailty' and our stakeholder feedback to use a broader definition of frailty and to include psychosocial well-being. For future studies it will be important to have larger

samples in RCTs and to have sufficient power for subgroup analyses to determine what intervention works best for what level of frailty. We also could not perform a meta-analysis as the interventions were so different in terms of treatment duration, frequency and different combinations of interventions. Further studies should consider utilising the frailty components rather than set definitions. Finally, even though the scoping review allowed for qualitative studies, none were identified, which provides another potential area for future enquiry. In conclusion, most interventions were feasible, safe and reduced the level of frailty in older community-dwelling pre-frail and frail individuals, but more studies are needed to confirm these findings.

Key points

- This scoping review focused on interventions targeting the level of frailty showed that there were 14 studies of which 9 were shown to significantly reduce the level of frailty in community-dwelling older adults.
- More research is needed as the few conducted studies so far have had heterogeneous study populations and future studies should include larger samples and more older adults with cognitive impairment.
- No study involved caregivers of frail older adults who may facilitate participation in the intervention study and may benefit from the intervention themselves.

Supplementary data

Supplementary data are available at *Age and Ageing* online.

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Conflicts of interest

None declared.

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References

1. Dent E, Kowal P, Hoogendijk EO. Frailty measurement in research and clinical practice: a review. *Eur J Intern Med* 2016; 31: 3–10.
2. Turner G, Clegg A. Best practice guidelines for the management of frailty: a British Geriatrics Society, Age UK and Royal College of General Practitioners report. *Age Ageing* 2014; 43: 744–7.
3. Collard RM, Boter H, Schoevers RA, Oude Voshaar RC. Prevalence of frailty in community-dwelling older persons: a systematic review. *J Am Geriatr Soc* 2012; 60: 1487–92.
4. Fried LP, Tangen CM, Walston J *et al*. Frailty in older adults: evidence for a phenotype. *J Gerontol A Biol Sci Med Sci* 2001; 56: M146–56.
5. Ng TP, Feng L, Nyunt MS *et al*. Nutritional, physical, cognitive, and combination interventions and frailty reversal among older adults: a randomized controlled trial. *Am J Med* 2015; 128: 1225–36.
6. Vellas B. The White Book on Frailty. IAGG 2016 Available at: URL: <http://www.garn-network.org/documents/WHITEBOOKONFRAILTY-USVERSION.pdf>
7. Puts MT, Toubasi S, Atkinson E *et al*. Interventions to prevent or reduce the level of frailty in community-dwelling older adults: a protocol for a scoping review of the literature and international policies. *BMJ Open* 2016; 6: e010959.
8. Arksey H, O'Malley J. Scoping reviews: towards a methodological framework. *Int J Soc Res Methodol* 2005; 8: 19–32.
9. Colquhoun HL, Levac D, O'Brien KK *et al*. Scoping reviews: time for clarity in definition, methods, and reporting. *J Clin Epidemiol* 2014; 67: 1291–4.
10. Daudt HM, van MC, Scott SJ. Enhancing the scoping study methodology: a large, inter-professional team's experience with Arksey and O'Malley's framework. *BMC Med Res Methodol* 2013; 13: 48.
11. Moher D, Liberati A, Tetzlaff J, Altman DG. Preferred reporting items for systematic reviews and meta-analyses: the PRISMA statement. *J Clin Epidemiol* 2009; 62: 1006–12.
12. Souto RQ, Khanassov V, Hong QN, Bush PL, Vedel I, Pluye P. Systematic mixed studies reviews: updating results on the reliability and efficiency of the mixed methods appraisal tool. *Int J Nurs Stud* 2015; 52: 500–1.
13. Cesari M, Vellas B, Hsu FC *et al*. A physical activity intervention to treat the frailty syndrome in older persons—results from the LIFE-P study. *J Gerontol A Biol Sci Med Sci* 2015; 70: 216–22.
14. Binder EF, Schechtman KB, Ehsani AA *et al*. Effects of exercise training on frailty in community-dwelling older adults: results of a randomized, controlled trial. *J Am Geriatr Soc* 2002; 50: 1921–28.
15. Gill TM, Baker DI, Gottschalk M *et al*. A prehabilitation program for physically frail community-living older persons. *Arch Phys Med Rehabil* 2003; 84: 394–404.
16. Gine-Garriga M, Guerra M, Pages E, Manini TM, Jimenez R, Unnithan VB. The effect of functional circuit training on physical frailty in frail older adults: a randomized controlled trial. *J Aging Phys Act* 2010; 18: 401–24.
17. Chan DC, Tsou HH, Yang RS *et al*. A pilot randomized controlled trial to improve geriatric frailty. *BMC Geriatr* 2012; 12: 58.
18. Kim H, Suzuki T, Kim M *et al*. Effects of exercise and milk fat globule membrane (MFGM) supplementation on body

- composition, physical function, and hematological parameters in community-dwelling frail Japanese women: a randomized double blind, placebo-controlled, follow-up trial. *PLoS One* 2015; 10: e0116256.
19. Kwon J, Yoshida Y, Yoshida H, Kim H, Suzuki T, Lee Y. Effects of a combined physical training and nutrition intervention on physical performance and health-related quality of life in prefrail older women living in the community: a randomized controlled trial. *J Am Med Dir Assoc* 2015; 16: 263–8.
 20. Tarazona-Santabalbina FJ, Gomez-Cabrera MC, Perez-Ros P *et al.* A multicomponent exercise intervention that reverses frailty and improves cognition, emotion, and social networking in the community-dwelling frail elderly: a randomized clinical trial. *J Am Med Dir Assoc* 2016; 17: 426–33.
 21. Li CM, Chen CY, Li CY, Wang WD, Wu SC. The effectiveness of a comprehensive geriatric assessment intervention program for frailty in community-dwelling older people: a randomized, controlled trial. *Arch Gerontol Geriatr* 2010; 50 (Suppl. 1):S39–42.
 22. Cameron ID, Fairhall N, Langron C *et al.* A multifactorial interdisciplinary intervention reduces frailty in older people: randomized trial. *BMC Med* 2013; 11: 65.
 23. Gustafsson S, Wilhelmson K, Eklund K *et al.* Health-promoting interventions for persons aged 80 and older are successful in the short term—results from the randomized and three-armed elderly persons in the risk zone study. *J Am Geriatr Soc* 2012; 60: 447–54.
 24. Yamada M, Arai H, Sonoda T, Aoyama T. Community-based exercise program is cost-effective by preventing care and disability in Japanese frail older adults. *J Am Med Dir Assoc* 2012; 13: 507–11.
 25. Mitoku K, Shimanouchi S. Home modification and prevention of frailty progression in older adults: a Japanese prospective cohort study. *J Gerontol Nurs* 2014; 40: 40–7.
 26. Lessende MI, Iturbe GA, Cortes BJJ. The frail elderly. Detection and management in primary care (El anciano frágil. Detección y tratamiento en AP). *Aten Primaria* 2010; 42: 388–98.
 27. European Innovation Partnership in active and healthy ageing. Prevention and early diagnoses of frailty and functional decline, both physical and cognitive, in older people. A compilation of good practices, 1st edition. Bruxelles Belgium: European Commission. http://ec.europa.eu/research/innovation-union/pdf/active-healthy-ageing/gp_a3.pdf.
 28. Marzetti E, Calvani R, Landi F *et al.* Innovative medicines initiative: the SPRINTT project. *J Frailty Aging* 2015; 4: 207–8.
 29. European Commission. European scaling-up strategy in active and healthy ageing innovation. A Europe 2020 Initiative. Bruxelles Belgium: European Commission. http://ec.europa.eu/research/innovation-union/index_en.cfm?section=active-healthy-ageing&pg=documents.
 30. Behm L, Eklund K, Wilhelmson K *et al.* Health promotion can postpone frailty: results from the rct elderly persons in the risk zone. *Public Health Nurs* 2016; 33: 303–15.

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