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Physical therapy treatment on frailty syndrome: systematic review

Atuação da fisioterapia na síndrome de fragilidade: revisão sistemática

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Abstract

Objective: To carry out a systematic review of the literature on physical therapy interventions and their effect on frail community-dwelling elders. **Methods:** Systematic review of studies published until June 2008 in the databases Medline, Embase, PEDro, SciELO, LILACS and Cochrane Library. We excluded studies with samples composed of institutionalized, hospitalized and non-frail participants, studies not aimed at treating frailty, and studies that were not specifically related to physical therapy. **Results:** In accordance with the exclusion criteria, out of the 152 Medline articles, only 15 were considered for analysis, out of the 71 PEDro articles only one was considered as the other ten had already been selected in Medline, and out of the 461 Embase articles only two that had not been selected in others databases were included in this study. A total of seven different types of interventions were verified: 1) muscle strengthening; 2) exercises for muscle strengthening, balance, coordination, flexibility, reaction time and aerobic training; 3) functional training; 4) physical therapy; 5) at-home physical therapy; 6) environment adaptation and prescription of assistive device; 7) water exercise. The results of some studies were contradictory even with similar interventions. The analyzed studies had different definitions for fragility, which made it difficult to compare the results. **Conclusion:** There is little evidence of the effect of physical therapy intervention on frail community-dwelling elders; thus, it is not possible to reach a consensus or conclusion on the effectiveness of the therapeutic regimens proposed for this complex syndrome.

Key words: elderly; frail; physical therapy; rehabilitation.

Resumo

Objetivo: Revisar sistematicamente a literatura sobre intervenções fisioterapêuticas e seus efeitos em idosos frágeis da comunidade. **Métodos:** Revisão sistemática de estudos publicados até junho de 2008 nas bases de dados Medline, Embase, PEDro, SciELO, LILACS e Biblioteca Cochrane. Foram excluídos os artigos cuja amostra era constituída de idosos não frágeis, institucionalizados e hospitalizados; aqueles cujas intervenções propostas não foram a fragilidade e não eram específicos de fisioterapia. **Resultados:** De acordo com os critérios de exclusão, dos 152 artigos encontrados no Medline, apenas 15 foram incluídos para análise; dos 71 artigos encontrados na base de dados PEDro, apenas um, uma vez que os outros 10 artigos encontrados já haviam sido selecionados pelo MEDLINE, e dos 461 artigos encontrados na base de dados Embase, apenas dois que não haviam sido selecionados nas outras bases de dados foram incluídos neste estudo. Foi verificado um total de sete diferentes tipos de intervenções: 1) fortalecimento muscular; 2) exercícios de fortalecimento muscular, equilíbrio, coordenação, flexibilidade, tempo de reação e treinamento aeróbico; 3) treino funcional; 4) fisioterapia; 5) fisioterapia realizada no domicílio; 6) adaptação ambiental e prescrição de dispositivo e 7) exercício na água. Os resultados de alguns estudos foram contraditórios mesmo com intervenções semelhantes. Os estudos analisados utilizaram formas distintas para definir fragilidade, o que dificultou as comparações dos resultados. **Conclusão**: Existem poucas evidências dos efeitos da intervenção fisioterapêutica em idosos frágeis comunitários, dificultando estabelecer consenso ou conclusões sobre a eficácia das propostas terapêuticas nessa complexa síndrome.

Palavras-chave: idoso; fragilidade; fisioterapia; reabilitação.

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Introduction

Studies on the frail elderly population are still scarce worldwide and in Brazil. However, the increase in frail elders, associated with their social and economic impact, has generated increased interest in the topic and the need to better investigate this population[1]. A major difficulty in studying this population is the definition of frailty. Although there is no consensus on the definition of frailty, it is widely accepted as a multifactorial, clinical syndrome characterized by a state of physiological vulnerability resulting from a decrease in energy reserves and the ability to maintain or restore homeostasis after a destabilizing event[2,3]. Frailty syndrome is complex and involves declines in many physiological domains, including strength and muscle mass, flexibility, balance, coordination and cardiovascular function[4,5], which generate high risk of falls, functional decline, hospitalization and death[6]. Frailty leads to the deterioration of quality of life, caregiver overload and high health care expenses[7]. Thus, non-pharmacological interventions that can prevent or delay the progression of frailty are necessary[3,8,9].

Exercise programs are pointed out as the best type of intervention to improve physical function[3]. However, despite the evidence demonstrating the beneficial effects of exercise in the elderly, there is still a limited number of studies on the effects of exercise programs on frail elders. The aim of this study was to carry out a systematic review of the literature on the effects of physical therapy interventions on frail community-dwelling elders.

Methods

Using the descriptors frail or frailty, older adults or elderly, rehabilitation or intervention, physical therapy or exercise therapy and the equivalents in Portuguese and Spanish, we found articles which had those key words on the title or abstract and were published until June 2008 in the electronic databases MEDLINE, Embase, PEDro, SciELO, LILACS and Cochrane Library, in English, Portuguese and Spanish. We also carried out a manual search in the dissertation and thesis libraries at Universidade Federal de Minas Gerais, Universidade de São Paulo, Universidade Federal do Rio de Janeiro, Universidade Federal do Rio Grande do Sul, Universidade de Campinas and Universidade Federal de São Carlos, which are the main centers for research in this area and allow this search. Additionally, we consulted experts in the field to investigate the possibility of other references that were not part of the databases consulted.

The inclusion criterion was that the study should be a clinical trial, controlled clinical trial or randomized clinical trial. Studies were excluded if the sample was composed not only of frail elders, the goal of intervention was not frailty, the intervention was not specifically a physical therapy intervention or if there were multiple interventions. Studies that presented only preliminary data or were conducted with institutionalized or hospitalized elders were also excluded. The articles were chosen by two independent reviewers, according to the inclusion criteria, the title and the abstract. In case of disagreement, the reviewers read the full article, discussed it, and passed it on to a third reviewer.

The methodology of the selected studies was evaluated by the PEDro scale[10,11], which is widely used in the field of rehabilitation. The scale has a total score of 10 points[10,11] and evaluates the methodological quality of experimental studies. Scores ≥5 are considered of high quality[12]. The studies were classified by two reviewers independently. The Kappa Index was used to evaluate the level of agreement between reviewers in relation to the PEDro scores. For the final quality classification, the discrepant items were reviewed and discussed until consensus on the score was reached[11].

Results

In the search performed in June 2008, 152 studies were found in the MEDLINE database, only 15 of which met all the inclusion criteria; 71 were found in the PEDro, 11 of which were selected. Of these 11 articles, 10 had already been selected in MEDLINE. In Embase database, 461 articles were found, and only two articles from this database had not been selected in other database searches and met the inclusion criteria. No other articles were found in the remaining databases. The characteristics of the selected articles in terms of intervention, outcomes and results are presented in Table 1. There was great variability in the type of intervention used and the outcomes analyzed, with a total of seven different types of intervention. Moreover, the criteria used to define the frail elders varied considerably from study to study (Table 2).

Most of the articles (56%) had scores ≥5 on the PEDro scale (EP), and thus were considered of high quality[12] (Table 2). Regarding this classification, the evaluators showed good agreement (Kappa = 0.829, $p<0.001$).

Muscle strengthening

Five studies evaluated the effects of strength training in frailty elders[1,5,13-15]. Two found no significant differences both for

Table 1. Characteristics of the selected articles.

Author/Year	Participants	Outcomes	Intervention	Effects (based on enumeration of outcomes)
Ota et al.[1]	n=46 (77±years)	1) Isometric hand and lower limb strength 2) Functional mobility (TUG, 10-meter gait) 3) Balance (functional range and one-foot balance time)	Duration: 12 weeks, 2x/week IG: Power Rehabilitation (equipment adapted for elders, training on machine with mild resistance) CG: instructed to maintain habitual lifestyle	1) There was no significant difference between groups with regard to change in muscle strength. 2) There was a significant difference between groups with regard to change in TUG (p=0.033) and gait (p=0.007). 3) There was a significant difference only for functional range (p=0.036)
Binder et al.[4]	n=115 (IG: 83±4.0 years; CG: 83±4 years) IC: age > 78 years	1) Functional mobility (Modified PPT) 2) Muscle strength (isokinetics, extension and flexion of the knee) 3) Flexibility 4) Balance (Functional range, one-foot balance and Berg) 5) Functional capacity (Questionnaires on ADLs) 6) Quality of life (SF-36) 7) Depression (Geriatric depression scale) 8) Aerobic capacity (VO_2 peak)	Duration: 3-phase program with 36 sessions performed 3x/week each. IG: Phase 1: Exercises for flexibility, balance, coordination and reaction time; Phase 2: Strength training (65% of RM, progressing to 85 to 100% of RM); Phase 3: Resistance training (20 minutes on treadmill or stationary bike). CG: At-home program with 9 flexibility exercises.	1) IG: Significant improvement over CG (p=0.02). 2) IG: Significant increase in strength of flexors (p=0.02) and extensors (p=0.004) in comparison to CG. 3) IG and CG: NS effect 4) Significant improvement in IG on Berg (p=0.06) and one-foot balance (p=0.05) over CG (p=0.02). (Considered significant p-values less than 0.1). 5) IG and CG: NS effect 6) Improvement in SF-36 (p=0.01) 7) IG and CG: NS effect 8) Significant improvement over CG (p=0.001).
Latham et al.[5]	n=243 (79.1±6.9 years) IC: age > 65 years	1) Occurrence of falls 2) Fear of falls (modified self-efficacy scale) 3) Self-reported health (SF-36 component) 4) Functional mobility (TUG, time elapsed to walk 4 m) 5) Balance (Berg scale) 6) Muscle strength (extensors of the knee - manual dynamometer)	Duration: 10 weeks, 3x/week IG: Resistance exercises for quadriceps with ankle weights (60-80% of 1RM), 3 x 8 repetitions. Stretching. Supervision by physical therapist for weekly monitoring of progress, alternating visits and telephone calls. CG: received telephone calls and visits from physical therapist (general orientation)	IG and CG: There was no significant change in any outcome assessed. Note: IG had a greater significant risk of musculoskeletal injury than CG.
Gill et al.[7]	n=188 (IG: 82.8±5.0 years; CG: 83.5±5.2 years) IC: age > 75 years	1) Functional capacity (Questionnaire on 8 ADLs) 2) Institutionalization	Duration: 16 visits from physical therapist in 6 months IG: exercises based on skill, risks removed from environment and training with assistance device when necessary CG: education protocol and monthly visits (care effect)	1) Reduction in disability score (p=0.008 at 7 months and p=0.02 at 12 months) 2) Lower number of institutionalizations in IG (NS)
Sullivan et al.[13]	n=71 (78.2±6.4 years) IC: age ≥ 65 years	1) Body composition (fat-free muscle area and lean body mass: CT and plethysmography) 2) Functional mobility (sit-to-stand test, normal and maximum gait speed test, climbing stairs) 3) Muscle strength (1RM)	Duration: 12 weeks, 3x/week IG: Muscle strengthening with progressive resistance. Flexors and extensors of the hip and knee with leg press and wrist and shoulder muscles with chest press device. Progression until 80% of 1RM. CG: resistance training with mild load (10% to 20% of initial 1 RM)	1) There was no significant effect of exercise in the cross-section, but the use of testosterone led to a significant increase over the placebo group (p=0.005). 2) IG and CG: NS effect 3) Significant improvement in muscle strength in both groups (p<0.001), but improvement in the IG was significantly higher than in the CG.

Table 1. Continued.

Author/Year	Participants	Outcomes	Intervention	Effects (based on enumeration of outcomes)
Chandler et al.[14]	n=100 (77.6 years) IC: age > 64 years; MMSE score ≥ 18.	1) Muscle strength (Cybex) 2) Balance (functional range and spontaneous balance) 3) Gait (6-minute test and 10-meter gait speed) 4) Mobility (Mobility Skills Protocol and Stand up from chair) 5) Self-Efficacy (FES) 6) Disability (MOS-36)	Duration: 10 weeks, 3x/week IG: Exercises supervised by a physical therapist at home. Resistance exercises for lower limbs, with thera-band and own weight as resistance (extension and abduction of hip, flexion and extension of knee, dorsiflexion, lifting heels, stand up from chair and climb stairs). 2 x 10 repetitions. CG: instructed not to perform physical exercise	1) Strength gain significantly greater in IG than CG (p ranged between 0.001 and 0.06 for different muscle groups) 2) Strength gain was not related to change in balance. 3, 4 and 5) Strength gain was associated to change in gait speed (β=0.8; p=0.02), mobility (β=1.35; p=0.00009) and self-efficacy (β=10.1; p=0.05). 6) Strength gain was not related to change in disability.
LaStayo et al.[15]	n=11 (80.2 years). IC: high risk for falling	1) Quadriceps cross-sectional area (biopsy) and strength (isometric –manual dynamometer) 2) Balance (Berg scale) 3) Stair descent ability (time) 4) Risk for falling (TUG)	Duration: 11 weeks, 3x/ week. IG: eccentric strength training for lower extremities with a custom-made eccentric cycle ergometer CG: traditional resistance training	1) Significant improvement in cross-sectional area in both groups and in strength just in the IG 2) Significant improvement in the IG 3) Significant improvement in the IG 4) Significant improvement in the IG and CG, but IG improved more
Ehsani et al.[16]	n=46 (IG: 83±3.6 years; CG: 84±4.2 years)	1) Resting heart rate and blood pressure 2) Peak oxygen uptake (VO_2 peak) – Treadmill 3) Cardiovascular adaptations during test (cardiac output, heart rate, blood pressure, left ventricular stroke work) 4) Body composition: lean body mass and weight	Duration: 9 months, 3x/week. Each phase lasted 3 months. IG: 1st phase: physical therapy; 2nd: physical therapy + strength training; 3rd: conditioning exercise program (treadmill, stationary bike and rowing, depending on tolerance of each participant) CG: at-home exercise (stretching, relaxation, yoga) and supervised exercise once a month.	1) Resting heart rate and blood pressure did not change in IG and CG (NS). 2) VO_2 peak increased significantly in the intervention group and did not change in the control group (p<0.0001). 3) Cardiac output increased significantly in IG (p=0.027). Left ventricular stroke work, heart rate and systolic pressure increased significantly in IG (p=0.037, p=0.009 and p=0.003) 4) IG and CG: NS effect
Worm et al.[17]	n=46 (IG: 80.5±4.9 and CG: 81.9 ± 3.6 years) IC: age > 74 years	1) Physical Function (Berg and self-reported functional ability SF-36) 2) Walking test (10 meters) 3) Muscle strength (maximal voluntary contraction of the shoulder abductors through Isobex) 4) Aerobic capacity (VO2 maximal)	Duration: 12 weeks, 2x/week, 60 minutes (by supervision) in addition to a daily home based program of 8-10 minutes. IG: Exercises: flexibility, aerobics, rhythm, balance, reaction exercise and muscle training (strength and endurance). CG: was not involved in any intervention.	1) Significant improvement in IG on Berg (p<0.001) and in self-reported functional ability (p=0.02). 2) IG exhibited significant improvement in walking speed (p=0.03) and a decrease in number of steps (p=0.01). 3) Significant improvement in IG in muscle strength (p≤0.02). 4) No statistical analysis was carried out.
Chin et al.[18]	n=217 (78.5±5.7 years) IC: age > 70 years	1) Subjective wellbeing (Dutch scale of subjective wellbeing for older persons) 2) Self-reported health 3) Social contact	Duration: 17 weeks, 2x/week IG: Training in functional skills and use of these skills in context. CG: instructed not to perform any physical activity and participated in social programs every two weeks.	1) There was no significant change in score on wellbeing questionnaire in either group. 2 and 3) There was no significant difference in self-reported health or social contact in either group.
Chin et al.[19]	n= 157 (78.7±5.6 years) IC: age ≥ 78 years	1) Functional capacity (ability to balance for 10 sec in tandem; gait speed and stride length; time required to stand up from a chair five times, touch left foot with right hand and put on a coat) 2) Physical fitness (Groningen Test) 3) Self-reported disability	Duration: 17 weeks, 2x/week, 45 minutes IG: Exercises: warm up, skill training (reach toes, stand up from chair, throw, etc), use of these skills in context. CG: instructed not to perform any physical activity and participated in social programs every two weeks.	1) IG exhibited significant improvement in functional capacity (time required to stand up from a chair, reach toes and gait speed) (p<0.001). 2) There was no significant effect in total fitness score. 3) IG and CG: no significant effect on disability.

Table 1. Continued.

Author/Year	Participants	Outcomes	Intervention	Effects (based on enumeration of outcomes)
Jong et al.[20]	n=217 (Mean: 79 years) IC: age > 70 years	1) Food intake 2) Appetite 3) Perception of taste and smell 4) Body weight and lean body mass (imaging).	Duration: 17 weeks, 2x/week. IG: Group exercises, training in functional skills, use of these skills in context and cool down. CG: instructed not to perform any physical activity and participated in social programs every two weeks.	1) IG: Slight positive effect on food intake (p=0.05). 2 and 3) No significant effect in either group. 3) No significant effect in either group. 4) Increase in total body weight in IG over CG (p=0.041). Reduction in lean mass was significantly lower (p=0.014) in the group that participated in the exercises in comparison to the control group.
Jong et al.[21]	n=217 (Mean: 79 years) IC: age > 70 years	1) Anthropometric measurements (body mass, height, BMI, hip/waist circumference ratio) 2) Body composition (lean mass and fat mass, bone mass, bone mineral density and calcium)	Duration: 17 weeks, 2x/week. IG: Group exercises. Training in functional skills, use of these skills in context and cool down. CG: instructed not to perform any physical activity and participated in social programs every two weeks.	1) There was no effect of the intervention on anthropometric variables. 2) IG: Significant difference in lean body mass in comparison to the control (p=0.02). IG exhibited no effect regarding bone parameters.
Helbostad et al.[22]	N= 77 (81±4.5 years). IC: age ≥ 75 years; falls history; walking aid; MEEM score ≥ 22	1) Quality of life (SF-36) 2) Walking ability (speed, duration and frequency of outdoor walks)	Duration: 12 weeks IG: Progressive functional strength and balance exercises with physical therapist in groups (2x/ week) + CG intervention CG: 4 functional non-progressive, at-home exercises (2x 10 daily)	1) 3 months: Mental Health Index (p=0,01) and emotional aspects (p=0.003) improved more in the IG than CG. 9 months: no differences between groups. Mental Health Index and emotional aspects improved in the IG (p=0.01 and p=0.032). 2) 3 months: no difference for walking speed and duration of outdoor walks in the IG e CG. 9 months: gait speed improved in the IG (p=0.022).
Brown et al.[23]	n= 87 (IG and CG: 83±4 years) IC: age ≥ 78 years, sedentary	1) Functional mobility (modified PPT) 2) Muscle strength (knee, ankle, hip, should and grip) 3) Flexibility 4) Balance (functional range, one-foot balance, Romberg and Berg) 5) Sensitivity 6) Gait analysis 7) Coordination and speed	Duration: 36 sessions held 3x/week. IG: 22 exercises focused on flexibility, strength, balance, coordination and reaction time. CG: 9 flexibility exercises performed at home.	1) Significant improvement in IG (p<0.05) 2) Significant improvement in IG regarding strength of extensors and flexors of the knee (p=0.02 and 0.009). 3) Significant improvement in both groups (p=0.001 to p=0.05). 4) Significant improvement in IG on Romberg, one-foot balance and Berg (p<0.05). 5) There was no change in sensitivity in either group. 6) Significant improvement only in cadence (p<0.05) 7) There was no significant change in these parameters in either group.
Gill et al.[24]	n=188 (IG: 82.8±5.0 years; CG: 83.5±5.2 years) IC: age > 75 years	1) Functional capacity (questionnaire on 8 ADLs) 2) Muscle strength (extensors of the knee – manual dynamometer) 3) Functional mobility (POMA and Physical Performance Test)	Duration: 6 months, 3x/week IG: At-home physical therapy. Exercises for gain in ROM, balance and muscle strength (2x10). Environment orientation and training in assistance device. CG: education protocol.	1, 2 and 3) No comparisons were performed between groups or before and after intervention for these outcomes. Other results: After 4 months, IG was less prone to falls than CG (p=0.04). 6 out of the 7 elderly individuals who suffered a fracture from falls were in the CG. Angina was more frequent in CG (p=0.01)

Table 1. Continued.

Author/Year	Participants	Outcomes	Intervention	Effects (based on enumeration of outcomes)
Mann et al.[25]	n= 104 (Mean: 73 years) IC: MMSE score above 23	1) Functional capacity (Independence - FIM, CHART and Older American Research and Services Center Instrument) 2) Pain (Functional Status Index) 3) Healthcare cost	Duration: At-home visits every 6 months Program: Modification of risks in environment. Prescription and treatment of use of assistance device Follow-up CG: received normal care services	1) CG and IG: decline in functional capacity after 18 months. CG: greater decline on FIM (p=0.04) and increase in pain (p=0.01) than IG. 2) CG: Increase in pain after 18 months (p=0.05). 3) IG: greater expenditures on home modifications and purchase of gait assistance devices (p<0.001). CG: greater expenditures on institutionalization (p<0.01) and medical visits (p<0.01). No significant differences in overall expenditures.
Sato et al.[26]	n=30 (IG-1: 79.2±5.1 years; IG-2: 75.3±6 years; CG: 77.6±6.8 years) IC: age ≥ 65 years	1) Health-related quality of life (SF-36) 2) Disability on ADLs (FIM)	Duration: 24 weeks. IG-1 performed 1x/week and IG-2 performed 2x/week IG: exercise program in water (walking, training in ADLs, strengthening and stretching exercises). CG: participated in recreation and socialization activities.	1) Significant improvement in mental and physical components in IG-1 and IG-2 (p<0.05). Improvement in physical component was greater (p<0.05) in IG-2 than IG-1 at 3 months, but similar to IG-1 at 6 months. 2) Significant differences at 6 months in IG-1 and IG-2 (p=0.004 and p=0.002) and at 3 only in IG-2 (p=0.002). CG: no significant differences.

NS=non-significant; IG=Intervention Group; CG=Control Group; BMI=Body Mass Index; PPT=Physical Performance Test; ADLs=Activities of Daily Living.

Table 2. Studies included in analysis: definitions of frailty and methodological quality by the PEDro Scale (PS).

Author/Year	PS	Definition of frailty
Ota et al.[1]	4	Not explained (seems to have adopted the criterion that elderly individual needed support care for a long period of time).
Binder et al.[4]	4	Mild to moderate frailty: Having two of the following criteria: 1) score between 18-32 on modified physical performance test; 2) difficulty or need for assistance on 2 or + IADLs and BADLs; 3) VO_2 peak between 10-18 mL/kg min.
Latham et al.[5]	8	Frail elderly individual: one or more health problems or functional limitations from a list of indications that includes dependence on ADLs, bedridden for long period, limitation in mobility or recent falls.
Gill et al.[7]	6	Requiring more than 10 s to perform rapid gait test or unable to stand up from a chair with arms crossed. Elderly individuals with one of these criteria considered moderately frail; those with both criteria considered severely frail.
Sullivan et al.[13]	7	Not explained (seems to have adopted the criterion of elderly individual that exhibited recent functional decline).
Chandler et al.[14]	6	Unable to descend stairs (step/steps, without support).
LaStayo et al.[15]	3	Not established, but all subjects presented sarcopenia and were at high risk for falling (TUG score > 14 seconds).
Ehsani et al.[16]	5	Mild to moderate frailty: Having two of the following criteria: 1) score between 18-32 on modified physical performance test; 2) difficulty or need for assistance on 2 or + IADLs and BADLs; 3) VO_2 peak between 10-18 mL/kg min.
Worm et al.[17]		Not explained (seems to have adopted the criterion that elders over 74 years and not able to leave their home unaided or unattended or without mobility aids).
Chin et al.[18,19]	5	Inactivity (no participation in physical activity of moderate or high intensity) and involuntary weight loss.
Jong et al.[20,21]	4	Requiring healthcare (≥ 70 years, inactivity, BMI < 25 or involuntary weight loss).
Helbostad et al.[22]	8	To present at least one of the criteria: 1) history of falling during last year; 2) use of walking aid.
Brown et al.[23]	4	Score < 32 and > 17 on Physical Performance Test questionnaire.
Gill et al.[24]	2	Requiring more than 10 s to perform gait test or being unable to stand up from a chair with arms crossed.
Mann et al.[25]	5	Did not define frailty (included elderly individuals who needed some type of help at home).
Sato et al.[26]	6	Elderly individuals who needed help on at least one of five ADLs.

ADLs=activities of daily living; IADLs=instrumental activities of daily living; BADLs=basic activities of daily living; TUG=Timed "Up and Go"; BMI=body mass index.

quadriceps muscle strength[5] and lower and upper limb muscle strength[1]. The three remaining studies showed a significant increase in muscle strength. In the study conducted by Sullivan et al.[13], high- and low-resistance isotonic exercises increased the leg and arm muscle strength of frail elders, particularly in the high-resistance training group. Chandler et al.[14] found a gain in strength of 10 to 16% after a low to moderate exercise program. LaStayo et al.[15] found an increase in the cross-sectional area and strength of the lower limbs after eccentric strength training on a cycle ergometer.

All articles also evaluated the effect of strength training on functional mobility, but only two studies[1,15] found a significant improvement in the time taken to perform the Timed Up and Go (TUG) test and the 10-meter walk[1] and in stair descending ability[15]. The remaining studies[5,13] did not find a significant difference for measures of functional capacity. Three studies evaluated balance[1,5,15] with conflicting results. Ota et al.[1] found an improvement in the Functional Reach test after a strength training program for upper and lower limb muscles. LaStayo et al.[15] found an improved Berg Balance Scale score in the group that trained on the cycle ergometer. In contrast, Latham et al.[5] found no benefits of quadriceps strengthening in the Berg Balance Scale score.

Exercises for muscle strengthening, balance, coordination, flexibility, reaction time and aerobic training

Three studies evaluated the impact of a multiple-intervention program, including muscle strengthening, balance, coordination, flexibility, reaction time and aerobic training on different outcomes when treating a frail elder[4,16,17]. Peak O_2 uptake (VO_2 peak) was a common outcome in the studies by Ehsani et al.[16] and Binder et al.[4], and both found a significant increase of 14%. Ehsani et al.[16] also evaluated the impact of this protocol on cardiac output and left ventricular stroke work with significant increases in the experimental group. Regarding the other outcomes evaluated by Binder et al.[4], the intervention program produced significant improvement in muscle strength, balance, self-perceived health and function (self-report and performance). Worm et al.[17] found significant improvement in the performance and self-report of physical function in gait (speed and number of steps) and muscle strength, but there was no statistical analysis of VO_2 max.

Functional training

Five studies evaluated the effects of an exercise program focused on functional skills training (reach, stand up from chair, throw, etc.) necessary to perform daily activities in the frail community-dwelling elders[18-22]. Four of these studies used the same protocol of intervention, but evaluated different outcomes. Chin et al.[18] evaluated the effect of intervention on the subjective wellbeing, self-reported health and social contact and found no significant changes. However, Helbostad, Sletvold and Moe-Nilssen[22] found significantly greater improvement than the control group in the mental health index and emotional aspects of quality of life. The results of that same study, however, did not show significant effects of functional training on gait speed[22]. In another study, there was a significant improvement in the functional capacity of the elders in the intervention group[19]. The activities that had significant changes were standing up from chair, reaching toes and gait speed. Regarding self-reported functional capacity, there was no significant change. Regarding body composition, there was an increase in lean body mass in the elders who underwent functional training[20,21]. There was no significant change in body mass, waist and hip circumference.

Physical therapy (balance exercises, coordination, flexibility, strengthening and reaction time)

We found only one study that evaluated the effects of this type of intervention on frail community-dwelling elders[23]. It showed significant improvement in muscle strength, flexibility, balance, coordination, cadence and function in the intervention group. There were no significant differences for reaction time variables, sensitivity and gait variables. The control group, which performed the exercises to gain range of motion at home, only showed significant improvement in flexibility.

At-home Physical Therapy (environment adaptation + prescription of assistive devices + exercise)

Two studies evaluated the impact of a personalized physical therapy program based on the evaluation of the elder and his home environment. The program was held in the homes of elderly and supervised by a physical therapist[7,24]. The outcomes vary between the two studies. In the first study[24], most of the elders did not advance beyond the initial level of resistance in the strengthening exercises. There was no statistical analysis of the data, which hampers its generalization. The authors also reported that the program was safe, because the adverse events were not more common in the experimental group. In the other study[7], the intervention group had a significant

reduction in disability compared to the group that received educational lectures. The benefits were greater in the moderate frailty group compared to the severe group.

Environment adaptation + prescription of assistive device

One study evaluated the effectiveness of environmental intervention combined with the prescription of assistive devices, when necessary, in function, pain and health care cost of frail elders[25]. After 18 months of intervention, both groups showed a decline in function evaluated by the Functional Independence Measure (FIM) questionnaire, however this decline was greater in the control group. Thus, the intervention was not able to prevent functional decline, but it did slow it down. Only the control group showed an increase in pain. The comparison of health care cost found no difference in total expenses, however the control group had greater expenses with institutionalization.

Water exercise

Only one study evaluated the effect of water exercise on frail elders[26]. The study investigated the effect of once-weekly and twice-weekly intervention over a six-month period. In the quality of life outcome, there was a significant increase in the physical and mental components of the SF-36 questionnaire at three and six months of exercise, compared with the pre-intervention assessment. There were no differences in the control group. There was also a significant difference in the FIM score between the pre-intervention and six-month assessments for both intervention groups and between the pre-intervention and three-month assessments only for the twice-weekly group. No differences were found in the control group[26].

Discussion

This systematic review shows the lack of studies on intervention in frail community-dwelling elders, despite the great importance of the topic. This lack may be related to the great challenges of working with this population, such as the lack of standardized criteria for the definition of frailty, ethical issues and high dropout and mortality rates, which hamper the performance of these studies[8]. One problem that complicates the evaluation of interventions in frail elders is the fact that the analyzed studies use different concepts to define frail elders. The definitions ranged from functional changes and need for help to the combination of multiple characteristics (Table 2). These limitations made it impossible to generalize the results and to compare these studies with other studies.

Ferrucci et al.[8] attempted to solve this problem by proposing the use of a consensus for studies on interventions in frail elders. These authors recommend the evaluation of the mobility, nutrition and body composition domains. This recommendation is based on the fact that the frailty syndrome is multisystemic and multifactorial in nature[3,6]. Although considered synonymous by many authors and health professionals, disability and frailty are separate entities and can occur in isolation in the elderly. This distinction is well demonstrated in the study by Fried et al.[2], in which 72.8% of frail elders had no disability and 72% of disabled elders were not frail.

This multisystemic character of frailty and its different definitions may also have influenced the great variety of outcomes found in the studies. This heterogeneity of outcomes further complicates the verification of evidence in the rehabilitation of frail elders. However, some studies share similar outcomes, the most common being functional capacity evaluated by self-reported performance or by physical performance measures[1,4,5,7,13-15,17-20,22-26]. This fact may be related to the increased risk of functional decline presented by this population and to the serious repercussions of disability[6,8,9].

The forms of intervention differed greatly between studies, even when the outcome was the same. Some studies attempted a more pragmatic therapeutic approach with protocols varying according to the individual evaluation of each elder[24], some with exercises that could be performed at home[5,14], others with specific exercises to be performed in clinical settings[1,13] and another with a combination of exercise at home and in the clinical setting[17].

Regarding the muscle strengthening programs, the study results were contradictory in several evaluated outcomes. Differences in treatment parameters do not seem to justify the significant differences in results, as most of the parameters were different between studies that found the same result and had similarities with studies that had different results. In the strengthening studies, the intervention period ranged from 10[5,14] to 12 weeks[1,13], two[1] to three times a week[5,13-15], and the number of repetitions was three sets of eight[5,13] or ten[1] or two sets of ten[14]. All studies adopted a systematic load adjustment and differed in muscle strength training equipment, with the exception of one study that did not describe how the load adjustments were made or the number of sets[17]. Caution is needed when interpreting the effects of strengthening in frailty elders, since the studies have issues with regard to quality[1,15], methodological structure[5,13] and definition of frailty[1,5,13-15,17].

As described above, two studies evaluated the impact of a three-stage program including physical therapy, muscle strengthening and aerobic training[4,16] to treat frail octogenarians. The two studies were developed at the same study center and with the same researchers. The sample of the study by Ehsani et al.[16] consisted of elders who took part in the study by Binder et al.[4], and the protocol was the same. However, the study by Ehsani et al.[16] focused on aspects related to cardiorespiratory function, while Binder et al.[4] also evaluated aerobic capacity and other aspects related to functional capacity, muscle function, balance and self-related health. The two studies found positive effects of this protocol on the evaluated variables, showing that even a frail octogenarian is capable of making beneficial biological adaptations. Worm et al.[17], who also used multiple interventions, found benefits of this intervention in frail elders, but did not give a clear definition of frail elder.

There is little evidence of the benefits of functional training in frail elders. Although five articles were found on the effects of functional training, four of them belonged to the same study, but considering different outcomes[18-21]. In fact, the articles were simply divided according to the outcomes. Thus, despite the benefits of the program to functional capacity, increase in lean body mass and quality of life, the results are still scarce for this type of intervention.

Studies on the effectiveness of physical therapy interventions and environment adaptation plus prescription of assistive devices were found in the literature[7,23-25]. One advantage of these interventions is that they are similar to the approach taken by the physical therapist in clinical practice, with implementation of a multifactorial program. The study by Brown et al.[23] evaluated the effect of a low-intensity physical therapy program including balance, coordination, flexibility, strengthening and reaction time exercises on the treatment of frail elders. The authors found significant improvements in muscle strength, flexibility, balance, coordination, cadence and function after six months of intervention, three times a week. They concluded that this may be an effective alternative for elders who cannot follow more rigorous programs. However they also concluded that, despite the improvement in physical function, frailty was not eliminated, thus enhancing the importance of prevention.

The authors who evaluated the effectiveness of environment adaptation and prescription of assistive devices and of these approaches combined with exercise came to the important conclusion that these interventions were able to reduce functional decline, but not avoid it[7,25]. Both studies followed up the elders for a period of 12 and 18 months, and one of them showed that the benefits only appeared after six months of intervention. Thus, the duration of interventions in frail elders in order to improve the function should be chosen with caution. Furthermore, the level of frailty must be taken into account, because when the elders were divided into moderate and severe, those with severe frailty did not benefit from the intervention. However, one should be cautious in interpreting these data due to the difficulty of categorizing the level of frailty and the small number of studies evaluating this issue.

The only study that evaluated the benefits of water exercise was the study by Sato et al.[26]. They found an improvement in quality of life and function in elders who they considered frail. They also found that the frequency of practice also influences the speed of improvement. The researchers considered frail the elders who had five functional limitations and adopted more stringent selection criteria. Therefore, depending on the definition of frailty used by a professional, the water environment can place the elders at risk of complications.

A major problem verified in this review was related to the quality of the available studies. Some important methodological limitations were found, and some studies show low methodological quality in the PEDro scale evaluation[1,4,15,20,23,24], which complicates the interpretation of results. In two studies, the elders were not randomly assigned to groups[5,15]. In many of them, the examiners were not blinded[1,4,7,15-21,23-25], there was no analysis by intention-to-treat[1,4,7,14,16-21,23-25], and only one study[22] mentioned that the sample size was calculated. This issue becomes extremely important in studies with high dropout and mortality rates, as it is the case of the analyzed studies. It is recommended that sample losses be limited to 20% and included in the sample calculation, and that analyses be run by intention-to-treat[8]. The studies did not follow these recommendations. Regarding statistical power, only one article[5] made this calculation, but it is not possible to say whether the lack of significant improvement after intervention in some studies was due to a lack of efficacy of the technique or due to insufficient sample size.

Another difficulty encountered by the present study was the large number of interventions found in the literature, with a small number of publications for each type of intervention. This certainly limits the conclusions. Future studies should evaluate each specific type of intervention, considering that there is a clear need of intervention studies on the subject. Moreover, it is important that future studies use appropriate criteria for the definition of frailty and make them clear in the text.

Conclusion

There is little evidence of the effects of interventions or prevention on frail community-dwelling elders. The diversity of criteria used to define the frail elder makes it difficult to

conduct and to compare studies. Due to the small number of studies found, it was not possible to reach a consensus regarding the effectiveness of interventions. Some authors seem to agree that, despite the significant gains in strength, balance and functional capacity, the intervention were not able to reverse or prevent the progression of frailty.

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