

SYSTEMATIC REVIEW

Effects of physical training on physical performance in institutionalised elderly patients (70+) with multiple diagnoses

ELISABETH RYDWIK¹, KERSTIN FRÄNDIN², GUNNAR AKNER¹

¹Nutrition and Pharmacotherapy Unit A1:05, Research and Development Unit for the Elderly North West, Department of Geriatric Medicine, Karolinska Hospital, Karolinska Institutet, 171 76 Stockholm, Sweden

²Karolinska Institutet, Neurotec Department, Division of Physiotherapy, 141 83 Huddinge, Sweden

Address correspondence to: G. Akner. Fax: (+46) 8651 1441. Email: gunnar.akner@chello.se or elisabeth.rydwik@nvso.sll.se

Abstract

Objective: the positive effect of physical training in healthy elderly people is well documented. The aim of this systematic review was to describe the effect of physical training on physical performance in institutionalised elderly patients with multiple diagnoses.

Design: systematic literature review of randomised controlled trials regarding effects of physical training of elderly (70+) subjects.

Methods: the randomised controlled trials were evaluated using a modified version of an evaluation form originally developed by the Cochrane Collaboration. It is based on a weighted scale of 0–100 points, and ranks the studies as high, moderate or low methodological quality. A total of 16 randomised controlled trials were included in the review.

Results: six studies scored as high quality, eight as moderate and two as low. There was a large heterogeneity in the studies concerning sample size, types of interventions and types of assessments. There is strong evidence for a positive effect of physical training on muscle strength and mobility; moderate evidence for an effect on range of motion; and contradictory evidence regarding gait, activities of daily living, balance and endurance.

Conclusions: more studies are required, with larger sample sizes, higher specificity as to the types of interventions and assessments, greater focus on clinically relevant outcomes such as endurance and activities of daily living, and also, for example, quality of life and mortality.

Keywords: multiple diagnoses, institutionalised, elderly, physical training, assessment, systematic review

Introduction

In Sweden, the percentage of the population aged 65 and older will increase by over 55% in the next 50 years. More than half of this increase will be 80+ [1]. The WHO has adopted the definition of Active Ageing put forth by the Canadian Ministry of Health, which defines it as 'a process of optimising opportunities for physical, social and mental well-being throughout life course in order to extend life expectancy' [2].

Several published reviews deal with physical activity in non-institutionalised elderly people; however, we have found no systematic reviews focusing on institutionalised elderly subjects.

Many of the reviews on healthy elderly focus on muscle strength and endurance [3–13]. Muscle wasting from 50–80 years of age is probably the result of an ageing process in the neuromuscular system combined with a decreased level of physical activity. The contribution of each of these factors is unknown [3, 4]. The effect of strength training on healthy elderly people is well documented [14–17].

Numerous investigations have demonstrated that VO_{2max} declines with age at a rate of approximately 1% per year. It is postulated that much of the reduction associated with ageing may be due to sub-clinical disease and inappropriate lifestyle rather than to ageing itself [5]. Activities of daily living (ADL) demand an increasing percentage of VO_{2max} in advancing age, which may be a reason for the impairment in ADL function in many elderly people [6]. A meta-analysis has demonstrated that high-intensity aerobic training has a favourable effect on endurance for healthy elderly people compared to low-intensity training [5].

The relationship between strength training, aerobic training, and various ailments in elderly people is the topic in two reviews [7, 8]. The authors conclude that both strength training and aerobic training may affect bone mineral density, glucose homeostasis and the risk of falling. Strength training improves muscle mass, strength and muscle quality, while aerobic training mainly affects cardio-vascular fitness, blood pressure and plasma lipoprotein profiles [7, 8].

Regarding balance, there is evidence that vision and somatosensory input are much more important for older adults compared to younger ones. In tests of the vestibular system alone, older adults show significantly increased postural sway. Many of the older adults lose stability and require assistance to regain balance during the test. Ankle dorsal-extension weakness has also proven to be a factor in balance dysfunction [18]. The positive effect of physical training on balance has been shown in several studies of healthy elderly people [19–22].

Physical training affects muscle strength and endurance and is therefore important in delaying the crossing of the threshold to physical dependence [9]. If a person is close to this threshold, even a minor incident or temporary illness can cause physical dependence [10].

It has been claimed that physical weakness and a low functional level in old age are consequences of a sedentary lifestyle, which may lead to a need for nursing home care due to the inability to live a functional and independent life [11]. However, there are also numerous reasons associated with being in a long-term care facility – functional impairment, cognitive impairment, stroke, Parkinson's disease, absence of care-giver etc. [23].

The aim of this study is to describe the effect of physical training on physical performance in institutionalised multiple-diagnosis elderly people aged 70+, by means of a systematic review.

Methods

Literature search

The literature search was conducted on PubMed, Medline, Cinahl, Amed and PeDRO with the following keywords: elderly, nursing home, residential home, frailty, multiple diagnoses, physical training, exercise, strength, endurance, balance, range of motion, ambulation, gait, walking, activities of daily living, physiotherapy, physical therapy, rehabilitation and randomised controlled trials. Languages were limited to Swedish and English. The search was also complemented with references in articles and 'related articles'. The search was conducted on four different occasions between September 2000 and August 2002.

Criteria for inclusion

Randomised controlled trials (RCT), original quantitative studies only, published in 1980–2002 in referee-reviewed journals. Intervention programmes consisting of physical training. Subjects with a mean age of 70+, with multiple diagnoses and living in an institution.

Evaluation of methodological quality

The Cochrane Collaboration has developed a method of studying and evaluating RCTs for back and neck pain [24–26]. The Swedish Council on Technology Assessment in Health Care (SBU) has translated the evaluation form, including a weighing scale from 0–100 points (Appendix 1, English version – on website). We have modified the SBU form to fit RCTs on physical training and made changes regarding

comparability of relevant baseline characteristics (B), relevant outcome measurements (M) and adequate follow-up period (O) (Appendix 2 – on website).

According to SBU recommendations, the evaluation was conducted in three phases.

Phase 1. Survey of abstracts

All 104 abstracts were evaluated and relevant articles passed on to phase two.

Phase 2. Survey of articles

The 41 relevant articles were read and those that did not fulfil the criteria for inclusion were excluded.

Phase 3. Evaluation

The remaining 16 RCTs were evaluated independently using the modified form described above (Appendix 2 – on website). In subsequent meetings we tried to reach a consensus on each criterion. Studies with 30 points or less were classified as low methodological quality, studies with 31–60 points as moderate quality and studies with more than 60 points as high quality.

Definitions of assessment of physical performance

In the present review we have defined the assessments of physical performance as follows:

Muscle strength – strength measured in a specific muscle (e.g. quadriceps) or muscle group (e.g. handgrip) etc.

Mobility – chair stand, stair climbing, step test, transfer (other than gait), activity level.

Gait – speed, step length, distance.

ADL – personal activities of daily living, e.g. bathing, dressing, toileting, feeding.

Balance – dynamic and static balance, postural sway.

Endurance – VO_{2max} , heart rate.

Range of motion – measured in a specific joint, e.g. spinal flex, knee extension/flex etc.

Classification of evidence

The following criteria were used to classify the degree of evidence for each of the seven different aspects of physical performance – muscle strength, mobility, gait, ADL, balance, endurance and range of motion:

Strong evidence – concordant results in more than half of RCTs of high quality.

Moderate evidence – i) concordant results in one RCT of high quality and one or more RCTs of moderate or low quality, ii) concordant results in more than half of RCTs of moderate or low quality.

Limited or contradictory evidence – one RCT with high, moderate or low quality, or contradictory results in several RCTs.

No evidence – no RCT.

Results

Methodological quality

Supplementary Table (on website) shows the result of the evaluation of methodological quality in the reviewed RCTs.

The 16 RCTs scored an average of 54 points (range 24–75) out of a maximum score of 100 [27–42].

High quality RCTs (61–100 p)

Methodological weaknesses were mainly due to small subject groups [29–32] or lack of: a blinded evaluation [31], subject blinding [27, 30, 32], a placebo treatment [27, 28, 30, 32] or an intention-to-treat analysis [27–32].

Moderate quality RCTs (31–60 p)

Methodological weaknesses were mainly due to inadequate comparability between groups at baseline [35–38, 40], a dropout rate greater than 20% [33, 34, 36, 37]; small subject groups [34–40]; lack of a blinded evaluation [35, 37–40], subject blinding [33–40], a placebo treatment [33–40] or an intention-to-treat analysis [33–36, 38–40]; insufficient assessment variables [33, 37, 39, 40] and an insufficient description of statistical data [36, 38, 40].

Low quality RCTs (0–30 p)

These RCTs shared many methodological weaknesses, such as inadequate comparability between groups at baseline [42]; no description of the randomisation procedure; small subject groups; a dropout rate greater than 20%; insufficient description of the intervention and compliance; lack of a blinded evaluation, subject blinding, a placebo treatment or an intention-to-treat analysis; insufficient assessment variables; and an insufficient description of statistical data.

The design of the studies

Table 1 shows a summary of the 16 RCTs [27–42]. The RCTs were very heterogeneous as regards the number of subjects ($n=11$ –392), types of interventions and types of assessment variables.

Table 2 shows the diversity between the types of interventions and types of assessments in the individual RCTs. Strength training was the most common intervention, followed by gait and range-of-motion training. Two studies did not describe the intervention sufficiently enough to allow classification of the type of intervention [33, 41]. The most common assessment was mobility, followed by muscle strength and gait.

The findings of the studies

Table 3 shows a summary of the results of the RCTs. No RCT showed any negative results of physical training.

RCTs with high methodological quality showed significant improvements in muscle strength [29–32], mobility [27, 29, 31, 32], gait speed [31, 32], ADL [28, 29], balance and range of motion [29].

RCTs with moderate quality showed significant improvements in muscle strength [35, 36], mobility [35, 37, 40], gait [37, 40], wheelchair propulsion [36, 40], ADL [35], endurance [36] and range of motion [35]. ADL showed significant improvement in one of these RCTs, but only for the most dysfunctional subjects [34]. One RCT showed no significant improvements of the assessed physical functions, but showed a positive effect of the physical training on cost savings per bed per year [33]. The other two RCTs showed no significant improvements on any of the assessed functions [38, 39].

Two RCTs scored as low quality. One of them showed a significant improvement of mobility [41], and the other a significant decrease in exercise heart rate [42].

Apart from the physical assessment variables, some RCTs included assessment of nutrition [31], depression [27, 28, 34, 35], cognition [27, 30, 33], quality of life [27, 33], hospital admissions and mortality [34], falls efficacy and fear of falling [38].

Figure 1 shows the number of RCTs with significant positive and non-significant results, respectively, for the seven assessment variables, grouped according to RCT methodological quality (high, moderate, low) in institutionalised elderly people. The studies that have combined the same type of training and assessment are indicated.

Muscle strength

Four high-quality and two moderate-quality studies showed a significant positive result concerning muscle strength, while one high-quality and two moderate-quality studies showed a non-significant result. All nine studies combined the same type of training and assessment.

Mobility

Seven studies with high (4) or moderate (3) quality and one with low quality showed a positive result for mobility. Only four high- or moderate-quality studies showed a non-significant result. Four out of twelve studies included mobility training in the intervention.

Gait

Two high-quality studies and two moderate-quality studies showed a positive result for gait, however, two studies with high quality and two with moderate quality showed a non-significant result. Gait training was included in the intervention in six out of eight studies.

ADL

Two studies with high quality and one study with moderate quality showed a positive result concerning ADL. One high-quality study and two moderate-quality studies showed a non-significant result. Only one of the studies included ADL training in the intervention.

Balance

One high-quality study showed a positive result concerning balance. Three studies with high quality and three with moderate quality showed a non-significant result. Only three studies out of seven studies included balance training in the intervention.

Endurance

One study with moderate quality and one study with low quality showed a positive result concerning endurance. One high-quality and one moderate-quality study showed a non-significant result. All four studies included endurance training in the intervention.

Range of motion

One study with high quality and one with moderate quality showed a positive result concerning range of motion. One moderate-quality study showed a non-significant result. All

Table 1. A summary of the RCTs included in the review

Author [ref]	Intervention		Control	Assessment
	Description of randomisation	Type ^a		
Mulrow 1994 [27]	Yes, partly	Type 1, 2, 4, 6	Individual social visits 3 times/week for 4 months	<i>Strength</i> (isom 1e, ue); <i>Mobility</i> (PDI); <i>ADL</i> (Katz); <i>Balance</i> (PDI); <i>Range of motion</i> (PDI); <i>Quality of life</i> (SIP); <i>Cognition</i> (MMSE); <i>Depression</i> (GDS)
Morris 1999 [28]	Yes	Group 1 type 1 (1e + ue) and 5 Group 2 – type 7 (Self Care for Seniors)	Type 1, 3 times weekly Type 5, Twice a week for 10 months	<i>Mobility</i> (time required to stand up five times in a row); <i>Gait</i> (6-minute-walk); <i>ADL</i> (MDS); <i>Balance</i> (time-keeping in 5 different positions); <i>Depression</i> (GDS)
Lazowski 1999 [29]	Yes	Type 1 (1e + ue) and 2, 5, 6	Type 6 and memory games etc.	<i>Strength</i> (isom-elbow-flex, shoulder abd, handgrip, hip abd/add/flex/ext, isom knee-ext, isometric knee-ext); <i>Mobility</i> (TUG, stair-climbing); <i>Gait</i> (speed 7 m); <i>ADL</i> (FIM); <i>Balance</i> (Berg's Balance scale); <i>Range of motion</i> (1e + ue)
McMurdo 1994 [30]	Yes	Type 1 (1e + ue) and type 6	Twice weekly for 6 months	<i>Strength</i> (isom max q-ceps); <i>Mobility</i> (step test); <i>Reaction time, Cognition</i> (MMSE)
Fiatrone 1994 [31]	Yes, partly	Group 1 type 1 (1e) + Nutr supplement Group 2 Nutrition supplement Group 3 type 1	Group 1, 3 – 3 times weekly Group 2 once a day, for 10 weeks	<i>Strength</i> (hip/knee ext. 1 RM); <i>Mobility</i> (stair climbing); <i>Gait</i> (speed); <i>ADL</i> (Katz), <i>Nutritional intake, Body composition, Cognition</i> (MMSE), <i>Depression</i> (GDS)
Sauvage 1992 [32]	Yes, partly	Type 1 (1e) and 3	3 times weekly for 12 weeks	<i>Strength</i> (isokinetic knee-ext/flex); <i>Mobility</i> (Tinetti); <i>Gait/Balance</i> (Murray et al); <i>Endurance</i> (VO _{2max})
Przybylski 1996 [33]	Yes, partly	Unspecified rehabilitation program 1 PT and 1 OT / 50 residents	2 years	<i>Mobility</i> (COVS); <i>ADL</i> (FIM, FAM); <i>Cost analysis</i> per bed every 6 months

continued

Table 1. continued

Author [ref]	Subjects	Description of randomisation	Intervention			Control	Assessment
			Type ^a	Dose	Frequency/duration		
Meuleman 2000 [34]	<i>n</i> = 58 [78] (9 F) ^b <i>m</i> = age 75 Inclusion: Impaired function \geq 1 activities of ADL	Yes	Type 1 (le + ue) and type 3	Type 1 1 \times 15 reps progressively, type 3 50–65% intensity progressively	Type 1 – 3 times weekly Type 3 – twice weekly	Yes	<i>Strength</i> (isom dominant arm and leg); <i>ADL</i> (P + I); <i>Endurance</i> (heart frequency)
McMurdo 1993 [35]	<i>n</i> = 41 [49] (33 F) ^b <i>m</i> = age 81 Exclusion: severe communication difficulties	Yes	Type 1 (le + ue) and type 6	Progressive low-intensity exercise performed seated for 45 min	Twice weekly for 7 months	Reminiscence sessions	<i>Strength</i> (handgrip); <i>Mobility</i> (chair-stand); <i>ADL</i> (Barthel Index); <i>Balance</i> (postural sway); <i>Range of motion</i> (knee-ext/flex, spinal flex); Depression (GDS); Cognition (MMSE); Quality of life (LSI)
Schnelle 1996 [36]	<i>n</i> = 72 [97] (81 F) <i>m</i> = age 84 Inclusion: 65 +, medical order for physical restraint	No	Type 1 (ue) and 3, 4, 5	Individually prescribed progressive exercise	3 times weekly for 9 weeks	Yes	<i>Strength</i> (isom handgrip); <i>Mobility</i> (chair-stand \times 1 and \times 3, stair climbing); <i>Gait/Wheelchair</i> (walking endurance, wheelchair mobility endurance, calculated by average speed); <i>Endurance</i> (rowing – number of reps and resistance). SAFE assessments (security during ambulation)
Gillies 1999 [37]	<i>n</i> = 15 [20] (19 F) <i>m</i> = age 87.5 Inclusion: 70 +, mobile	Yes, partly	Type 4, 5	30 s \rightarrow 1 min at each station progressively	Twice weekly for 12 weeks	Type 6 (ue) and social activities	<i>Mobility</i> (chair-stand \times 1, \times 3, stair climbing); <i>Gait</i> (distance on 15 s)
Schoen-felder 2000 [38]	<i>n</i> = 16 [16] (12 F) <i>m</i> = age 82 Inclusion: 65 +, walking, MMSE \geq 20 p	Yes, partly	Type 1 (le) and 5	Type 1 – 5 \rightarrow 10 reps progressively, type 5 \rightarrow 10 min progressively	3 times weekly for 3 months	Yes	<i>Strength</i> (heel-raise – number of reps); <i>Gait</i> (speed 6m); <i>Balance</i> (parallel and tandem-standing); Cognition (MMSE); Risk for falls (RAFS); Fear of fall and Falls Efficacy (Tinetti)
Crilly 1989 [39]	<i>n</i> = 17 [50] (50 F) <i>m</i> = age 82 Inclusion: Walk	Yes	Type 1, 2, 6	15 \rightarrow 35 min progressively	3 times weekly for 3 month	Yes	<i>Balance</i> (postural sway)

continued

Table 1. *continued*

Author [ref]	Subjects	Description of randomisation	Intervention Type ^a	Dose	Frequency/duration	Control	Assessment
Schnelle 1995 [40]	<i>n</i> = 76 [94] (59 F) ^b <i>m</i> = age 85 Inclusion: Incontinent, follow simple instructions	No	Type 4, 5 + prompted voiding	Progressive exercises following prompted voiding	4 times weekly for 8 weeks	Prompted voiding	<i>Mobility</i> (number of chair-stands for 30 sec, activity-level observed by nurse); <i>Gait/Wheelchair</i> (walking endurance, wheelchair mobility endurance, calculated by average speed)
O'Hagan 1994 [41]	<i>n</i> = 45 [71] ^c <i>m</i> = age 81, 5 Inclusion: No previous physiotherapy	No	Exercise by physiotherapist + exercise by nursing home staff	1 hour once a week + 10 min twice a week	3 times weekly for 1 year	Yes	<i>Mobility</i> (chair-stand – time-keeping, chair-stand assistance 6 categories); Level of normal activity (6 levels)
Naso 1990 [42]	<i>n</i> = 11 [15] ^c age 64–97 Exclusion: serious cardiac disease and dementia	No	Type 3	80% intensity for 2–15 min	3 times weekly for 1 year	Yes	<i>Endurance</i> (Heart Rate uc and le ergometer)

^aIntervention – Type 1) Strength training, 2) Balance training, 3) Aerobic training, 4) Mobility training, 5) Gait training, 6) Range-of-motion training, 7) ADL-training.

^bNumber of females in the analysed group.

^cGender not reported.

n = number of subjects; [n] = Intention-to-treat group; F = Female; M = Male; *m* = mean; *le* = lower extremity; *IADL* = Instrumental Activities of Daily Living; *PADL* = Personal Activities of Daily Living; *MMSE* = Mini Mental State Examination; *GDR* = Geriatric Depression Scale; *1 RM* = 1 Repetition Maximum; *LSI* = Life Satisfaction Index; *HR* = Heart Rate; *SAFE* = The Safety Assessment for the Frail Elderly; *MDS* = Minimum Data Set; *TUG* = Timed Up and Go; *FIM* = Functional Independence Measure; *PDI* = Physical Disability Index; *SIP* = Sickness Impact Profile; *FAM* = Functional Assessment Measures; *COVS* = Physiotherapy Clinical Outcome Variables; *Grp* = Group; *Isom* = Isometric.

Table 2. Type of physical training and assessment in the 16 RCTs

Type of training and assessment																
Muscle strength	T + A	T	T + A*	T + A*	T + A*	T + A*	T + A	T + A*	T + A*	T + A	T					
Mobility	T + A*	A	A*	A	A*	A*	A	A*	T + A	T + A*			T + A*	A*		
Gait	T + A		T + A	A*		A*			T + A	T + A*	T + A					
ADL	A	T + A*	A*			A	A	A*								
Balance	T + A	A	T + A*			A			A			A	T + A			
Endurance					T + A	T + A			T + A*					T + A*		
Range of motion	T + A	T + A*		T					T + A*			T				
Studies ref no.	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42

T = Training; A = Assessment.

* = Significant effect of training.

For example: In study 27, muscle strength was both trained and assessed, but without significant positive result.

three studies included range of motion training in the intervention.

Evidence in conclusion

Strong evidence

There is strong evidence for a positive effect of physical training on muscle strength and mobility.

Moderate evidence

There is moderate evidence for a positive effect of physical training on range of motion.

Limited or contradictory evidence

There is contradictory evidence for the effect of physical training on gait, ADL, balance and endurance.

Discussion

Methodological considerations

The RCTs showed a large heterogeneity regarding number of subjects, types of physical training and assessments. Therefore, it was not appropriate to conduct a meta-analysis.

The literature search was conducted on several occasions and with several different combinations of keywords in an attempt to cover as many studies as possible. The search was also conducted through related articles and references in articles found. Some studies have probably still been missed despite this extensive search.

The original evaluation form used by the SBU in various reviews had to be revised to fit this review, where the focus was on the effect of physical training instead of back and neck pain. We contacted the SBU and searched the Cochrane Collaboration Library to investigate if such forms were available previously. However, no such form was found. One disadvantage with the revision of the form could be that relevant facts, for example other choices of assessment variables or the length of the physical training period, were not accounted for. This may have made scoring inequitable.

The original evaluation form has advantages and disadvantages in itself. Some disadvantages are related to the difficulty of blinded subjects and placebo treatments in evaluating physical training interventions. It is often impossible to blind the subjects and it is questionable if it is ethical to

mislead the subjects in the control group. These circumstances make it even more important to use blinded evaluators to eliminate at least some of the bias. Blinded evaluators have been used somewhat in two RCTs, but since the evaluation form does not allow scoring points to be divided up, the result had to be either 10 points or zero. We decided to give them 10 points each, since they described the situation and tried to avoid some of the bias.

We categorised the RCTs in three methodological quality categories (high, moderate and low), instead of two according to the Cochrane Collaboration. The reason was to avoid the sharp line between high and low quality, where a few points can make the difference. If only two categories had been used, the study by Schnelle *et al.* [36] (51 p) would have been categorised as high quality while the study by Gillies *et al.* [37] (49 p) would have been categorised as low. The major difference between the two studies was the number of assessment variables.

Study design considerations

The importance of specificity of physical training has been pointed out in recent decades [43–45]. However, this present review shows a large diversity both within and between the studies. The diversity within the studies concerning types of physical training and assessments is surprising considering the acknowledged importance of training specificity.

For example, muscle strength was usually assessed using isometric strength tests, although the intervention consisted of dynamic muscle strength training. It has been shown that a significant improvement could be seen after dynamic muscle training when the muscle group was tested dynamically with one repetition maximum (1RM) and in isokinetic torque, or through muscle hypertrophy, but not when tested isometrically [46, 47]. However, an older study has shown that dynamic and isometric strength are correlated [48].

Strength, aerobic and range-of-motion training were not included in the intervention unless they were assessed (Table 2). This may suggest that the authors in these RCTs only expected a positive result when the physical training was specific.

Two RCTs conclude that range-of-motion training is not challenging enough and will not prevent functional decline in institutionalised elderly people [29], and that such training only provides minimal benefit for many residents [27].

Table 3. A summary of the results of the 16 RCTs grouped with regard to the seven assessment variables and study methodological quality (high, moderate, and low)

Ref	Strength	Mobility	Gait/wheelchair	ADL	Balance	Endurance	Range of motion	Study quality
[27]	NS	↑ mobility and assistive device	-	NS	NS	-	NS	High
[28]	-	NS	NS	↑ group 1, 2	NS	-	-	High
[29]	↑ knee-ext, hip, elbow-flexion group 1	↑ TUG group 1	NS	↓ FIM group 2, unchanged group 1	↑ Berg's balance scale group 1	-	↑ upper- and lower extremity grp1	High
[30]	↑ knee-ext group 1	NS	-	-	-	-	-	High
[31]	- grp 1,3	- stair climbing, spontaneous activity grp 1,3	- gait speed grp 1,3	Only conducted at baseline	-	-	-	High
[32]	↑ knee-ext combined left/right	↑ Tinetti	↑ step length left, gait speed	-	NS	NS	-	High
[33]	-	NS COVS $P=0.08$	-	NS	-	-	-	Moderate
				FIM $P=0.07$, FAM $P=0.06$				
[34]	NS	↑ chair-stand	-	↑ for the most dysfunctional	-	NS	-	Moderate
[35]	↑ hand-grip	NS SAFE, NS chair-stand	-	↑ Barthel	NS	-	↑ spinal- flexion	Moderate
[36]	↑ hand-grip left	NS SAFE, NS chair-stand	NS gait, ↑ wheelchair speed/endurance	-	-	↑ rowing endurance	-	Moderate
[37]	-	↑ chair-stand × 3 NS × 1, NS stair climbing	↑ gait	-	-	-	-	Moderate
[38]	NS	-	NS	-	NS	-	-	Moderate
[39]	-	↑ chair-stand, activity-level	↑ max gait/wheelchair endurance	-	NS	-	-	Moderate
[40]	-	-	-	-	-	-	-	Moderate
[41]	-	↑ chair-stand on time	-	-	-	-	-	Low
[42]	-	-	-	-	-	↓ HR ue-ergometer, duration NS	-	Low

↑ = significant increase; ↓ = significant decrease; NS = not significant, - = not reported. For further abbreviations, see Table 2.

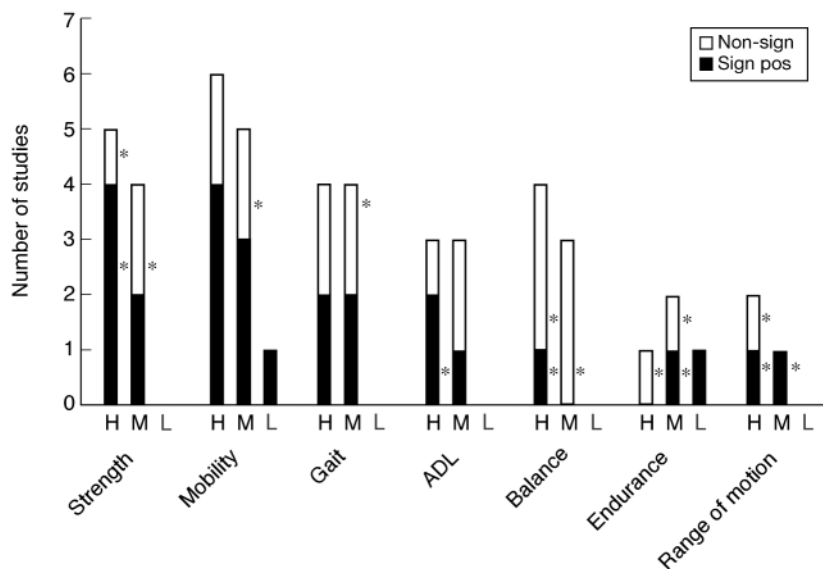


Figure 1. Number of RCTs showing significant positive and non-significant results grouped by methodological quality (high = H, moderate = M, low = L) and the seven different assessment variables. The studies that have combined same type of training and assessment are indicated by * to the right of each bar.

They suggest that physical training should focus on muscle strength and mobility for this group of elderly people [27].

It is questionable if this group of elderly people with multiple diagnoses is able to pursue efficient aerobic training. The non-significant effects may be due to factors such as insufficient muscle strength to support aerobic training [32] and disturbed co-ordination [42].

Regarding balance, there was a lack of specificity between training and assessment. Balance was trained in three RCTs, but was assessed in seven studies (Table 2). In one study the training consisted of seated training, including strength and range of motion; where one of the assessment variables was postural sway [35]. Seated training may however be irrelevant since balance training has only been shown to be effective if performed without support [49]. Balance was assessed with postural sway in two studies [35, 39]. Recent studies have shown that postural sway does not correlate with clinical functional balance measurements, and the authors suggest that this may indicate that the tests measure different aspects of balance [50, 51]. The results of this review indicate that strength training alone is not enough to improve balance. Specific balance training, perhaps in combination with strength training, seems important to improve balance.

The RCTs did not give a detailed report on the various diseases and disorders that usually underlie impaired physical function in elderly people. Strength gains in one or two specific muscles may not be clinically relevant if they do not lead to improvements in mobility, gait and ADL for this group. Furthermore, none of the studies discuss choices of type of physical training or assessments. The International Classification of Functioning, Disability and Health (ICIDH) model [52] could have been used to describe on which level the physical training took place and on which

level effects of the intervention were expected. The studies that assessed mobility, gait and ADL all included strength training in the intervention. This may suggest that strength training on the body function level affects mobility, ADL and gait on the activity level.

It has been suggested that there is a higher correlation between leg muscle strength and gait for persons under the 'threshold of physical dependence' than for those over the threshold [53]. Muscle strength/power, stair climbing ability and habitual activity level are all essential for the ability to perform ADL [54, 55]. This may explain why muscle strength training was the most common choice for physical training.

For this group of elderly people, physiological factors may not be the only ones affecting gait and ADL. Gait function might be influenced by psychological and environmental factors in combination with physiological factors for elderly people living in an institution [29]. The habitual activity-level is most likely an important factor for ADL-function and may reflect a person's ambition to maintain independence. Nursing staffs tend to deliver help to the residents, in many cases to save time, and the residents gradually get accustomed to receiving help [56]. Such habits may be difficult to break even if the residents could become more independent after a period of physical training. To break the 'cycle of dependence', it is important to combine physical training for the residents with education of the nursing staff. It is important to offer the residents the opportunity to make personal choices, otherwise they risk developing feelings of unworthiness and powerlessness. This may lead to a withdrawal and a decline in functional abilities and performance skills [33].

None of the RCTs in this review showed a significant positive effect of physical training on quality of life. A meta-analysis

of the FICSIT trials showed that physical training can improve quality of life for frail elderly people, but the improvement is only modest [57].

Only two RCTs tried to assess costs [33] and the effect on mortality [34] between the groups. Further studies of this kind are needed.

The sensitivity of the instruments used for assessment is vital for detecting differences. Several RCTs used assessment forms that combined different aspects of e.g. mobility (COVS, PDI), balance (Berg's balance scale, PDI) and ADL (FIM, Katz, Barthel) (see Table 1). These types of scales may not be appropriate for detecting differences on a group level in institutionalised elderly subjects with multiple diagnoses. However, they are clearly appropriate in clinical settings where patients are monitored on an individual basis.

The importance of reporting effect sizes in physical training studies to allow result comparison has been emphasised [58]. The authors also claim that it is important to match the participant's capacity level to establish norms for assessments and to develop a standard method of quantifying physical training programs.

Many RCTs reported non-significant improvements on various assessment variables. This may have been due to the small sample size in many studies. Power calculations were only reported in a few studies. One explanation of the small sample size could be that physical training studies are costly, since they demand the participation of many supervisors, especially for this group of elderly people.

We decided to include only RCTs; however, the randomisation is often insufficiently described, and cluster randomisation was the most common type. Only a few studies have tried to stratify the subjects in order to improve comparability between groups. This review shows that a randomised study is not equal to high quality. Controlled clinical trials with a large sample size and high specificity between types of training and assessment variables, blinded evaluation etc. may be more valuable than some of the RCTs in this review with low or moderate methodological quality.

General considerations

We are aware that the heterogeneous results regarding the effects of physical training on seven different physical functions could be considered to imply contradictory evidence. However, we still believe that the conclusions drawn above are valid.

Concerning balance (Figure 1) it is important to note that 'absence of evidence is not evidence of absence' [59]. It has been shown that misinterpretation of non-significant results due to, for example, low statistical power in several RCTs could lead to a long delay in introducing a new treatment or denying patients treatment [59, 60]. Four of the studies showing a non-significant result concerning balance had a total sample size of less than 50 subjects ($n = 11-41$) [32, 35, 38, 39]. Further studies with larger sample sizes and with the inclusion of specific balance training are needed before any further conclusions may be drawn.

In conclusion, this review indicates strong evidence for a positive effect of physical training on muscle strength and mobility for institutionalised elderly people. More studies with (i) larger sample sizes, (ii) stratified randomisation,

(iii) higher specificity regarding types of physical training and assessments and (iv) blinded evaluation are needed before any further conclusions can be drawn.

Key points

- Large heterogeneity in published physical training RCTs in elderly (70+) subjects (patient sample size, physical training type and dose, assessment type).
 - Insufficiently described randomisation procedure and lack of stratification.
 - Lack of clinically relevant outcome measures.
-

References (shortened version for print only)

PLEASE NOTE: The very long list of references supporting this review has meant that only the most important are listed here and are in **bold type** throughout the text. The full list of references is available on our website: <http://www.ageing.oupjournals.org/>

5. Lemura LM, von Duvillard SP, Mookerjee S. The effects of physical training of functional capacity in adults. Ages 46–90: a meta-analysis. *J Sports Med Phys Fitness* 2000; 40: 1–10.
6. Evans WJ. Effects of exercise on body composition and functional capacity of the elderly. *J Gerontol A Biol Sci Med Sci* 1995; 50 Spec No: 147–50.
7. Hurley BF, Hagberg JM. Optimizing health in older persons: aerobic or strength training? *Exerc Sport Sci Rev* 1998; 26: 61–89.
9. Malbut-Shennan K, Young A. The physiology of physical performance and training in old age. *Coron Artery Dis* 1999; 10: 37–42.
18. Woollacott MH, Shumway-Cook A. Changes in posture control across the life span – a systems approach. *Phys Ther* 1990; 70: 799–807.
19. Ledin T, Kronhed AC, Möller C, Möller M, Ödkvist LM, Olsson B. Effects of balance training in elderly evaluated by clinical tests and dynamic posturography. *J Vestib Res* 1990–1991; 1: 129–38.
23. Rockwood K, Stolee P, McDowell I. Factors associated with institutionalisation of older people in Canada: testing a multifactorial definition of frailty. *J Am Geriatr Soc* 1996; 44: 578–82.
24. Van Tulder MW, Assendelft WJJ, Koes BW, Bouter LM and the Editorial Board of the Cochrane Collaboration Back Review Group. Method Guidelines for Systematic Reviews in the Cochrane Collaboration Back Review Group for Spinal Disorders. *Spine* 1997; 22: 2323–30.
27. Mulrow CD, Gerety MB, Kanten D *et al.* A randomized trial of physical rehabilitation for very frail nursing home residents. *JAMA* 1994; 271: 519–24.
28. Morris JN, Fiatarone M, Kiely DK *et al.* Nursing rehabilitation and exercise strategies in the nursing home. *J Gerontol A Biol Sci Med Sci* 1999; 54: M494–500.
29. Lazowski DA, Ecclestone NA, Myers AM *et al.* A randomized outcome evaluation of group exercise programs in long-term care institutions. *J Gerontol A Biol Sci Med Sci* 1999; 54: M621–8.
30. McMurdo MET, Rennie L. Improvements in quadriceps strength with regular seated exercise in the institutionalized elderly. *Arch Phys Med Rehabil* 1994; 75: 600–3.

31. Fiatarone MA, O'Neill EF, Doyle Ryan N *et al.* Exercise training and nutritional supplementation for physical frailty in very elderly people. *N Eng J Med* 1994; 330: 1769–75.
32. Sauvage LR, Myklebust BM, Crow-Pan J *et al.* A clinical trial of strengthening and aerobic exercise to improve gait and balance in elderly male nursing home residents. *Am J Phys Med Rehabil* 1992; 71: 333–42.
33. Przybylski BR, Dumont DE, Watkins ME, Warren SA, Beaulne PA, Lier DA. Outcomes of enhanced physical and occupational therapy service in a nursing home setting. *Arc Phys Med Rehabil* 1996; 77: 554–61.
34. Meuleman JR, Brechue WF, Kubilis PS, Lowenthal DT. Exercise training in the debilitated aged: strength and functional outcomes. *Arch Phys Med Rehabil* 2000; 81: 312–8.
35. McMurdo MET, Rennie L. A controlled trial of exercise by residents of old people's homes. *Age Ageing* 1993; 22: 11–5.
36. Schnelle JF, Mac Rae PG, Giacobassi K, MacRae HS, Ouslander JG. Exercise with physically restrained nursing home residents: maximizing benefits of restraint reduction. *J Am Geriatr Soc* 1996; 44: 507–12.
37. Gillies E, Aitchison T, MacDonald J, Grant S. Outcomes of a 12-week functional exercise programme for institutionalised elderly people. *Physiotherapy* 1999; 7: 349–57.
38. Schoenfelder DP. A fall prevention program for elderly individuals. *J Gerontol Nurs* 2000; 26: 43–51.
39. Crilly RG, Willems DA, Trenholm KJ, Hayes KC, Delaquerrere-Richardson LFO. Effect of exercise on postural sway in the elderly. *Gerontology* 1989; 35: 137–43.
40. Schnelle JF, MacRae PG, Ouslander JG, Simmons SF, Nitta M. Functional incidental training, mobility performance and incontinence care with nursing home residents. *J Am Geriatr Soc* 1995; 43: 1356–62.
41. O'Hagan CM, Smith DM, Pileggi KL. Exercise classes in rest homes: effect on physical function. *NZ Med J* 1994; 107: 39–40.
42. Naso F, Carner E, Blankfort-Doyle W, Coughy K. Endurance training in the elderly nursing home patient. *Arch Phys Med Rehabil* 1990; 71: 241–3.
46. Brown AB, McCartney N, Sale DG. Positive adaptations to weight-lifting training in the elderly. *J Appl Physiol* 1990; 69: 1725–33.
49. Dickstein R, Shupert CL, Horak FB. Fingertip touch improves postural stability in patients with peripheral neuropathy. *Gait Posture* 2001; 14: 238–47.
52. World Health Organisation. International Classification of Functioning, Disability and Health. ICF Introduction. 54th World Health Assembly for International Use. London: World Health Organisation, May 2001.
54. Foldvari M, Clark M, Laviolette LC *et al.* Association of muscle power with functional status in community-dwelling elderly women. *J Gerontol A Biol Sci Med Sci* 2000; 55: M192–9.
58. Spirduso WW, Cronin DL. Exercise dose-response effects on quality of life and independent living older adults. *Med Sci Sports Exerc* 2001; 33 (Suppl 6): S598–608.
59. Altman DG, Bland JM. Absence of evidence is not evidence of absence. *Br Med J* 1995; 311: 485.

Received 8 September 2002; accepted in revised form 3 July 2003