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Physical fitness training for stroke patients

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ABSTRACT

Background
Stroke patients have impaired physical fitness and this may exacerbate their disability. It is not known whether improving physical fitness after stroke reduces disability.

Objectives
The primary aims were to establish whether physical fitness training reduces death, dependence and disability after stroke. The secondary aims included an investigation of the effects of fitness training on secondary outcome measures (including, physical fitness, mobility, physical function, health and quality of life, mood and the incidence of adverse events).

Search strategy
We searched the Cochrane Stroke Group Trials Register (June 2003), the Cochrane Central Register of Controlled Trials (CENTRAL) (The Cochrane Library, Issue 4 2002), MEDLINE (1966 to December 2002), EMBASE (1980 to December 2002), CINAHL (1982 to December 2002), SPORTDiscus (1949 to December 2002), Science Citation Index Expanded (1981 to December 2002), Web of Science Proceedings (1982 to December 2002), Physiotherapy Evidence Database (December 2002), REHABDATA (1956 to December 2002) and Index to UK Theses (1970 to December 2002). We handsearched relevant journals and conference proceedings and screened reference lists. To identify unpublished and ongoing trials we searched trials directories and contacted experts in the field.

Selection criteria
Randomised controlled trials were included when an intervention represented a clear attempt to improve either muscle strength and/or cardiorespiratory fitness, and whose control groups comprised either usual care or a non-exercise intervention.

Data collection and analysis
Data from eligible studies were independently extracted by two reviewers. The primary outcome measures were death, disability and dependence. The lack of common outcome measures prevented some of the intended analysis.

Main results
A total of 12 trials were included in the review. No trials reported death and dependence data. Two small trials reporting disability showed no evidence of benefit. The remaining available secondary outcome data suggest that cardiorespiratory training improves walking ability (mobility). Observed benefits appear to be associated with specific or ‘task-related’ training.

**Authors’ conclusions**

There are few data available to guide clinical practice at present with regard to fitness training interventions after stroke. More general research is needed to explore the efficacy and feasibility of training, particularly soon after stroke. In addition more specific studies are required to explore the effect of content and type of training. Further research will require careful planning to address a number of issues peculiar to this type of intervention.

**PLAIN LANGUAGE SUMMARY**

Physical fitness training for stroke patients

Little is known about whether fitness training is beneficial for stroke patients. Physical fitness is important for the performance of everyday activities. The physical fitness of stroke patients is impaired after their stroke, this may reduce their ability to perform everyday activities and exacerbate any stroke-related disability. This review of 12 trials found that, although fitness training after stroke may improve walking ability, there are too few data for reliable conclusions to be drawn.
**BACKGROUND**

Little is known about the effectiveness of interventions that are aimed at improving the physical fitness of stroke patients. This review will aim to establish whether physical fitness training is beneficial to stroke patients when provided during or after their rehabilitation or ward care, in particular whether it is associated with a reduction in death, dependence and disability.

**What is physical fitness?**

‘Physical activity’ describes all bodily movement that is produced by the contraction of skeletal muscle and which substantially increases energy expenditure (USDHHS 1996). This includes the muscular work required to maintain posture, to walk, to perform activities of daily living, and for occupational, leisure and sporting activities. Any temporary and involuntary reduction in the ability of muscle to generate force and/or sustain repeated contractions both during and after physical activity is termed ‘fatigue’. ‘Physical fitness’ is a set of attributes, which people have or achieve, that relate to the ability to perform physical activity (USDHHS 1996). The key components of physical fitness include:

(1) **Cardiorespiratory fitness**

Relates to an individual’s ability to perform physical activity for an extended period. It is conferred by the central capacity of the circulatory and respiratory systems to supply oxygen (USDHHS 1996), and the peripheral capacity of skeletal muscle to utilise oxygen (Saltin 1980).

(2) **Muscular strength**

This is the maximum force that can be generated by a specific muscle or muscle group. The ability to sustain repeated muscular actions or a single static contraction is termed ‘muscular endurance’ (USDHHS 1996).

(3) **Body composition**

This includes total and regional bone mineral density, and the relative amounts and distribution of adipose tissue, muscle and other vital parts of the body (USDHHS 1996).

All three components of physical fitness can adapt to changes in physical activity. Physical fitness is improved by activity and impaired by inactivity.

**Physical fitness in patients after stroke**

(1) **Ageing and disease - pre-existing impairments**

Prior to their stroke many patients already have impaired physical fitness. This is because many stroke patients are elderly, and will therefore have already experienced the decline in cardiorespiratory fitness and muscle function that occurs with normal ageing (Skelton 1999; Harridge 2000; Malbut-Shennan 2000). In addition, many stroke patients have co-existing physical diseases, which are associated with impaired physical fitness.

(2) **Hemiparesis - a direct effect**

The hemiparesis which may occur after stroke can dramatically reduce the amount of muscle mass available for contraction during physical activity. This therefore imposes an immediate impairment in physical fitness and can prevent, or increase the difficulty of everyday tasks such as walking. The slower speeds of locomotion seen in patients with hemiparesis (30 m/min) incur approximately the same oxygen cost (10 ml/kg/min; Hash 1978) as healthy people walking approximately twice as fast (60 m/min) (Waters 1999); thus the hemiparetic gait is energetically very inefficient.

(3) **Reduced mobility - an indirect effect**

Acute stroke often reduces mobility as a result of neurological deficits such as motor weakness, ataxia, apraxia, impaired conscious level, and sometimes as a result of sensory and visuospatial deficits (Warlow 1996). This often leads to a reduction in physical activity, which in turn further reduces physical fitness. In healthy people, reduced mobility through bed rest, habitual inactivity or joint immobilisation (e.g. with a cast) leads to a rapid loss of physical fitness. For example, bed rest for three weeks in healthy young adults leads to a 25% reduction in maximum oxygen uptake (VO2 max), a measure of cardiorespiratory fitness (Saltin 1968). Cast immobilisation causes a local reduction in muscle strength of 3-4% in healthy people within one week (Appell 1990), and is accompanied by muscular atrophy and changes in local muscle metabolism (MacDougall 1977). Inactivity or immobility can cause loss of muscle, an increase in body fat, and a reduction in bone mineral density in all people (Roche 1996).

In stroke patients there appear to be no data examining the relationship between reduced physical activity post-stroke, and loss of cardiorespiratory fitness. After stroke, limb muscle strength is usually impaired; the deficit is greater on the paretic side, but some effect is seen bilaterally (Andrews 2000), suggesting that stroke patients’ immobility as well as hemiparesis reduces muscle strength. Post-stroke there is a progressive reduction in the bone mineral density of upper and lower body limbs on both the paretic, and to a lesser extent the normal side (Liu 1999), suggesting that a general reduction in mobility contributes to a reduction in bone mineral density.

In summary, hemiplegia increases the demands of physical activity, while age, hemiparesis and reduced physical fitness impair the ability to perform muscular work and the capacity to tolerate it. Therefore, even whilst carrying out everyday tasks stroke patients may need to draw upon a high proportion of their maximum capability to perform muscular work, leaving little in reserve. This will render physical activity more fatiguing and uncomfortable, and may even prevent it being performed at all.

**Physical fitness training (Training)**

‘Physical fitness training’ (or training) is defined as a planned, structured regimen of regular physical exercise deliberately performed to improve one or more components of physical fitness.
Training is structured such that the physical demands of the intervention progressively increase, that is the intensity (rate of energy expenditure), frequency and/or duration of the exercise increase throughout the programme. Training interventions are typically targeted at the improvement or maintenance of either cardiorespiratory fitness, or strength and muscular endurance (ACSM 1998). Both types of training intervention can be employed concurrently and both have the capacity to modify body composition. Importantly any improvements in the three components of physical fitness are transient and reversible i.e. when training is discontinued, physical fitness deteriorates to pre-training levels.

For people who are already healthy there is an association between physical activity, including exercise, and long-term health benefits (USDHHS 1996). Epidemiological data indicate that physical activity may reduce the risk of stroke, ischaemic heart disease, diabetes, hypertension, osteoporosis and cancer (Booth 2000). Regular physical activity, including exercise, can enhance quality of life and improve the low physical fitness associated with old age (Young 2001b). People with a variety of existing diseases may benefit from training which forms part of their rehabilitation (Young 2001a). Training has also been employed in the rehabilitation of people with heart failure, neuromuscular disease, diabetes mellitus, arthritis, spinal cord injury, osteoporosis and in the treatment of obesity (Frontera 1999).

Given that healthy people and those with different chronic diseases all benefit from physical activity and training, it is plausible that stroke patients may also benefit. Improvements in physical fitness may improve gait, balance, and motor control; which may, in turn, improve mobility, reduce the risk of falls and fractures, reduce disability and improve quality of life. For example, improvements in cardiorespiratory fitness may compensate for the increased energy requirement of the hemiparetic gait by conferring a smaller relative demand during ambulation (Macko 1997; Waters 1999). It has been argued that improvements in cardiorespiratory fitness might also reduce the risk of subsequent cardiovascular and cerebrovascular events (Goldberg 1988). It should be noted that physical activity, and training in particular, may be associated with some adverse effects. Accordingly, the risks of training-induced soft tissue injuries, altered muscle tone, falls and vascular events will be investigated as part of this review.

**OBJECTIVES**

**Primary objectives**

The three primary objectives of this review were to determine whether stroke patients allocated training compared with controls, at any time after the onset of their stroke, were less likely to be:

(a) dead,
(b) dead or dependent, or
(c) disabled, at the end of intervention.

**Secondary objectives**

(1) **Determine the effect of training on secondary outcome measures (see Types of outcome measures)**

Outcomes were assessed at the end of intervention or the scheduled end of follow-up. This may be at some defined point during the training and/or some weeks or months after the training is complete.

(2) **Determine the effect of factors which could influence the primary and secondary outcome measures (see Subgroup analyses)**

(a) Effect of the dose of training, including:

- whether the frequency, intensity and duration of training sessions exceeded or fell below recommended levels for development of fitness (ACSM 1998);
- degree of progression;
- the duration of the training programme.

(b) Effect of the type of training, including:

- type of training (e.g. cardiorespiratory and/or strength training);
- mode of exercise (e.g. cycling, weight training);
- upper and/or lower extremity;
- affected and/or unaffected limb.

(c) Effect of timing of training:

- during usual care versus after usual care.

(d) The degree to which benefits or effects were retained:

- duration of training effect;
- effect of measures to facilitate continuation of exercise after the end of intervention.

(e) Effect of initial patient status on outcome measures:

- effect of initial disability on outcome;
- effect of training on ambulatory patients with mild, severe or no hemiparesis.

(f) Effect of physical activity performed by control groups.

(g) Effect of trial quality.

**METHODS**

**Criteria for considering studies for this review**
Types of studies
Randomised controlled trials (RCTs), single-blinded or open, were considered where studies made the following comparisons:

(1) Comparison 01: Cardiorespiratory training versus control
- Cardiorespiratory training plus usual care versus usual care (during usual care)
- Cardiorespiratory training versus no training (after usual care)

(2) Comparison 02: Strength training versus control
- Strength training plus usual care versus usual care (during usual care)
- Strength training versus no training (after usual care)

(3) Comparison 03: Mixed training (cardiorespiratory plus strength) versus control
- Mixed training plus usual care versus usual care (during usual care)
- Mixed training versus no training (after usual care)

Usual care included hospital or ward care. Control groups were exposed to either physical activity occurring during usual care or 'no training', comprising either no intervention or a non-exercise intervention (e.g. attention control groups); separate analyses were intended for each subgroup.

Types of participants
Stroke patients of any age were considered if they were considered medically stable enough for training by the trialists. It had been intended that the ambulatory patients be categorised further into subgroups with mild, severe or no hemiparesis. Patients were included irrespective of the time since the onset of the stroke.

Types of interventions
Training interventions included any of the following:

(1) Cardiorespiratory training
The aim of this type of training is to improve the cardiorespiratory component of fitness. It is typically performed for extended periods of time on devices or ergometers (e.g. treadmill, cycling, rowing), or utilising other modes of activity such as walking or stair climbing.

(2) Strength training
This is performed primarily to improve the strength and muscular endurance component of fitness. It is typically carried out by making repeated muscle contractions resisted by body weight, elastic devices, masses, free-weights or specialised machine weights, or isokinetic devices. Concentric, isometric or eccentric contractions of any muscle groups were considered.

(3) Mixed training
This describes training interventions which comprise different activity components, some intended to improve cardiorespiratory fitness and others to improve strength and muscular endurance, for example a training programme comprising both cycling and weight training.

Training interventions were included only where clear evidence was described of an intention to train the participants, i.e. a systematic, progressive increase in the intensity or resistance, the frequency and/or the duration of exercise throughout the programme. The 'dose' of the cardiorespiratory and/or strength training components of a programme were individually categorised as falling within or below the ACSM guidelines on developing and maintaining fitness (ACSM 1998). Measures of adherence to training were sought since this can modify the 'dose' of training. For the purposes of this review we defined adherence as both (a) degree of attendance at training sessions, and (b) compliance with exercise instructions, etc, during training sessions.

Some training programmes may focus the training just on either the upper or lower extremities. Since this may influence some of the outcome measures subgroup analyses comparing upper body, lower body and whole body training interventions were included. If any description of a training regimen was unclear, then the authors were contacted for further information.

Types of outcome measures
Studies that included any scale measuring relevant domains were included. Studies that incorporated any of the primary or secondary outcome measures were included.

(1) Primary outcome measures
(a) Case fatality; numbers of deaths from all causes
(b) Death or dependence
(c) Disability

(2) Secondary outcome measures
(a) Adverse effects
Recurrent non-fatal cardiovascular or cerebrovascular events; altered muscle tone; training-induced injury; incidence of falls; incidence of fractures.

(b) Physical fitness
For example, cardiorespiratory fitness: exercise duration, exercise heart-rate and oxygen consumption (VO2). Muscle strength and power output. Body composition: bone mineral density, body mass index (BMI), adiposity.

(c) Mobility
For example, gait speed and walking ability.

(d) Physical function
For example, task performance, balance and stair climbing.

(e) Health-related quality of life
Any relevant scale.

(f) Mood
Any relevant scale. Assessments of outcome occurred at the scheduled end of a training period (end of intervention), or at any other defined point either within the trial and/or some weeks or months after the training is complete (scheduled end of follow-up). The categories of secondary outcome measures (a-f) represent a superficial change from the published protocol intended to improve clarity. No new outcome measures have been added and the analysis has not been influenced.

**Search methods for identification of studies**

See: ’Specialized register’ section in CochraneStrokeGroup

Relevant trials were identified in the Cochrane Stroke Group trials register, which was last searched by the Review Group Co-ordinator in June 2003. In addition, the following electronic bibliographic databases were searched.

1. Cochrane Central Register of Controlled Trials (The Cochrane Library, Issue 4 2002)
2. MEDLINE 1966 to December 2002 (OVID)
3. EMBASE 1980 to December 2002 (OVID)
4. CINAHL 1982 to December 2002 (OVID)
5. SPORTDiscus 1949 to December 2002 (OVID)
6. Science Citation Index Expanded 1981 to December 2002
7. Web of Science Proceedings 1982 to December 2002
9. REHABDATA 1956 to December 2002 (http://www.naric.com/search/rhab/)
10. Index to UK Theses 1970 to December 2002

The structure of the searches comprised a generic ‘Stroke’ component, supplemented with search terms for locating studies that related to exercise, physical fitness, cardiorespiratory training or strength training. Studies were limited to trials and intervention studies by a further subset of maximally sensitive search strings. The MEDLINE search strategy (Appendix 1) comprised both MESH controlled vocabulary (/) and free text terms (.tw.). An equivalent search strategy was generated for the other databases using the same logic as the MEDLINE search strategy but modified to accommodate differences in indexing and syntax.

**Additional searches**

1. References from retrieved articles were examined to identify additional relevant trials that meet the inclusion criteria.
3. Liaison with investigators of identified trials to identify unpublished and/or ongoing trials.
4. Liaison with investigators involved in relevant physiotherapy reviews for The Cochrane Collaboration (Anne Moseley).
5. National and international experts and organisations were contacted to identify unpublished and/or ongoing trials (Lynn Legg, Jan Potter, Christine Meek, Carol Gulian, Janice Eng, Elizabeth Protas, Sharon Kilbreath, Francine Malouin, Averell Overby and Gert Kwakkel, Royal College of Physicians).
7. Citation tracking of all retrieved papers by Science Citation Index.
8. Ongoing trials were identified using the Internet Stroke Centre’s Stroke Trials Directory database (http://www.strokecenter.org/trials/), the metaRegister of Controlled Trials (http://www.controlled-trials.com/mrct/) and by liaising with investigators.

**Data collection and analysis**

**Study selection**

The title and abstract (where available) of studies identified by the electronic search strategies, along with correspondence describing any unpublished trials, were independently screened for relevance by one reviewer (DS). Where the study was potentially relevant the full publication was obtained. Three reviewers (DS, plus CG or GM) independently applied the selection criteria to the full publications. A consensus discussion resolved disagreements on whether studies were included in the review. A fourth reviewer (AY) was consulted where disagreements persisted. For any relevant or potentially relevant trial identified, published in a language other than English, translation was available in collaboration with the Cochrane Stroke Group.

**Methodological quality assessment**

The methodological quality of the selected trials was assessed by two reviewers (DS plus CG or GM) using a validated quality scale (Jadad 1996). This tool assesses randomisation, blinding and a description of withdrawals and dropouts to give an overall score between 0 and 5. Scores of less than 3 are associated with ‘poor’ trial quality, and 3 to 5 with ‘good’ trial quality. Additional information was obtained including an indication as to whether different trialists were involved in intervention, outcome assessment, and reporting. Assessments were made of the reliability and validity of any measurement tool, scale or method employed by trialists of included studies. Where the article did not contain sufficient information for completion of the quality assessment the authors were contacted. Where missing information could not be retrieved...
the criteria were scored as ‘unclear’ or ‘unknown’. The process was completed using a standard form and a fourth reviewer (AY) arbitrated where no agreement could be reached.

Data extraction

Data were independently extracted by two reviewers (DS plus CG or GM). The data extraction form included the methods and methodological quality information, and the following.

- Participants: number recruited, number randomised, number analysed; age; gender; stroke type, affected side; time from stroke to trial entry; first or recurrent stroke; whether ambulatory, non-ambulatory or initially non-ambulatory; walking aids.
- Interventions: type of training - cardiovascular/strength/mixed; exercise mode; training frequency; training duration; training intensity; programme duration; evidence of programme progression; upper and/or lower body training; affected and/or unaffected side trained; evidence of training adherence (attendance and/or compliance); description of usual care.
- Setting: inpatient or outpatient; supervised or self-lead; home-based or hospital/unit based.
- Outcome measures: for continuous variables baseline values and measures of variability (mean and standard deviation (SD) or standard error (SE)) were recorded. Where the SD of the mean difference was not reported it was calculated from the baseline and follow-up data (Follmann 1992).

Analysis of results

Statistical analysis was carried out using the Cochrane Review Manager software (RevMan 4.2). For dichotomous variables the individual and pooled statistics were calculated using a fixed-effect model and reported as Peto ratios with 95% confidence intervals. For continuous data pooled weighted mean differences (WMD) with 95% confidence intervals were recorded. Where different scales were employed by different studies for the assessment of the same outcome (i.e. dependence and disability) standardised mean differences (SMD) with 95% confidence intervals were calculated. Where meta-analyses were included, tests of homogeneity (Chi² statistic) between comparable trials were carried out. In all meta-analyses both a fixed-effect and a random-effects model was applied; non-identical results were considered indicative of statistical heterogeneity, and the most conservative outcome was reported. Whenever this, and other evidence (Chi² p > 0.1) of statistical heterogeneity was present, explanations were sought using the subgroups below. Funnel plots of pooled data were planned to investigate publication bias.

Subgroup analyses

Some, but not all, of the secondary objectives could be fulfilled using the following subgroup analyses to compare the effects of the following.

- Training programmes which meet the ACSM guidelines (ACSM 1998) and those that do not.
- Long duration (> 12 weeks) or short duration (< 12 weeks) training programmes.
- Cardiorespiratory, strength or mixed training.
- Different modes of exercise.
- Training programmes concentrating on upper or lower extremity exercise.
- Training programmes concentrating on affected or unaffected limbs.
- Training during usual care or after usual care.
- Inclusion of measures to facilitate continuation of exercise between the end of intervention and the scheduled end of follow up.
- Mild, severe or no hemiparesis.
- Control groups utilising no intervention, a non-exercise intervention or other intervention.
- ‘Good’ or ‘poor’ trial quality (Jadad 1996).

Sensitivity analyses

Sensitivity analyses assessed the effect of the following.

- Inclusion of trials in which the reviewers considered the control condition or usual care to contain elements which may provide an intentional, or unintentional training effect.
- Inclusion of trials examining mixed cardiorespiratory/strength training of which only one component met or exceeded the ACSM guidelines (ACSM 1998).
- Blinding, drop-outs and withdrawals.

Results

Description of studies

See: Characteristics of included studies; Characteristics of excluded studies; Characteristics of ongoing studies.

The search strategy identified a number of relevant review articles (Ernst 1990; Wagenaar 1991; Giuliani 1995; Potempa 1996; Andersen 2001) and a systematic review (van der Lee 2001) and the bibliographies of these were screened for further studies. On the basis of information in the title and abstract, 42 studies were identified as being potentially relevant and full papers obtained. Of these, 31 studies did not meet the inclusion criteria and the reasons for their exclusion are documented in Characteristics of excluded studies.

A total of 11 published RCTs met the inclusion criteria and are discussed in the current review (Inaba 1973; Glasser 1986;
Cuviello-Palmer 1988; Richards 1993; Potempa 1995; Duncan 1998; Teixeira 1999; Dean 2000; Kim 2001; da Cunha 2002; Pohl 2002a/Pohl 2002b). The studies took place in, and involved participants from, Australia (one), Canada (three), Germany (one) and USA (six). The trial by Pohl 2002 included two different treadmill training intervention groups sharing the same control group. The data are included in this review as two separate comparisons (Pohl 2002a; Pohl 2002b) and referred to as separate ‘trials’. The trial by Inaba 1973 consisted of two intervention arms sharing the same control group, only one of which met the inclusion criteria. Therefore 12 trials are described in the review and the details are summarised as 12 separate entries in Characteristics of included studies. Additional information about some trials was obtained from the authors (Richards 1993; Dean 2000; Kim 2001; da Cunha 2002) and additional data from another (Duncan 1998). One RCT met the inclusion criteria (Bateman 2001) but examined a mixed population of participants with different brain pathologies including stroke. The stroke-only data (control N = 32/79; intervention group N = 38/78) may be available for inclusion in a future version of this review, therefore the trial is described in Characteristics of ongoing studies. In addition to the data of Bateman 2001 there are six further trials described in Characteristics of ongoing studies that are either ongoing or for which data are not yet available (Chu; Isaacs; Kilbreath; Lum; Mead; Protas).

Table 1. Summary of the training intervention programmes

<table>
<thead>
<tr>
<th>Trial</th>
<th>Type</th>
<th>+/- ACSM</th>
<th>Training Mode</th>
<th>Duration min/d</th>
<th>Frequency d/wk</th>
<th>Programme Length wk</th>
<th>Usual Care</th>
</tr>
</thead>
<tbody>
<tr>
<td>da Cunha 2002</td>
<td>CR</td>
<td></td>
<td>Body weight supported treadmill training</td>
<td>20</td>
<td>5</td>
<td>2-3</td>
<td>During</td>
</tr>
<tr>
<td>Cuviello-Palmer 1988</td>
<td>CR</td>
<td></td>
<td>Kinetron</td>
<td>7-17</td>
<td>6</td>
<td>3</td>
<td>During</td>
</tr>
<tr>
<td>Dean 2000</td>
<td>CR, STR</td>
<td></td>
<td>Walking, Circuit training</td>
<td>60</td>
<td>3</td>
<td>4</td>
<td>After</td>
</tr>
</tbody>
</table>

Participants

A total of 289 patients were randomised and attended baseline assessment in the 12 included trials. Six withdrawals occurred after randomisation and baseline assessment due to illness (two), transport costs (one), discharge (one), failure to complete training (one) and one unreported reason. Therefore 283 patients (male:female 3:2; precise numbers unclear) were available for outcome assessment at the end of training. The mean time since onset of stroke in participants in the trials ranged from 7.7 years in trials examining training after discharge (Teixeira 1999) to 8.8 days in trials examining training before discharge from hospital (Richards 1993).

The mean age of the patients was approximately 63 years. Eleven of the 12 trials recruited patients who were ambulatory at baseline (N = 271/289) and one of the 12 (Richards 1993; N = 18/289) recruited patients who were non-ambulatory at baseline.

Interventions

A recent potentially relevant systematic review of exercise therapy for arm function in stroke patients (van der Lee 2001) included 13 RCTs. All 13 trials had already been identified by the search strategy employed in this review, but only one (Duncan 1998) met the current inclusion criteria. Of the remaining 12 trials, two were identified as not relevant. Although the other 10 were identified as being potentially relevant they were excluded as none was found to include an intervention with a clear fitness training component as defined in this review.
### Table 1. Summary of the training intervention programmes (Continued)

<table>
<thead>
<tr>
<th>Study</th>
<th>Type</th>
<th>Mode</th>
<th>Intervention</th>
<th>Duration</th>
<th>Sessions/Week</th>
<th>Intervention Type</th>
<th>Completed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Duncan 1998</td>
<td>CR, STR</td>
<td>+STR</td>
<td>Walking or cycling, elastic resisted contractions</td>
<td>-90</td>
<td>3</td>
<td>12 (8 supervised, 4 home-based)</td>
<td>After</td>
</tr>
<tr>
<td>Glasser 1986</td>
<td>CR</td>
<td></td>
<td>Kinetron</td>
<td>20-60</td>
<td>5 (2 sessions /d)</td>
<td>5</td>
<td>After</td>
</tr>
<tr>
<td>Inaba 1973</td>
<td>STR</td>
<td>+STR</td>
<td>Resistance training</td>
<td>UN</td>
<td>UC (daily)</td>
<td>4-8</td>
<td>During</td>
</tr>
<tr>
<td>Kim 2001</td>
<td>STR</td>
<td>+STR</td>
<td>Resistance training</td>
<td>30</td>
<td>3</td>
<td>6</td>
<td>After</td>
</tr>
<tr>
<td>Pohl 2002 (a)</td>
<td>CR</td>
<td></td>
<td>Treadmill training</td>
<td>30</td>
<td>3</td>
<td>4</td>
<td>During</td>
</tr>
<tr>
<td>Pohl 2002 (b)</td>
<td>CR</td>
<td></td>
<td>Treadmill training</td>
<td>30</td>
<td>3</td>
<td>4</td>
<td>During</td>
</tr>
<tr>
<td>Potempa 1995</td>
<td>CR</td>
<td>+CR</td>
<td>Cycling</td>
<td>30</td>
<td>3</td>
<td>10</td>
<td>After</td>
</tr>
<tr>
<td>Richards 1993</td>
<td>CR, STR</td>
<td></td>
<td>Treadmill, Kinetron</td>
<td>104</td>
<td>5 (2 sessions /d)</td>
<td>5</td>
<td>During</td>
</tr>
<tr>
<td>Teixeira 1999</td>
<td>CR, STR</td>
<td>+CR, +STR</td>
<td>Walk and step or cycle. Resistance training</td>
<td>60-90</td>
<td>3</td>
<td>10</td>
<td>After</td>
</tr>
</tbody>
</table>

**Timing of intervention**

The interventions of six trials comprising 124/289 patients occurred after usual care (Glasser 1986; Potempa 1995; Duncan 1998; Teixeira 1999; Dean 2000; Kim 2001). The interventions of the remaining six trials (165/289 patients) took place during usual care (Inaba 1973; Cuviello-Palmer 1988; Richards 1993; da Cunha 2002; Pohl 2002a; Pohl 2002b). Only three trials (Cuviello-Palmer 1988; Richards 1993; da Cunha 2002) comprising 48/289 patients commenced interventions in the acute phase (< one month) post-stroke. In all other trials the interventions commenced months or years after stroke.

**Duration of intervention**

The training programmes ranged from two to three weeks (da Cunha 2002) up to 10 weeks (Potempa 1995; Teixeira 1999), or 12 weeks including four weeks of unsupervised home-based training (Duncan 1998). All included trials involved three or more days of training per week, sometimes with more than one session per day (Glasser 1986; Richards 1993).

Individual training sessions ranged between seven and 90 minutes of training on each occasion. The duration of training was approximately 50 minutes or less during usual care (Cuviello-Palmer 1988; Richards 1993; da Cunha 2002; Pohl 2002a; Pohl 2002b), and 30 to 90 minutes after discharge (Glasser 1986; Potempa 1995; Duncan 1998; Teixeira 1999; Dean 2000; Kim 2001). A duration of training was not specified by Inaba 1973.

**Cardiorespiratory training interventions**

All trials except Inaba 1973 and Kim 2001 included some component of cardiorespiratory training (N = 215). The modes of cardiorespiratory training activated the large muscle groups of the lower limbs using equipment such as treadmills, cycle ergometers and isokinetic devices (Kinetron). In addition, walking, stepping and circuit training were used. The duration of this cardiorespiratory component commenced above or progressed to a minimum of 20 minutes per session. All cardiorespiratory training interventions showed some element of progression, usually an increase in duration of exercise. Only two trials (Potempa 1995; Teixeira 1999; N = 55/215) quantified the intensity of cardiorespiratory
training, and its progression, in terms of a percentage of a partici-

dant’s maximal capacity. Both studies met the ACSM 1998 guide-

lines for the development of cardiorespiratory fitness in healthy

individuals. In the other 10 studies (N = 160/215) it was not pos-

tible to judge whether the intervention met the guidelines.

Strength training interventions

Five trials included a component of strength training (Inaba 1973; Duncan 1998; Teixeira 1999; Dean 2000; Kim 2001; N = 134). Two of the trials (Inaba 1973; Kim 2001) included only strength training and this was confined to the affected lower limb only; the remaining trials included bilateral training of the lower or both upper and lower limbs. The modes of strength training comprised muscle contractions resisted by weights (Inaba 1973; Teixeira 1999), elastic devices (Duncan 1998; Teixeira 1999) or body weight (Teixeira 1999; Dean 2000). An isokinetic dynamometer was used by Kim 2001. The isokinetic Kinetron device was used by Richards 1993 as a means of increasing muscle strength, although this has a more obvious role for cardiorespiratory training. The trials included evidence of progression and four quantified the intensity of muscle contraction either in relation to maximum strength (Inaba 1973; Teixeira 1999; Kim 2001) or number of res-

isted contractions that could be tolerated (Duncan 1998). The in-


Adherence to training interventions

Dean 2000 reported 75% attendance at training after usual care, Pohl 2002a and Pohl 2002b report 100%, and Richards 1993 84% attendance at training during usual care. Teixeira 1999 did not report attendance but described attempts to make up missed sessions. da Cunha 2002 excluded participants if they attended fewer than nine training sessions. Compliance during training sessions was difficult to fully quantify since measures of exercise intensity are frequently not reported. No trials described compliance to training during sessions. Attendance at, and compliance during training were encouraged in one trial (Dean 2000) through supervision of training, provision of transport and group exercise. Duncan 1998 ensured attendance during eight weeks of home-based training through one-to-one supervision; however compliance during a further four weeks of unsupervised training remained unknown.

Risk of bias in included studies

Randomisation

All included trials were described as randomised. The participants of Duncan 1998 were balanced into groups of similar size by ran-

domising in blocks of 10. Six trials balanced group size and base-

line characteristics using the following approaches: matched pairs (Dean 2000), balanced blocks (Teixeira 1999), stratified based on initial disability (Barthel Index; Richards 1993), stratified using age, gender and time since stroke (Kim 2001), and restricted ran-

domisation in blocks based on walking speed (Pohl 2002a; Pohl 2002b).

Trial quality

Other indicators of trial methodological quality were poorly re-

ported. Six of the 12 trials described blinding of the outcome as-

sessor, five fully described dropouts and withdrawals, and two de-

scribed randomisation methods. No trials described how blinding was achieved. When a simple model of methodological quality (Jadad 1996) was applied to these data four trials were classified as good (Richards 1993; Kim 2001; Pohl 2002a; Pohl 2002b). The remainder were classified as poor. The individual scores are described in Characteristics of included studies. There were inadequate data to explore the effect of trial quality on outcome. Even though supplementary information relating to trial quality was obtained from authors (Dean 2000; da Cunha 2002) it generally remains unclear whether poor scores reflect trial methodology or arise from incomplete reporting.

Blinding

Other than concealing the hypothesis of a trial of exercise, the blinding of the patients is not possible in exercise intervention studies. Placebo responses may arise in comparisons with a non-ex-

ercise control intervention, and particularly where no intervention is used (after discharge and lag-control trials). However Kim 2001 attempted to ‘blind’ by informing participants that they would be allocated one of two different leg-training interventions. In the Dean 2000 trial the outcome assessor was reported to have ac-

cidentally observed a group training session thus potentially identi-

fying the members of the intervention group.

Losses to follow up

Loss of participants prior to randomisation can influence the extrapolation and generalisability of the results (Schulz 2002). Three participants were lost from Potempa 1995, and a total of nine within Pohl 2002a plus Pohl 2002b.

Loss of participants after randomisation may bias the comparison of the intervention and control groups. In da Cunha 2002 three out of 15 (20%) and Dean 2000 three out of 12 (25%) of the participants were lost to follow up comprising two participants from each intervention group and one from each control group lost (N = 6). Losses of 20% or more may seriously threaten the validity of trials (Schulz 2002). Where data from da Cunha 2002 and Dean 2000 are combined in meta-analyses their weighting was often small and sensitivity analyses of their exclusion did not influence the findings. Furthermore, although data for intention-
to-treat analysis was not obtained, loss to follow up of these small numbers are unlikely to bias the overall findings of this review. da
Cunha 2002 excluded those with poor attendance, this manner of exclusion after randomisation removes the possibility of intention to treat analysis and threatens methodological quality. A large proportion (101/177) of patients recruited to the Inaba 1973 trial were lost both before and after randomisation. The distribution of losses across excluded and included arms of the trial remain unknown. Data for 54 patients were analysed per protocol for Inaba 1973. One reason given for dropouts was discharge before the end of the study.

Recruitment
The participants in the Teixeira 1999 trial were volunteers recruited from a stroke club and from media advertisements, and those in the Kim 2001 trial were recruited on a volunteer basis from the surrounding community. This may render these studies susceptible to self-selection bias and thus affect the generalisability of the findings.

Reliability of outcome measures
The clinical scales used as outcome measures in this review are in common use in stroke trials. With regard to mobility outcomes, the repeatability of maximal walking speed has been demonstrated in stroke patients (intraclass correlation coefficient (ICC) 0.87 to 0.88; Green 2002). With regard to measures of physical fitness in stroke patients, the methods are less well established. The reliability of measures of muscle strength on stroke patients has been explored, for example Eng 2002 reported test-retest reliability of muscle strength using an isokinetic dynamometer (ICC 0.62 to 0.94). However these measures were limited to the affected limb and utilised very specific equipment. Some reliability data are available for measurements of peak oxygen uptake (VO2 peak) in stroke patients (ICC 0.94; Potempa 1995).

Types of comparison
The anticipated comparisons published a priori in this review protocol were:
(1) training plus usual care versus usual care; and
(2) training versus no exercise or non-exercise intervention.
Some data did not match the anticipated comparisons. In the cases of da Cunha 2002, Pohl 2002a and Pohl 2002b the cardiorespiratory treadmill walking interventions substituted an equivalent duration of usual care gait training (training plus % usual care versus usual care). Similarly, in the fitness training intervention of Glasser 1986, training replaced part of the non-exercise intervention after usual care (training plus % control versus control). These types of comparison ensure that experimental and control groups receive a similar amount of intervention. Time spent in therapy would otherwise be a confounding factor since it is known to influence rehabilitation outcomes similar to those sought in this review (Kwakkel 1997; Kwakkel 1999; Kwakkel 2002; Langhorne 2002).

Effects of interventions
A summary of the outcome measures from the included trials are described in Table 2 (Primary outcome measures) and Table 3 (Secondary outcome measures). Outcomes reported by authors as statistically significant (p < 0.05) are denoted by a ‘*’ in Table 2 and Table 3, where no significant (p > 0.05) benefit was observed a ‘NS’ was used. Numerical data are described in tables and the text as mean standard deviation.

Table 2. Primary outcome measures

<table>
<thead>
<tr>
<th>Trial</th>
<th>Death</th>
<th>Disability</th>
<th>Dependence</th>
</tr>
</thead>
<tbody>
<tr>
<td>da Cunha 2002</td>
<td>-</td>
<td>Functional Independence Measure - incomplete scale used (lower extremity; NS)</td>
<td></td>
</tr>
<tr>
<td>Cuviezzo-Palmer 1988</td>
<td>-</td>
<td>Functional Measure (NS)</td>
<td>Independence</td>
</tr>
<tr>
<td>Dean 2000</td>
<td>-</td>
<td>Functional In-</td>
<td></td>
</tr>
</tbody>
</table>

Table 3. Secondary outcome measures

<table>
<thead>
<tr>
<th>Trial</th>
<th>Death</th>
<th>Disability</th>
<th>Dependence</th>
</tr>
</thead>
<tbody>
<tr>
<td>da Cunha 2002</td>
<td>-</td>
<td>Functional Independence Measure - incomplete scale used (lower extremity; NS)</td>
<td></td>
</tr>
<tr>
<td>Cuviezzo-Palmer 1988</td>
<td>-</td>
<td>Functional Measure (NS)</td>
<td>Independence</td>
</tr>
<tr>
<td>Dean 2000</td>
<td>-</td>
<td>Functional In-</td>
<td></td>
</tr>
</tbody>
</table>
Table 2. Primary outcome measures (Continued)

<table>
<thead>
<tr>
<th>Trial</th>
<th>Physical fitness</th>
<th>Mobility</th>
<th>Physical Function</th>
<th>Health Status &amp; QoL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Duncan 1998</td>
<td>-</td>
<td>Barthel Index (NS)</td>
<td>Lawton instrumental activities of daily living (NS)</td>
<td></td>
</tr>
<tr>
<td>Glasser 1986</td>
<td>-</td>
<td>Lawton instrumental activities of daily living (NS)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Inaba 1973</td>
<td>-</td>
<td>Activities of daily living (*)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Kim 2001</td>
<td>-</td>
<td>Lawton instrumental activities of daily living (NS)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pohl 2002 (a)</td>
<td>-</td>
<td>Lawton instrumental activities of daily living (NS)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pohl 2002 (b)</td>
<td>-</td>
<td>Lawton instrumental activities of daily living (NS)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Potempa 1995</td>
<td>-</td>
<td>Lawton instrumental activities of daily living (NS)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Richards 1993</td>
<td>-</td>
<td>Barthel Index - incomplete scale used (NS)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Teixeira 1999</td>
<td>-</td>
<td>Lawton instrumental activities of daily living (NS)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 3. Secondary outcome measures

<table>
<thead>
<tr>
<th>Trial</th>
<th>Physical fitness</th>
<th>Mobility</th>
<th>Physical Function</th>
<th>Health Status &amp; QoL</th>
</tr>
</thead>
<tbody>
<tr>
<td>da Cunha 2002</td>
<td>Cycle Workload Watts (NS); Cycling time (NS); Heart rate (NS); peak VO2 (*) ; Blood pressure (NS)</td>
<td>Functional Ambulation Categories (*); Functional Independence Measure - Locomotor scale (NS); Comfortable walking speed 5-min (NS); Maximum walking speed 5-metres (NS)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cuviello-Palmer 1988</td>
<td>Comfortable walking speed (NS)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dean 2000</td>
<td>Comfortable walking speed (<em>) ; Maximum walking speed (</em>)</td>
<td>Timed up and go (NS); Sit to stand (<em>) ; Step Test (</em>)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Table 3. Secondary outcome measures  (Continued)

<table>
<thead>
<tr>
<th>Study</th>
<th>Outcome Measures</th>
<th>Outcome Measures</th>
<th>Outcome Measures</th>
</tr>
</thead>
<tbody>
<tr>
<td>Duncan 1998</td>
<td>Comfortable walking speed (NS); Maximum walking speed (*)</td>
<td>Berg Balance Scale (NS); Jepsen hand test (NS); Fugl-Meyer Lower Extremity (*)</td>
<td>MOS-36 (NS)</td>
</tr>
<tr>
<td>Glasser</td>
<td>Function of ambulation Profile (NS); Maximum walking speed (*)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Inaba 1973</td>
<td>Muscle strength (*)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Kim 2001</td>
<td>Muscle strength (*)</td>
<td>Comfortable walking speed (NS); Maximum walking speed (NS)</td>
<td>Stair climbing - comfortable speed (NS); Stair climbing - maximum speed (NS)</td>
</tr>
<tr>
<td>Pohl 2002 (a)</td>
<td></td>
<td>Maximum walking speed (<em>); Functional Ambulation Categories (</em>)</td>
<td></td>
</tr>
<tr>
<td>Pohl 2002 (b)</td>
<td></td>
<td>Maximum walking speed (<em>); Functional Ambulation Categories (</em>)</td>
<td></td>
</tr>
<tr>
<td>Potempa 1995</td>
<td>Maximal cycling work-load Watts (<em>); Maximal cycling time (</em>); Heart rate (NS); Peak VO2 (*) ; Blood pressure (NS)</td>
<td>Fugl-Meyer score (NS)</td>
<td></td>
</tr>
<tr>
<td>Richards 1993</td>
<td></td>
<td>Barthel Index - ambulation scores (NS)</td>
<td>Fugl-Meyer Lower Extremity (NS); Fugl-Meyer Upper Extremity (NS); Fugl-Meyer Balance (NS)</td>
</tr>
<tr>
<td>Teixeira 1999</td>
<td></td>
<td>Comfortable speed (*)</td>
<td>Human Activity Profile (*)</td>
</tr>
</tbody>
</table>

Where data were combined in meta-analyses, the chi-squared statistic did not indicate statistical heterogeneity (p > 0.1). Unless stated otherwise the results of both fixed and random-effects meta-analysis were identical. Funnel plots of data combined in meta-analyses were inconclusive because data for so few trials were combined. The small numbers of trials within each meta-analysis (maximum three) limited the usefulness of any planned subgroup and sensitivity analyses.

**Effect of training on primary outcome measures**

(1) Case fatality
None of the 289 included patients was reported to have died during the included trials.

(2) Death or dependence
No measures of dependence were reported, and therefore neither was the composite outcome of death or dependence.

(3) Disability
Disability data reported by Cuvello-Palmer 1988 and Duncan 1998 were combined in a meta-analysis (Comparison 01; Outcome 01) to show no significant effect of training (SMD -0.06,
95% CI -0.76, 0.65). Cuviello-Palmer 1988 reported changes in the functional independence measure (FIM) scores and concluded that it was not beneficial to perform cardiorespiratory training on an isokinetic ergometer (Kintron II) during two to three weeks of usual care. Duncan 1998 showed no significant effect of mixed training on the changes observed in the Barthel Index ADL or the Lawton Instrumental ADL. Individual patient data for Duncan 1998 showed Barthel Index scores reaching a ceiling of 100 in five out of 20 participants at baseline and 10 out of 20 at follow up, therefore the Lawton Instrumental ADL data were adopted for the meta-analysis. Incomplete disability scales were reported by da Cunha 2002 (FIM; locomotor scale) and Richards 1993 (Barthel Index; ambulation) and were therefore excluded from the analysis. Inaba 1973 reported that 18 out of 28 patients receiving strength training of the affected lower limb improved in 10 activities of daily living (no scale used) compared with only 10 out of 26 of those receiving only ADL training (p < 0.05). The authors of this trial state that little additional improvement occurred during a further month of training although these data are not presented. The mixed brain lesion trial by Bateman 2001 includes measures of disability and dependence using the Barthel Index, FIM and Nottingham Extended Activities of Daily Living (NEADL) but a subset of this data limited to stroke patients is not yet available. Since few disability data were available it was not possible to examine the effect of initial disability on secondary outcome measures.

Effect of training on secondary outcomes

(1) Adverse effects
No trials reported the incidence of recurrent non-fatal cardiovascular or cerebrovascular events. In addition there were no data available describe altered muscle tone, or the incidence of falls, fractures or training induced injury.

(2) Physical fitness

Cardiorespiratory Fitness
Potempa 1995 and da Cunha 2002 measured aspects of cardiorespiratory fitness during incremental cycling exercise. Both described a significantly higher peak VO2 following cardiorespiratory training compared with controls (Potempa 1995; 18.8 ± 4.8 versus 15.2 ± 4.32 ml/kg/min and da Cunha 2002 11.6 ± 2.76 versus 8.32 ± 2.05 ml/kg/min). However, meta-analysis of the pooled data (Comparison 01; Outcome 02) showed no significant improvement in VO2 (WMD 2.51 ml/kg/min, 95% CI -0.20, 5.23), or maximal work rate (WMD 14.1 Watts, 95% CI -11.8, 40.0). da Cunha 2002 assessed the economy of gait during five minutes of walking in terms of the oxygen cost per unit distance (ml/kg/m walked) and reported a moderate (but non-significant) effect size of 0.7 SD units.

Potempa 1995 also reported a post-training increase in maximal work rate and decreased maximal heart rate during incremental cycling exercise. da Cunha 2002 reported no effect on heart rate or blood pressure during incremental cycling exercise.

Muscle Strength
Only two trials included muscle strength outcome measures (Inaba 1973; Kim 2001). Inaba 1973 showed that patients allocated strength training of the involved lower limb made significantly greater gains in the 10 repetition maximum compared with controls (12.18 versus 8.58 kg, p < 0.02) after one month of intervention. There were no differences between groups after two months of training. No standard deviations or standard error were included with these data. Kim 2001 showed patients allocated strength training of the involved lower limb on an isokinetic dynamometer (Kin-Com) exhibited no significant improvement in the strength of the trained leg compared with controls (sum % change in six muscle groups 507 ± 559 versus 142 ± 193, p = 0.06).

(3) Mobility

Functional ambulation categories
Significant improvements in Functional Ambulation Category (FAC) scores were reported by Pohl 2002a and Pohl 2002b after treadmill training, and by da Cunha 2002 after treadmill training with partial body weight support; these cardiorespiratory training interventions took place during usual care. Meta-analysis of these trials (Comparison 01; Outcome 04) showed a significant improvement in FAC scores (WMD 0.60, 95% CI 0.14, 1.06). The trial of da Cunha 2002 contributes only 5% of the weighting in this comparison.

Maximal walking speed
Maximal walking speed was measured by Dean 2000, Duncan 1998, Pohl 2002a and Pohl 2002b over 10 metres, by Glasser 1986 over six metres and da Cunha 2002 over five metres. Meta-analysis (Comparison 01; Outcome 05) of the cardiorespiratory training interventions of da Cunha 2002, Glasser 1986, Pohl 2002a and Pohl 2002b showed a significant overall improvement in maximal walking speed (SMD 0.42 m/sec, 95% CI 0.04, 0.79). Of these trials the greatest individual effect size (SMD 0.82 m/sec, 0.17, 1.47) was associated with the most intense and rapidly progressing training programme of Pohl 2002b. Excluding Glasser 1986 limits the analysis to treadmill training studies and increases the effect (SMD 0.50 m/sec, 95% CI 0.08, 0.91). Improvements in maximal walking speed compared with controls after a mixed training intervention were reported by Duncan 1998 (mean change 0.25 versus 0.09 m/sec) and by Dean 2000 (mean change 0.13 versus 0.02 m/sec; p < 0.05). The data could not be combined in a meta-analysis as standard deviation data was
not available for Duncan 1998. The benefits reported by Dean 2000 were retained after a two-month follow up.

**Comfortable or chosen walking speed**

Comfortable or chosen walking speed was assessed using a number of different protocols by da Cunha 2002 (five-minute walk), Dean 2000 (six-minute walk), Duncan 1998 (six-minute walk), Teixeira 1999 (22-metre walk), Kim 2001 (eight-metre walk) and Cuviello-Palmer 1988 (seven-second walk). Meta-analysis of the cardiorespiratory training interventions of da Cunha 2002 and Cuviello-Palmer 1988 delivered during usual care (Comparison 01; Outcome 06) indicated no significant benefit of training (SMD Fixed 0.12 m/sec, 95% CI -0.82, 0.57). The Cuviello-Palmer 1988 intervention represented a very small ‘dose’ of training since it was of short duration (seven to 12 minutes) and of very low intensity (heart rate within 20 beats/min of resting). Only Kim 2001 examined the effect of strength training in isolation on self selected walking speed and showed no significant benefit compared to control (mean change 0.04 0.13 versus 0.09 0.07 m/sec).

Dean 2000, Duncan 1998 and Teixeira 1999 examined the effect of a mixed training programme, including walking, delivered after usual care. Meta-analysis of these data (Comparison 03; Outcome 01) showed no significant benefit in chosen walking speed (SMD 0.13 m/sec, 95% CI -0.16, 0.42). Dean 2000 and Teixeira 1999 reported significant benefits within their studies, and those of Dean 2000 were retained after a two-month follow up. The matched pairs data of Dean 2000 are assessed as unmatched data in the meta-analysis. This may bias the results for this trial, however exclusion of Dean 2000 did not alter the findings of the pooled data.

Richards 1993 reported faster chosen walking speed at the end of a mixed training intervention (including walking) delivered during usual care (effect size 0.58). These data are excluded from the above meta-analysis as the participants were non-ambulatory at baseline (walking velocity of ‘zero’). The degree of benefit in this mixed training trial was associated with the amount of time spent on the gait training component (R² = 0.63). However, the increased comfortable walking speed reported by Richards 1993 was not retained after a three to six-month follow up.

(4) **Physical function**

A variety of physical function and motor function outcomes were reported (Table 3). Global Fugl-Meyer (FM) scores were reported by Potempa 1995 while other studies limited the measure to the upper extremity (FM-U; Duncan 1998; Richards 1993), lower extremity (FM-L; Duncan 1998; Richards 1993) and balance (FM-B Richards 1993) subsets of the FM scale. The only significant improvement reported was in FM-L by Duncan 1998. Significant improvements in simple physical tasks such as a timed step test and timed sit to stand were noted by Dean 2000 to occur after specific (or task-related) circuit training. Kim 2001 reported that strength training of the affected lower limb did not improve stair climbing ability. In addition to there being no significant strength gains, this intervention employed an isokinetic dynamometer to train only the affected lower limb, and was not considered specific or task-related training.

(5) **Health status and quality of life**

Very few measures relating to this domain were reported. Meta-analysis of the mixed training trials Duncan 1998 (SF-36) and Teixeira 1999 (Nottingham Health Profile) indicated no significant benefit of mixed training on health status and quality of life (Comparison 03; Outcome 02; SMD Random 0.29, 95% CI -1.37, 0.80).

Kim 2001 showed no significant benefit of strength training compared with a control on the physical health (mean change 38.6 6.7 versus 40.6 7.0) and mental health components (mean change 50.1 13.4 versus 55.6 7.3) of the SF-36.

(6) **Mood**

There were no data available relating to outcome measures of mood.

**Subgroup analyses**

Since few data were available it was not possible to perform any of the planned subgroup analyses. However, several observations relating to the effect of factors influencing primary and secondary outcome measures (Objective 2.2) are described in the Discussion.

**Sensitivity analyses**

The effect of loss to follow up in Dean 2000 and da Cunha 2002 was assessed. Exclusion of these trials from the meta-analyses did not influence any of the conclusions of this review. There were too few data to perform other intended sensitivity analyses.

**DISCUSSION**

The small number of relevant trials identified in this review and in particular their lack of primary outcome measures means that few conclusions can be drawn about the impact of physical fitness training or physical fitness on death, disability or dependence after stroke. The outcome measures described in the included trials were very diverse. This is typical of stroke rehabilitation trials and presents a problem when combining data in systematic reviews (Greener 2002).

(1) **Effect of training on primary outcome measures**
Cardiorespiratory fitness was shown to be impaired after stroke. Baseline VO2 peak of the participants in da Cunha 2002 and in Potempa 1995 was 30% and 50% to 60% respectively, of the values expected in untrained age and sex-matched healthy people (Shvartz 1990). The functional significance of low peak VO2 is an impaired ability to perform sustained aerobic exercise.

Cardiorespiratory training did not significantly improve VO2 peak or cycling performance, however the studies were underpowered to detect a difference in VO2 peak of the magnitude observed. Low exercise economy, (ie a higher absolute oxygen cost of a given task or activity) has important consequences for stroke patients since this also impacts upon the ability to perform sustained activity. Only da Cunha 2002 reported improved (walking) economy, but a small sample size and variable baseline data make analysis of this outcome measure difficult.

Muscle strength
There were too few data available to ascertain whether muscle strength can be increased via programmes of fitness training, including strength training. Muscle strength is known to be associated with standing, stepping and walking ability, but it is not known whether there is any functional benefit associated with improved strength in patients with stroke. The Inaba 1973 and Kim 2001 trials provided strength training of the involved lower limb only. Strength impairments post-stroke, although greater on the involved side, are known to occur bilaterally (Andrews 2000; Harris 2001). Therefore functional benefits arising from improved strength may not be apparent if training occurs unilaterally.

Those studies which examined mixed cardiorespiratory and strength training (Duncan 1998; Teixeira 1999; Dean 2000) measured neither cardiorespiratory fitness nor muscle strength. Therefore it was not possible to identify whether any particular benefits were associated with strength (or cardiorespiratory) training.

(c) Mobility
Treadmill walking (cardiorespiratory) training significantly improved the Functional Ambulation Category scores of patients with stroke. This is indicative of patients being less dependent on others for ambulation. This observation relies heavily on data from one trial (Pohl 2002a; Pohl 2002b) however it is of high quality and is of a robust design.

Cardiorespiratory training significantly improved mobility by increasing maximum walking speed over short distances (five to 10 metres). These observed benefits may have arisen due to improvements in motor function since improved cardiorespiratory fitness would logically provide little benefit to short duration effort. The contrast between the two comparisons of treadmill walking in Pohl 2002 (Pohl 2002a; Pohl 2002b) is a valuable one and suggests potential benefits of increasing the intensity of exercise. In Pohl 2002b the treadmill walking speed (exercise intensity) was
increased as much as could be tolerated every session, whereas in Pohl 2002a the speed progressed by a fixed, more modest amount. The improvements in mobility when traditional gait training (control group) was substituted with more intense treadmill training occurred even though the patients received 20% less total intervention time (12 versus 15 hours). Increased functional benefit was associated with the highest intensity and fastest progressing treadmill intervention (Pohl 2002b). Neither cardiorespiratory training during usual care, nor mixed training after usual care resulted in any improvement in comfortable or customary walking speed. All trials which included walking as part or all of the training intervention reported one or more significant improvements in ambulation outcome measures. The two trials that did not report improvements in ambulation outcome measures (Glasser 1986; Cuvello-Palmer 1988) both employed an isokinetic ergometer (Kinetrion) as the mode of training. Training on devices like this (including cycle ergometers) in isolation may not provide relevant adaptations that translate into functional benefits. Although planned subgroup analyses examining the effect of mode of exercise were not possible, this observation is compatible with the concept of ‘task-related’ or ‘specific’ training. There were too few data (Richards 1993) to examine the benefits of fitness training for non-ambulatory stroke patients. This data reinforced further the notion of specificity of training.

(d) Physical function
There were too few data on which to make any comment on physical function. Benefits appeared to occur when task-related training was employed (Dean 2000).

(e) Health related quality of life
There were too few data relating to health related quality of life.

(f) Mood
No conclusions could be drawn about the effect of training on mood as no outcome data were available.

(2.2) Factors influencing primary and secondary outcome measures
There were too few data for subgroup analyses however a number of important observations can be made.

(a) Dose of training
Although training has been shown to be of some benefit to patients after stroke there are too few data to establish a dose-response relationship between training and potential benefits for stroke patients.

• The ACSM 1998 criteria were used to define an effective overall ‘dose’ of fitness training as defined by the parameters of intensity, duration and frequency. The interventions of several trials (Inaba 1973; Potempa 1995; Duncan 1998; Teixeira 1999) met the criteria and showed benefits. Benefits were also noted in trials whose interventions did not meet the ACSM criteria. Other trials may have met these criteria but the interventions were not fully reported especially with regard exercise intensity.

• Exercise intensity is probably one of the most important fitness training variables; rather confusingly it is also used to describe the frequency and duration of therapeutic interventions (e.g. Kwakkel 2002). Only the data of Pohl 2002 examined this indicated that higher intensity walking training (Pohl 2002b) is more beneficial to maximal walking speed. However this intervention was also the most rapidly progressing so this effect is difficult to separate the effect from that of intensity.

• Poor adherence to a programme of training reduces the training dose and therefore the training stimulus. Attendance was reported in some studies and this was greatest during inpatient care. This review indicates stroke patients can complete a variety of different short-term training interventions.

(b) Type of training

• It is not known whether cardiorespiratory, strength or mixed training interventions are most beneficial. One ongoing trial (Kilbreath) will determine the relative effects of cardiorespiratory, strength and mixed training.

• Fitness, mobility and physical function data presented in the review demonstrate the specificity of the training response, and are supportive of the concept of ‘task-related’ training. Improvements in physical fitness were seen during exercise that mirrored that used during the intervention. All significant improvements in mobility outcomes reported within individual studies or meta-analyses were exclusively associated with interventions involving walking; no benefits occurred when walking was not included. The data of Richards 1993 further supports specificity as time spent gait training was associated with mobility outcomes.

• There were insufficient data to determine whether training limited to the upper or lower limbs, or the affected and unaffected limbs was beneficial.

(c) Retention of benefits
Only two trials (Richards 1993; Dean 2000) included follow-up measures of outcome after completion of training. Little, if any, information can be concluded about retention of benefits.
Functional improvements observed at the end of rehabilitation interventions (Kwakkel 1999) have been shown to disappear at a later stage (Kwakkel 2002), probably due to continued improvements in the control group rather than deterioration in function (Langhorne 2002). Increases in physical fitness are reversible, if training is reduced or stopped then cardiorespiratory and skeletal muscle adaptations will be lost. Therefore the benefits of fitness training interventions may be prone to being short-lived. In summary functional benefits mediated by increased physical fitness may not be sustained unless some form of training stimulus is maintained. At present there is no data examining facilitation of continued exercise after the end of fitness training. Long-term follow-up measures should be incorporated into future fitness training trials.

(d) Effect of initial patient status on outcome measures
There were not enough data to determine the effects of disability, ambulatory status or degree of hemiparesis.

(e) Effect of physical activity performed by control groups
There are not enough data to draw conclusions about the effect of different control group conditions on outcome; in addition there are too many other factors that make it difficult to isolate any effect.

(f) Effect of trial quality
Too few data prevent conclusions being drawn about the effect of trial quality on outcome. This was exacerbated by two other factors. First, one element of the validated quality scale used (Jadad 1996) relies on trials being described as double blind or not. Exercise intervention trials can never be double-blind therefore modifying the scale to instead score trials as being outcome assessor-blindened or not may undermine the validity of the tool. Second the few trials that were scored as ‘good’ comprised very different types of intervention that spanned the whole range of types of exercise, e.g. cardiorespiratory training (Pohl 2002a; Pohl 2002b), strength training (Kim 2001) and mixed training (Richards 1993), this makes the effects of ‘good’ trial quality difficult to isolate.

Sensitivity analyses
Although one of the proposed sensitivity analyses was carried out there were too few trials containing highly variable interventions for these analyses to be of any value.

Summary of findings

- Few of the data contributing to this review relate to the acute (< one month) phase post-stroke.
- This review suggests that stroke patients are able to adhere to and complete a variety of short-term fitness training regimens during usual care or after usual care interventions.
- The lack of primary outcome measures of disability, dependence and death do not allow any conclusions to be drawn at the present time. More disability data will be forthcoming from identified ongoing trials.
- Cardiorespiratory training did not improve cardiorespiratory fitness. Several ongoing studies examine cardiorespiratory interventions.
- Cardiorespiratory training, particularly using a treadmill, improved maximum walking speed over short distances and reduced the degree of dependence on others during ambulation.
- Strength training data are few and inconclusive. One strength training study is ongoing (Lum; N = 60), however this intervention is limited to the upper body.
- Mixed training data are few and inconclusive. Several ongoing studies comprise mixed interventions.
- Outcome data concerning physical function and health-related quality of life are scant and inconclusive.
- Outcome data regarding mood and adverse vascular or musculo-skeletal events are not available.
- It was not possible to determine the effect of factors (e.g. ‘dose’ and type of training) that could influence the primary and secondary outcome measures.
- Observations in this review support the idea that benefits may be greater when fitness training is specific or ‘task-related’.
- There were methodological issues with every included study that could undermine the generalisability and/or validity of the findings.

Issues for research

Generalisability
Future research should aim to establish the proportion of stroke patients with no contraindications to fitness training interventions, the proportion who typically become enrolled in training interventions and are available for follow up, and the degree of adherence to training that can be achieved. Within the included trials most participants were recruited months or years after stroke and were typically those with milder strokes (e.g. most were ambulatory). Further research is needed to examine whether fitness training is beneficial soon after stroke and with those who are more disabled.

Types of training Intervention
In general, larger trials of combined cardiorespiratory and strength training are required to explore the extent of potential benefits to
patients. The benefits associated with different modes of exercise (e.g., walking, cycling or circuit training) are not well understood nor are the potential costs of each. Delivery of training to individuals or groups has both cost and compliance issues. The effect of timing of fitness training, either early after stroke during usual care, or post-rehabilitation is not known. Where benefits are shown the dose-response relationship between post-stroke training and any benefits should be established in order to optimise interventions.

Randomisation
Age and gender have a strong influence on physical fitness (Young 2001b) and therefore should be balanced during randomisation in small trials.

Researcher blinding
Those involved with outcome assessment in trials of fitness training are susceptible to being unblinded. A test of blinding should be applied after each outcome assessment and reported statistically.

Outcome measures
Diverse outcome measures make pooling data from different studies difficult (Greener 2002). Therefore the concept of a ‘core set’ of outcome measures suitable for stroke patients (Tennant 2000) is attractive. In particular, disability and dependence should be considered primary outcome measures in trials of fitness training for stroke patients.

Long-term follow up
Improvements in physical fitness following training are known to be transient therefore the long-term retention of any benefits should be examined routinely in training studies.

Patient transport
Duncan 1998 noted that only three out of 20 patients could have participated if transport had not been provided. The study by Dean 2000 reported that one of 12 patients were lost to follow up because of transportation costs. This suggests that patient transport may be an important issue for patient recruitment and retention in trials.

Authors’ conclusions

Implications for practice
There is very little evidence available that can influence practice at the present time. Data suggesting that the fitness of some stroke patients can be improved with training suffers from methodological problems. The extent to which improved fitness might translate into other functional benefits is unclear. Benefits observed in fitness, mobility and physical function appear to be compatible with the concept of specific or ‘task-related’ training. This suggests that if training is provided after stroke it may be more beneficial if the form of exercise closely resembles the desired functional outcomes. However there are inadequate data to either encourage or discourage physical fitness training after stroke.

More exploratory research is required in this area. There are a number of important unanswered research questions and some important considerations for the design of such research.

Implications for research
Fitness training after stroke is an under-researched area. Beyond improvements in some measures of ambulation little is known about the benefits of fitness training in stroke patients, or the optimal regimen for improving fitness. There is a need for larger trials addressing simple questions of effectiveness, particularly soon after stroke. In addition smaller detailed studies are warranted examining the effects of different types of training and the manner of their delivery after stroke.

Acknowledgements

We thank the Cochrane Stroke group for their assistance in preparing the protocol and searching the literature. We would also thank all those who provided information about their own or others’ trials. If anyone knows of trials that we have omitted we would be grateful if they could contact Mr David Saunders.
References to studies included in this review

Cuviello-Palmer 1988  [published data only]

da Cunha 2002  [published data only]

Dean 2000  [published data only]

Duncan 1998  [published and unpublished data]

Glasser 1986  [published data only]

Inaba 1973  [published data only]

Kim 2001  [published data only]

Pohl 2002a  [published data only]

Pohl 2002b  [published data only]

Potempa 1995  [published data only]

Richards 1993  [published data only]

Teixeira 1999  [published data only]

Drummond 1996  [published data only]

Dickstein 1996  [published data only]

Feyns 1998  [published data only]

**Gelber 1995** [published data only]

**Gilbertson 1998** [published data only]

**Jongbloed 1989** [published data only]

**Jongbloed 1991** [published data only]

**Kwakkel 1999** [published data only]

**Laufer 2001** [published data only]

**Lincoln 1999** [published data only]

**Lindley 1994** [published data only]

**Logigian 1983** [published data only]

**Nilsson 2001** [published data only]

**Parker 2001** [published data only]

**Parry 1999** [published data only]

**Partridge 2000** [published data only]

**Peel 1995** [published data only]

**Platz 2001** [published data only]

**Pomeroy 2001** [published data only]

**Rimmer 2000** [published data only]

**Smith 1981** [published data only]

**Sullivan 2002** [published data only]

**Sunderland 1994** [published data only]
* Sunderland A, Fletcher D, Bradley L, Tinson D, Hewer RL, Wade DT. Enhanced physical therapy for arm function after stroke: a one
Physical fitness training for stroke patients (Review)

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References to ongoing studies

**Bateman 2001** ([published data only](#))


**Chu** ([unpublished data only](#))

A randomized controlled trial of water-based exercises for cardiovascular fitness in individuals with chronic stroke


Completion: Data completed, Submission possibly August 2002.

**Isaacs** ([unpublished data only](#))

EXERT (exercise evaluation randomised trial) - randomised trial comparing leisure centre-based exercise on prescription, home-based walking and usual advice in primary care. Ongoing study UN.

**Kilbreath** ([unpublished data only](#))

Does aerobic or resistance training improve walking ability in chronic stroke patients?. Ongoing study 2002.

**Lum** ([unpublished data only](#))


Completion: Sep 2003.

**Mead** ([unpublished data only](#))

STARTER (Stroke: A Randomised Trial of Exercise or Relaxation). Ongoing study Start: Dec 2002


**Prota** ([unpublished data only](#))

Stroke rehabilitation outcomes with supported treadmill ambulation training. Ongoing study Start: Jan 2001

Completion: Dec 2003.

**Additional references**

**ACSM 1998**


**Andersen 2001**


**Andrews 2000**


**Appell 1990**


**Booth 2000**


**Eng 2002**


**Ernst 1999**


**Follmann 1992**

Frontera 1999

Giuliani 1995

Goldberg 1988

Green 2002

Greener 2002

Hall 1996

Harridge 2000

Harris 2001

Hash 1978

Jadad 1996

Jolliffe 2002

Kwakkel 1997

Kwakkel 2002

Langhorne 2002

Liu 1999

MacDougall 1977

Macko 1997

Malbut-Shennan 2000

Malouin 1992

Potempa 1996

Roche 1996

Saltin 1968

Saltin 1980

Schulz 2002

Shvartz 1990

Skelton 1999
Skelton D, Young A, Walker A, Hoinville E. In: Health Education Authority, editor(s). Physical activity in later life: further analysis of...

Tennant 2000

USDHHS 1996

van der Lee 2001

Wagensaar 1991

Warlow 1996

Waters 1999

Young 2001a

Young 2001b

* Indicates the major publication for the study

CHARACTERISTICS OF STUDIES

Characteristics of included studies  [ordered by study ID]
### Cuvello-Palmer 1988

<table>
<thead>
<tr>
<th>Methods</th>
<th>DESIGN; Training + usual care vs. usual care only. Participants were evaluated before and after 3wks of training. Randomisation method unknown. DROP-OUTS; one patient’s data missing for one outcome measure (gait velocity); unknown reason TRAIL QUALITY; -1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Participants</td>
<td>20 stroke survivors recruited; Control: n=10; Male 7 Female 3; Age 71.8 ± 12.0 yrs; 12.0 ± 16.8 d post-stroke Intervention: n=10; Male 6 Female 4; Age 69.5 ± 14.1 yrs; 20.7 ± 13.2 d post-stroke All participants had hemiparesis INCLUSION CRITERIA; not known EXCLUSION CRITERIA; not known SETTING; Rehabilitation centre</td>
</tr>
<tr>
<td>Interventions</td>
<td>INTERVENTION: Cardiorespiratory training. Isokinetic ergometer allowing resisted reciprocal leg movements (Kinetron II); commencing at 2 x 7min/d for 5 d/wk, and 1 x 7min/d for 1 d/wk (total 6 d/wk) for 3 wks. Progressing to 10min per session in wk 2 and 12min in wk 3. Exercise intensity maintained at a heart rate of &lt;20 beats/min above resting. CONTROL: Usual care: 2 x 45min/d for 5 d/wk, and 1 x 45min/d for 1 d/wk (total 6 d/wk) for 3 wks. Gait training, mat exercises and transfer training achieved via strengthening exercises, post-neuromuscular facilitation (PNF), FES, Brunnstum, Rood and neurodevelopment techniques.</td>
</tr>
<tr>
<td>Outcomes</td>
<td>INCLUDED OUTCOMES FIM, Walking Speed, chosen (7 sec); Stride cadence steps/min OTHER OUTCOMES Stance symmetry; Contact time (sec) and other biomechanical gait parameters</td>
</tr>
<tr>
<td>Notes</td>
<td></td>
</tr>
</tbody>
</table>

### da Cunha 2002

<table>
<thead>
<tr>
<th>Methods</th>
<th>DESIGN; Training + usual care vs. usual care. Randomisation employed random numbers to pre-assign subjects to groups based on recruitment order. Participants were evaluated before and after 2-3wks of training. DROP-OUTS; 1 pulmonary complications in control group; 1 incomplete training (&lt;9 sessions) TRAIL QUALITY; 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Participants</td>
<td>15 stroke survivors recruited; Control: n=7; Male 7; Age 58.9 ± 12.9 yrs; 19.0 ± 12.7 d post-stroke Intervention: n=6; Male 6; Age 57.8 ± 5.5 yrs; 15.7 ± 7.7 d post-stroke All participants had hemiparesis INCLUSION CRITERIA; i) recent stroke (onset &lt;6wk), ii) significant gait deficit (&lt;36m/min; FAC score of 0,1 or 2), iii) sufficient cognition to participate in training (MMSE&gt;=21), iv) able to stand and take 1 or more steps without assistance</td>
</tr>
</tbody>
</table>

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**Physical fitness training for stroke patients (Review)**

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EXCLUSION CRITERIA; i) co-morbidity or disability other than hemiparesis, ii) recent MI, iii) any uncontrolled health condition, iv) joint disease or rheumatoid arthritis, v) obesity (>110kg), vi) cognitive impairment (mini-mental state exam <21).

SETTING; Rehabilitation centre

**Interventions**

INTERVENTION: Cardiorespiratory training. Treadmill walking with body weight support; 20min/d, 6 d/wk for 2-3 wks (until discharge). Intensity unknown, but rapid progression imposed by increasing speed and reducing body weight support. The 20min training replaced the 20min gait training component of the control.

CONTROL: Usual care. 3hr/d for 6d/wk for 2-3 wks until discharge. Included kinesiotherapy (1hr/d), occupational therapy (1hr/d) and physical therapy (1hr/d). The physical therapist included 20min of gait training comprising stepping, standing, turning etc. but not continuous walking.

**Outcomes**

INCLUDED OUTCOMES

da Cunha 2001 version: Cycle performance work rate (Watts); Cycle time to fatigue; Heart rate; VO2 submax (25Watts); VO2 max + resp data; Blood pressure; Stride cadence (steps/min); Functional ambulation categories; functional independence measure (lower limb; FIM-L)
da Cunha 2002 version; also included gait speed and energy expenditure

**Notes**

**Dean 2000**

**Methods**

DESIGN; Training vs. non-exercise intervention. Subjects were matched in pairs based on walking speed and then allocated to the intervention group or control group by drawing cards. Participants were evaluated before and after a 4 wk training intervention, and followed up 2 months later.

BLINDING; Blinding of outcome assessor for all except one outcome measure. The intended blinding may have been unmasked when the outcome assessor observed a group training session.

DROP-OUTS; 2 losses in the intervention group; 1 withdrew before training, 1 unavailable for follow-up. 2 losses in the control group; 1 withdrew before training, 1 withdrew due to illness.

TRIAL QUALITY; 2

**Participants**

12 stroke survivors recruited;
Control n=4/12; 3 Male, 1 Female; Age 64.8 ± 3.3 yrs; >3mths post-stroke.
Intervention n=5/12; 2 Male 3 Female (2 at follow-up); Age 68.8 ± 4.7 yrs; >3mths post-stroke.

INCLUSION CRITERIA; i) First stroke resulting in hemiplegia, ii) at least 3 mths post-stroke, iii) discharged from all usual rehabilitation, iv) available to attend all training sessions, v) able to walk 10m with or without walking aids

EXCLUSION CRITERIA; i) no medical condition which would prevent fitness training.

SETTING; Rehabilitation centre

**Interventions**

Intervention:
Mixed training cardiorespiratory + strength training. Performed in a group for 60min/d, 3d/wk for 4wks. Task-related lower-limb circuit training comprising i) cardiorespiratory training (treadmill and graded walking), ii) strength training (stepping, raising & reaching). Training intensity not quantified, but subjects observed as being 'tired and sweaty' post-exercise.

Control:
Upper limb functional exercises, considered 'sham' lower limb training. Performed in a group for 60min/d, 3d/wk for 4wks.
Outcomes

Included outcomes:
- Step test
- Walking Speed, chosen (6-min; outcome assessor not blinded)
- Walking Speed, maximum (10-metres)
- Timed up and go
- Peak vertical ground reaction force on sit to stand
- Other outcomes:
  - Grip strength
  - Bi- and uni-manual Purdue Pegboard

Notes

Duncan 1998

Methods

DESIGN; Home-based training + usual outpatient care vs. usual outpatient care only. Subjects randomised to two blocks of 10. Participants were evaluated before and after a 12 wk training intervention.

DROP-OUTS; none

TRIAL QUALITY; 2

Participants

20 stroke survivors recruited;
- Control; n=10; Age 67.8 7.2 yrs; 56 d post-stroke; 8 ischaemic strokes; 2 haemorrhagic
- Intervention; n=10; Age 67.3 9.6 yrs; 66 d post-stroke; 10 ischaemic strokes

Number of males/females not known

INCLUSION CRITERIA; i) 30-90d post-stroke, ii) minimal/moderately impaired sensorimotor function, iii) available to attend all training sessions, iv) ambulatory with or without supervision or walking aids, v) living at home, within 50 miles

EXCLUSION CRITERIA; i) medical condition which compromised outcome assessment or prevented fitness training, ii) mini-mental state score <18 or receptive aphasia

SETTING; therapist-supervised (for first 8 wks), home-based.

Interventions

Intervention

Mixed cardiorespiratory + strength training. Performed ~90 min/d, 3 d/wk for 12 wks (8 wks supervised 1:1 with therapist, 4wks alone). Functional exercises comprising i) assistive/resistive exercise, ii) balance exercises, iii) upper limb functional activities and iv) walking or cycling. Apart from some resisted exercise the training intensity was not quantified.

Control

Usual outpatient care. Physical and occupational therapy as advised by the patient’s physician. Averaging 44 min/d, 3.25 d/wk for 12 wks. Therapeutic interventions were during home or outpatient visits and comprised balance training (60%), progressive resistive exercise (strength training; 40%), bimanual activities (50%) and facilitative exercise (30%). Cardiorespiratory training was not provided (0%).

Outcomes

INCLUDED OUTCOMES;
- Barthel Index; Lawton Instrumental ADL; MOS-36; Walking Speed, chosen (6-min); Walking Speed, maximum (10-metres); Berg Balance Scale; Jebsen Hand Test; Fugl Meyer - upper; Fugl Meyer - lower
### Duncan 1998 (Continued)

#### Notes

<table>
<thead>
<tr>
<th>Glasser 1986</th>
</tr>
</thead>
</table>
| **Methods** | DESIGN; Training + % usual care vs. usual care.  
Participants evaluated before and after a 5wk training programme  
DROP-OUTS; none  
TRIAL QUALITY; -1 |

| Participants | 20 stroke survivors recruited;  
Control; n=10; 4 Male 6 Female  
Intervention; n=10; 6 Male 4 Female  
All participants aged 40 to 75 yrs and were 3-6 mths post-stroke. All participants exhibited hemiparesis with upper and lower extremity motor dysfunction; some showed sensory deficits and mild expressive or receptive aphasia.  
INCLUSION CRITERIA; not known  
EXCLUSION CRITERIA; not known  
SETTING; |

| Interventions | INTERVENTION: Cardiorespiratory training. Isokinetic ergometer (Kinetron) training twice a day 5 d/wk for 10 wks. The intensity was maintained at 50 - 100psi and duration of each session progressed from 10 to 30 min over the first 5 weeks.  
CONTROL: Description; Therapeutic exercise and gait training  
1 hr/session; 2 sessions/d, 5 d/wk for 5wks |

| Outcomes | INCLUDED OUTCOMES;  
Functional Ambulation Profile Score, Functional Ambulation Profile Walking Time. |

| Notes |

### Inaba 1973

#### Methods

DESIGN; Training + usual care vs. usual care. Participants were evaluated before and after 1-2 months of training. Randomisation to two intervention arms sharing the same control group was performed by an uninvolved third party.  
a) The ‘active exercise’ intervention did meet the inclusion criteria as it was not described as progressive in nature and included ergometry in which muscle contractions were not resisted.  
b) The ‘progressive resistive exercise’ (strength training) met the inclusion criteria and was included in the review.  
BLINDING; blinded outcome assessor  
DROP-OUTS; 101/177 patients lost to follow up across the control and both intervention groups. The 54 patients completed the control vs. strength training comparison; estimated dropouts -N=60. One reason given for dropouts was discharge before the end of the study.  
TRIAL QUALITY; 2
### Inaba 1973 (Continued)

| Participants | Control; n=26; Male 15; Female 11; Mean Age 56.9 yrs; <3mths post-stroke  
| | Intervention; n=28; Male 11; Female 17 Age 55.6 yrs; <3mths post-stroke  
| | All participants had hemiparesis.  
| | INCLUSION CRITERIA; i) Hemiparesis arising from cerebrovascular accident secondary to thrombosis, embolus or hemorrhage; ii) Able to follow verbal or demonstrated directions; iii) Extend the involved lower limb against a load of 1.1kg; iv) independent ambulation.  
| | EXCLUSION CRITERIA; i) etiology of aneurysm or trauma  
| | SETTING; Rehabilitation centre  
| Interventions | INTERVENTION: Strength Training. Progressive resistive exercise; once per day for 4-8 wks; extension of the affected lower limb from 90º to full knee extension whilst in the supine position on an Elgin table (machine weights). 5 repetitions at 50% maximum weight, and 10 at maximum.  
| | CONTROL; Conventional functional training, including stretching. 4-8 weeks until discharge.  
| Outcomes | INCLUDED OUTCOMES: Leg strength (10 repetition maximum); ability to perform 8 ADL.  
| Notes |  

### Kim 2001

| Methods | DESIGN; Training vs. non-training intervention. Randomisation stratified based on gender (M/F), age (50-59 or 60+ yrs) and time since onset of stroke (6 months - 2 yrs/ 2+ yrs). Participants were evaluated before and after 6wks of training.  
| | BLINDING; blinded outcome assessor and an attempt at subject blinding.  
| | DROP-OUTS; none  
| | TRIAL QUALITY; 4  
| Participants | 20 stroke survivors recruited;  
| | Control; n=10 ; Male 7; Female 3; Age 61.9 7.5 yrs; 3.2 1.2 yr post-stroke  
| | Intervention; n=10; Male 7; Female 3; Age 60.4 9.5 yrs; 4.9 3.3 yr post-stroke  
| | All participants had hemiparesis.  
| | INCLUSION CRITERIA; i) age >50yrs, ii) >6mths after first ever stroke, iii) walk 40m with +/- rest, +/- assistive device, iv) => stage 3 of Chedoke-McMaster Stroke Assessment, v ) tolerate 45min of exercise with rest intervals, vi) non-participation in other therapy programmes.  
| | EXCLUSION CRITERIA; i) Comprehensive aphasia, ii) not medically stable, ii) musculoskeletal problems not associated with stroke.  
| | SETTING; Rehabilitation centre  
| Interventions | INTERVENTION: Strength training. Isokinetic Dynamometer (Kin-Com); 45 min/d, 3 d/wk for 6wks. After a warm up this comprised 30min of 3 x 10 resisted repetitions of maximal effort concentric hip flexion/extension, knee flexion/extension and ankle dorsiflexion/plantarflexion of the affected lower limb. Progression in the resistance was achieved by increasing the preload on the Kin-Com device (Eng et al. 2002). ACSM guidelines met.  
| | CONTROL; Exactly the same as intervention except the resisted contractions replaced with passive range of motion movements
Kim 2001  (Continued)

Outcomes

INCLUDED OUTCOMES: lower extremity muscle strength, comfortable walking speed (m/sec over 8m), maximum walking speed (m/sec), stair walking performance (4 x 18cm steps). SF-36 Physical and Mental Health Component Summary Scores (PCS and MCS).

Notes

Pohl 2002a

Methods

DESIGN; Training + conventional physiotherapy vs. non-training intervention + conventional physiotherapy. Randomisation restricted to equal blocks based on 10-m walk time. Participants were evaluated before and after 4wks of training.
BLINDING; blinded outcome assessor
DROP-OUTS; 9 dropouts prior to randomisation due to infections in Pohl(a) and Pohl(b); comparison not specified.
TRIAL QUALITY; 3

Participants

40 stroke survivors recruited;
Control; n=20; Male 13; Female 7; Age 61.6 10.6 yrs; 113 130 d post-stroke
Intervention; n=20; Male 14; Female 6 Age 57.1 13.9 yrs; 118 144 d post-stroke
All participants had hemiparesis.
INCLUSION CRITERIA; i) presence of L or R hemiparesis for >4 wks, ii) impaired gait, iii) no or slight abnormal muscle tone (Ashworth Score 0 and 1), iv) ability to walk without assistance (FAC=3), v) 10-metre walk time >5sec and < 60sec, vi) class B exercise risk according to ACSM 1998b, vii) absence of known heart disease, viii) no evidence of heart failure, ischaemia or angina at rest or exercise, ix) appropriate rise in systolic blood pressure and absence of ventricular tachycardia during exercise.
EXCLUSION CRITERIA; i) Previous treadmill training, ii) class C or D exercise risk according to ACSM 1998b, ii) cognitive deficits (MMSE<26 of 30), iii) movement disorders, orthopaedic or gait influencing-diseases.
SETTING; Rehabilitation centre

Interventions

INTERVENTION: Total 12 hrs of treatment
a) Cardiorespiratory training. Treadmill walking (limited progression treadmill training); 30 min/d, 3 d/wk for 4wks. Minimal (=<10%) body weight support for first 3 sessions. Speed progressed =<5% of maximum per week (20% over 4wks). Gradient maintained at 0%.
b) Conventional Physiotherapy 45 min/d, 2 d/wk for 4 wks (usual care, included some gait training).
CONTROL; Total 15 hrs of treatment
c) Conventional gait training 30 min/d, 3 d/wk for 4wks. Comprised PNF and Bobath techniques
d) Conventional Physiotherapy 45 min/d, 2 d/k for 4 wks (usual care, included some gait training).

Outcomes

INCLUDED OUTCOMES: Maximum walking velocity; Functional ambulation categories
OTHER OUTCOMES: Stride cadence (steps/min); Stride length (m)

Notes
### Pohl 2002b

**Methods**

DESIGN; Training + conventional physiotherapy vs. non-training intervention + conventional physiotherapy. Randomisation restricted to equal blocks based on 10-m walk time. Participants were evaluated before and after 4wks of training.

BLINDING; blinded outcome assessor

DROP-OUTS; 9 dropouts prior to randomization due to infections in Pohl(a) and Pohl(b); comparison not specified.

TRIAL QUALITY; 3

**Participants**

40 stroke survivors recruited;

Control; n=20; Male 13; Female 7; Age 61.6 ± 10.6 yrs; 113 ± 130 d post-stroke

Intervention; n=20; Male 16; Female 4; Age 58.2 ± 10.5 yrs; 113 ± 115 d post-stroke

All participants had hemiparesis

INCLUSION CRITERIA; i) presence of L or R hemiparesis for >4 wks, ii) impaired gait, iii) no or slight abnormal muscle tone (Ashworth Score 0 and 1), iv) ability to walk without assistance (FAC=3), v) 10-metre walk time >5sec and < 60sec, vi) class B exercise risk according to ACSM 1998b, vii) absence of known heart disease, viii) no evidence of heart failure, ischaemia or angina at rest or exercise, ix) appropriate rise in systolic blood pressure and absence of ventricular tachycardia during exercise.

EXCLUSION CRITERIA; i) Previous treadmill training, ii) class C or D exercise risk according to ACSM 1998b, iii) cognitive deficits (MMSE<26 of 30), iv) movement disorders, orthopaedic or gait influencing-diseases.

SETTING; Rehabilitation centre

**Interventions**

**INTERVENTION:** Total 12 hrs of treatment

a) Cardiorespiratory training. Treadmill walking (structured speed dependent treadmill training); 30 min/d, 3 d/wk for 4wks. Minimal (=<10%) body weight support for first 3 sessions. Training sessions comprised repeated bouts increasing from 50% maximum up to maximum speed with rests between. Speed progressed maximally at each training visit. Gradient maintained at 0%.

b) Conventional Physiotherapy 45 min/d, 2 d/wk for 4 wks (usual care, included some gait training).

**CONTROL:** Total 15 hrs of treatment

a) Conventional gait training 30 min/d, 3 d/wk for 4wks. Comprised PNF and Bobath techniques

b) Conventional Physiotherapy 45 min/d, 2 d/wk for 4 wks (usual care, included some gait training).

**Outcomes**

INCLUDED OUTCOMES: Maximum walking velocity; Functional ambulation categories

OTHER OUTCOMES: Stride cadence (steps/min); Stride length (m)

**Notes**

### Potempa 1995

**Methods**

DESIGN; Training vs. non-exercise intervention. Randomisation restricted to blocks of 10 patients.

DROP-OUTS; 3 in the intervention group and 3 in the control group; occurred before randomization due to personal reasons and medical screening.

TRIAL QUALITY; 2

**Participants**

42 stroke survivors recruited;

Control; n=23; Male 15 Female 18;

Intervention; n=19; Male 8 Female 11;
<table>
<thead>
<tr>
<th>Potempa 1995 (Continued)</th>
</tr>
</thead>
<tbody>
<tr>
<td>All participants aged 43 to 70 yrs and were 216 43 d post-stroke. All participants had upper and lower limb hemiparesis</td>
</tr>
<tr>
<td>INCLUSION CRITERIA; i) medically stable, ii) at least 6 mths post-stroke, iii) completed formal rehabilitation</td>
</tr>
<tr>
<td>EXCLUSION CRITERIA; i) patients with brain stem lesions, ii) any clinical evidence that would preclude maximal exercise testing</td>
</tr>
<tr>
<td>SETTING; Therapist-supervised</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Interventions</th>
</tr>
</thead>
<tbody>
<tr>
<td>INTERVENTION: Cardiorespiratory training. Cycle ergometer training for 30 min/d, 3 d/wk for 10 wks. Intensity; 30-50% of maximal effort, increasing to maximum sustainable over first 4 wks</td>
</tr>
<tr>
<td>CONTROL: Non-exercise intervention. Passive range of motion exercises for 30 min/d, 3 d/w for 10 wks.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Outcomes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fugl Meyer, weight, blood pressure, heart rate at rest and during maximal exercise, VO2 max, RER, cycling work rate (Watts), exercise time.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Notes</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Richards 1993</th>
</tr>
</thead>
<tbody>
<tr>
<td>METHODS</td>
</tr>
<tr>
<td>DESIGN; Training + usual care vs. non-exercise therapy + usual care. Randomised allocation stratified based upon Barthel Index scores. Participants were evaluated before and after 5wks of training and after a 3-month follow-up. A second control group of conventional therapy was not used for comparison since i) it was much shorter in duration and ii) commenced later then the training intervention.</td>
</tr>
<tr>
<td>BLINDING; blinded outcome assessor.</td>
</tr>
<tr>
<td>DROP-OUTS; none</td>
</tr>
<tr>
<td>TRIAL QUALITY; 3</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Participants</th>
</tr>
</thead>
<tbody>
<tr>
<td>20 stroke survivors recruited;</td>
</tr>
<tr>
<td>Control; n=8 ; Male 2; Female 6; Age 67.3 11.2 yrs; 8.8 1.5 d post-stroke</td>
</tr>
<tr>
<td>Intervention; n=10; Male 5; Female 5; Age 69.6 7.4 yrs; 8.3 1.4 d post-stroke</td>
</tr>
<tr>
<td>INCLUSION CRITERIA; i) within 50km of treatment center, ii) men or women aged 40 - 80 yrs, iii) 0 - 7 d after first stroke, iv) middle cerebral artery syndrome identified by CT, v) under care of neurologist involved in study, vi) willing to sign informed consent.</td>
</tr>
<tr>
<td>EXCLUSION CRITERIA; i) other major medical conditions that would interfere with functional capacity or interfere with rehabilitation, ii) patients who were independently ambulatory 1 wk after stroke, iii) patients who were unconscious at onset.</td>
</tr>
<tr>
<td>SETTING; Hospital, Canada.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Interventions</th>
</tr>
</thead>
<tbody>
<tr>
<td>INTERVENTION: Task-oriented gait training programme (Malouin 1992) which used a tilt table, resisted exercises using a Kinetron, and treadmill walking. Intervention 104 min/d, 5 d/wk for 5 wks. Progression achieved via velocity and resistance (kinetron) increments. Programme likely to be a combined cardiorespiratory/strength training intervention.</td>
</tr>
<tr>
<td>CONTROL; Traditional neurophysical techniques. 109 min/d, 5 d/wk for 5 wks.</td>
</tr>
</tbody>
</table>
Richards 1993  
(Continued)

<table>
<thead>
<tr>
<th>Outcomes</th>
<th>INCLUDED OUTCOMES: Fugl-Meyer balance (FM-B), upper (FM-U) and lower (FM-L) extremity scores. Barthel Ambulation scores. OTHER OUTCOMES: Gait velocity and Berg Balance, not recorded at baseline.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Notes</td>
<td></td>
</tr>
</tbody>
</table>

Teixeira 1999

<table>
<thead>
<tr>
<th>Methods</th>
<th>DESIGN; Training vs. no intervention. First iteration only of a lag control design. Subjects randomly allocated to immediate or delayed intervention and balanced into similar groups. Subjects allocated delayed intervention received no intervention during the first iteration of the trial. Participants were evaluated before and after the first 10 wk iteration of the trial. DROP-OUTS; unknown TRIAL QUALITY; 1</th>
</tr>
</thead>
</table>
| Participants | 13 community dwelling stroke survivors recruited; Control; n=7; Male 1 Female 5; Age 69.4  8.85 yrs; 6.4  6.23 yrs post-stroke  
Intervention; n=6; Male 6 Female 1; Age 65.9  10.2 yrs; 9.15  12.7 yrs post-stroke  
All participants had unilateral stroke resulting in residual weakness and/or abnormal muscle tone. INCLUSION CRITERIA; i) at least 9 mths post-stroke, ii), independently ambulatory +/- walking aids and iii) no comprehensive aphasia  
EXCLUSION CRITERIA; i) non-stroke related disability  
SETTING; Therapist-supervised |
| Interventions | INTERVENTION: Mixed cardiorespiratory and lower extremity strength training. 60-90 min/d, 3 d/wk for 10wks. Cardiorespiratory training; graded walking, plus stepping or cycling progressing from 10 to 20 min/d, and from 50-70% of maximal cycling work rate over first 5 wk. Strength training; seven exercises involving use of body weight and progressive resistive exercise using different masses and elastic bands (Theraband). Each performed as 3 x 10 repetitions and progressing from 50-80% of 1 repetition maximum. Warm-up and warm-down 10 - 20min/d. CONTROL: No intervention in the first iteration of the lag control trial. |
| Outcomes | INCLUDED OUTCOMES: Walking Speed - comfortable pace (22 metres), Adjusted Activity Score, Nottingham Health Profile  
OTHER OUTCOMES: The following data were not available for the first iteration of the lag control; Lower limb muscle strength (peak torque Nm), Muscle tone assessment, Stair climbing. |
| Notes    | hr: hours  
d: day  
wk(s): week(s)  
psi: pounds per square inch |
### Characteristics of excluded studies  
**[ordered by study ID]**

<table>
<thead>
<tr>
<th>Study</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Baskett 1999</td>
<td>Intervention not physical fitness training: It is described as exercise and activities but no evidence of progressive cardiorespiratory and/or strength elements.</td>
</tr>
<tr>
<td>Dean 1997</td>
<td>Intervention not physical fitness training: Although an element of progression is present the intervention is more ‘practice’ than training as defined in this review.</td>
</tr>
<tr>
<td>Dickstein 1986</td>
<td>Intervention not physical fitness training: Although Post Neuromuscular Facilitation (PNF) and Bobath approaches may contain resistive exercises. Patient allocation not randomised: based on hospital administration procedures.</td>
</tr>
<tr>
<td>Dickstein 1997</td>
<td>Intervention not physical fitness training: Muscle contractions not resisted and not progressive. Patient allocation not randomised: Patients were sequentially assigned.</td>
</tr>
<tr>
<td>Drummond 1996</td>
<td>Interventions not physical fitness training: Two interventions, i) leisure therapy, and ii) conventional occupational therapy. Same data as Drummond 1995.</td>
</tr>
<tr>
<td>Feys 1998</td>
<td>Intervention not physical fitness training: The physical activity (rocking movements) showed no progression of intensity.</td>
</tr>
<tr>
<td>Gelber 1995</td>
<td>Intervention not physical fitness training: Comparison of traditional functional retraining and neurodevelopmental techniques. No relevant comparisons:</td>
</tr>
<tr>
<td>Gilbertson 1998</td>
<td>Intervention not physical fitness training: Home-based occupational therapy.</td>
</tr>
<tr>
<td>Jongbloed 1989</td>
<td>No relevant control group: Comparison of two occupational therapy interventions. Interventions not physical fitness training.</td>
</tr>
<tr>
<td>Jongbloed 1991</td>
<td>Intervention not physical fitness training: Occupational therapy related to leisure activities.</td>
</tr>
<tr>
<td>Kwakkel 1999</td>
<td>Intervention not physical fitness training: Investigation of rehabilitation of functional tasks; The principal author clarified that there was no progression of training intensity, the content of training was variable, and the treadmill training volume comprised only approximately 10% of patients.</td>
</tr>
<tr>
<td>Laufer 2001</td>
<td>Intervention not physical fitness training: Comparison of treadmill ambulation and overground walking No relevant comparisons:</td>
</tr>
<tr>
<td>Lincoln 1999</td>
<td>Interventions not physical fitness training: Comprised additional physiotherapy.</td>
</tr>
<tr>
<td>Lindsley 1994</td>
<td>The reference was published as an abstract only; the numerical data were not included and could not be recovered from the authors. This intervention may have been training although the abstract contained no mention of progression.</td>
</tr>
<tr>
<td>Reference</td>
<td>Description</td>
</tr>
<tr>
<td>--------------------</td>
<td>-----------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Logigian 1983</td>
<td>No relevant comparisons: Comparison of traditional and facilitation techniques. Intervention not physical fitness training: Although training elements may have been included it would be difficult to separate the effect of training from therapy.</td>
</tr>
<tr>
<td>Nilsson 2001</td>
<td>Comparison not relevant: Comparison of treadmill training with a physiotherapy approach to gait training (motor relearning programme) during usual care.</td>
</tr>
<tr>
<td>Parker 2001</td>
<td>Intervention not physical fitness training: Leisure therapy and occupational therapy</td>
</tr>
<tr>
<td>Parry 1999</td>
<td>Intervention not physical fitness training: Physiotherapy using Bobath and movement science approaches.</td>
</tr>
<tr>
<td>Partridge 2000</td>
<td>Intervention not physical fitness training: Comparison of amount of physiotherapy</td>
</tr>
<tr>
<td>Peel 1995</td>
<td>Not RCT: Case report</td>
</tr>
<tr>
<td>Platz 2001</td>
<td>Intervention not physical fitness training: Arm ability training comprised simple functional and manipulative tasks. (Same data presented as Platz 2000)</td>
</tr>
<tr>
<td>Pomeroy 2001</td>
<td>Intervention not physical fitness training: Weighted garments may offer increased resistance to muscle contraction but physical activity was neither controlled nor accurately monitored (patients log book).</td>
</tr>
<tr>
<td>Rimmer 2000</td>
<td>Patient allocation not randomised: Influenced by geographical location. The intervention was physical fitness training and comprised elements of cardiorespiratory, strength and flexibility training.</td>
</tr>
<tr>
<td>Smith 1981</td>
<td>Intervention not physical fitness training: Intensive and conventional physiotherapy and occupational therapy</td>
</tr>
<tr>
<td>Sullivan 2002</td>
<td>Comparison not relevant: Participants allocated three different treadmill training speeds.</td>
</tr>
<tr>
<td>Sunderland 1994</td>
<td>Intervention not physical fitness training: Comparison of orthodox and enhanced physiotherapy. Same data as Sunderland 1992</td>
</tr>
<tr>
<td>van der Lee 1999</td>
<td>Intervention not physical fitness training: Comparison not relevant: Comparison between forced use of affected arm and use of both arms.</td>
</tr>
<tr>
<td>Walker 1999</td>
<td>Intervention not physical fitness training: Occupational therapy</td>
</tr>
<tr>
<td>Werner 1996</td>
<td>Intervention not physical fitness training: Physical and Occupational therapy</td>
</tr>
<tr>
<td>Widén 1998</td>
<td>Intervention not physical fitness training: Home-based Physical and Occupational therapy</td>
</tr>
<tr>
<td>Wolfe 2000</td>
<td>Intervention not physical fitness training: Community-based Physical and Occupational therapy</td>
</tr>
</tbody>
</table>
### Characteristics of ongoing studies [ordered by study ID]

#### Bateman 2001

<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Methods</td>
<td></td>
</tr>
<tr>
<td>Participants</td>
<td>N=157 brain injured patients including 70 with stroke</td>
</tr>
<tr>
<td>Interventions</td>
<td>Intervention: up to 30min/d, 3 d/wk, 12wks, cardiorespiratory cycling training. Control; 30min/d, 3 d/wk, 12wks, relaxation therapy</td>
</tr>
<tr>
<td>Outcomes</td>
<td>Peak work rate, peak heart rate, BMI, Modified Ashworth Scale, Berg balance scale, Rivermead Mobility Index, 10-m walk velocity, Barthel Index FIM instrument, Nottingham Extended Activities of daily Living, fatigue questionnaire, Hospital Anxiety and Depression Scale</td>
</tr>
<tr>
<td>Starting date</td>
<td>Trial complete and published - see note.</td>
</tr>
</tbody>
</table>
| Contact information | Dr Andrew Bateman  
Department of Health Sciences, University of East London  
Stratford Campus  
Romford Road  
Stratford E15 4LZ  
Tel: (0044) 20 8223 4512  
E-mail a.bateman@uel.ac.uk |
| Notes               | The authors have agreed to partition the data for stroke patients only.                                                                                                                               |

#### Chu

<table>
<thead>
<tr>
<th>Trial name or title</th>
<th>A randomized controlled trial of water-based exercises for cardiovascular fitness in individuals with chronic stroke Chu KS, Eng JJ, Dawson AS, Harris J, Ozkaplan A, Gylfadótir HS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Methods</td>
<td></td>
</tr>
<tr>
<td>Participants</td>
<td>N=12 individuals with chronic stroke (&gt; 1 year), mild to moderate impairments, randomised into a RX/Control, testers blinded to group, subjects partially blinded as they were informed that they went either to an arm or leg group.</td>
</tr>
</tbody>
</table>
| Interventions       | Intervention: 60 min/d, 3 d/w, 8 wks, water-based group cardiorespiratory exercise program in chest deep water (walking, hopping, side stepping) in local community centre swimming pool  
Control: 60 min/d, 3 d/w, 8 wks, arm function group exercise program |
### Chu

(Continued)

<table>
<thead>
<tr>
<th>Outcomes</th>
<th>VO2max, gait speed, Nottingham Health Profile, maximal workload, Berg</th>
</tr>
</thead>
</table>
| Starting date | Start: Jan 2002  
Completion: Data completed, Submission possibly August 2002 |
| Contact information | Dr Janice Eng, School of Rehabilitation Sciences, University of British Columbia  
T325-2211 Wesbrook Mall, Vancouver, BC, V6T 2B5  
Tel: (604) 714-4105  
Fax: (604) 714-4168  
E-mail: janicee@interchange.ubc.ca  
Web: www.rehab.ubc.ca/jeng |
| Notes | |

### Isaacs

| Trial name or title | EXERT (exercise evaluation randomised trial) - randomised trial comparing leisure centre-based exercise on prescription, home-based walking and usual advice in primary care |
| Methods | |
| Participants | N=1500 stroke patients randomised to 3 groups |
| Interventions | Intervention 1: exercise scheme in local leisure centre. Intervention 2: home based walking programme or Control: Simple advice. All for 10 wks. |
| Outcomes | 1. Biological status, cardiovascular risk factors, health outcomes and quality of life before and after 10 weeks exercise programme or alternative and at 6 monthly intervals up to 1 year;  
2. Continuation of exercise after prescribed programme;  
3. Economic evaluation of different interventions. |
| Starting date | UN |
| Contact information | Dr Anthony Isaacs, EXERT Project, Middlesex University, Room 2D30, Bounds Green Road N11 2NQ  
Tel: 020 8411 5067  
E-mail: a.isaacs@mdx.ac.uk |
| Notes | National research register (UK) N0484008696 |

### Kilbreath

| Trial name or title | Does aerobic or resistance training improve walking ability in chronic stroke patients? |
| Methods | |
### Kilbreath (Continued)

| Participants | N = UN  
| Chronic stroke patients |
| Interventions | Intervention 1: cardiorespiratory cycle ergometer training.  
| | Intervention 2: Progressive resistive (strength) training.  
| | Intervention 3: Mixed cardiorespiratory cycle ergometer training, plus progressive resistive (strength) training.  
| | Control: No other rehabilitation |
| Outcomes | 6-min walk |
| Starting date | 2002 |
| Contact information | Dr Sharon Kilbreath,  
| School of Physiotherapy,  
| Faculty of Health Sciences,  
| University of Sydney  
| PO Box 170  
| Lidcombe,  
| NSW 1825  
| Tel: +61 293519278  
| E-mail: s.kilbreath@cchs.usyd.edu.au |

### Lum

| Trial name or title | Effects of strength training on upper-limb function in post-stroke hemiparesis |
| Methods | |
| Participants | N=60 expected. Community dwelling stroke survivors (< 6 mths). Aged 18 yrs or older, male or female. |
| Interventions | Intervention: Standard functional rehabilitation + high-intensity upper-body strength training.  
| | Control: Standard functional rehabilitation |
| Outcomes | Strength, Modified Ashworth Scale, Barthel Index, FIM, Fugl-Meyer (upper body). |
| | Completion: Sep 2003 |
| Contact information | Dr Peter Lum, VAMC, Palo Alto, California  
| | Tel: (650) 493-5000 664488  
| | E-mail: lum@roses.stanford.edu |
| Notes | NLM identifier NCT00037908 |
**Mead**

<table>
<thead>
<tr>
<th>Trial name or title</th>
<th>STARTER (Stroke: A Randomised Trial of Exercise or Relaxation)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Methods</strong></td>
<td></td>
</tr>
<tr>
<td>Participants</td>
<td>N=90 Community dwelling stroke patients</td>
</tr>
<tr>
<td>Interventions</td>
<td>Intervention: Mixed cardiorespiratory and strength training</td>
</tr>
<tr>
<td></td>
<td>Control: Relaxation therapy</td>
</tr>
<tr>
<td>Outcomes</td>
<td>Disability (FIM)</td>
</tr>
<tr>
<td></td>
<td>Nottingham Extended ADL</td>
</tr>
<tr>
<td></td>
<td>Rivermead Motor Assessment</td>
</tr>
<tr>
<td></td>
<td>Timed up and go</td>
</tr>
<tr>
<td></td>
<td>Cardiorespiratory fitness</td>
</tr>
<tr>
<td></td>
<td>Muscle strength and power output</td>
</tr>
<tr>
<td></td>
<td>Mood (HAD)</td>
</tr>
<tr>
<td>Starting date</td>
<td>Start: Dec 2002</td>
</tr>
<tr>
<td></td>
<td>Completion: Sept 2004</td>
</tr>
<tr>
<td>Contact information</td>
<td>Dr Gillian Mead</td>
</tr>
<tr>
<td></td>
<td><a href="mailto:Gillian.E.Mead@ed.ac.uk">Gillian.E.Mead@ed.ac.uk</a></td>
</tr>
</tbody>
</table>

**Notes**

**Protas**

<table>
<thead>
<tr>
<th>Trial name or title</th>
<th>Stroke rehabilitation outcomes with supported treadmill ambulation training</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Methods</strong></td>
<td></td>
</tr>
<tr>
<td>Participants</td>
<td>N=48 recent unilateral stroke patients expected. Aged 18 yrs or older, male or female.</td>
</tr>
<tr>
<td>Interventions</td>
<td>Intervention: Supported treadmill ambulation training + usual care.</td>
</tr>
<tr>
<td></td>
<td>Control: Usual care</td>
</tr>
<tr>
<td>Outcomes</td>
<td>FIM, oxygen consumption, Brain motor control assessment (BMCA)</td>
</tr>
<tr>
<td>Starting date</td>
<td>Start: Jan 2001</td>
</tr>
<tr>
<td></td>
<td>Completion: Dec 2003</td>
</tr>
<tr>
<td>Contact information</td>
<td>Dr Elizabeth Protas, VAMC, Houston, Texas</td>
</tr>
<tr>
<td></td>
<td>Tel: (713) 794-7117</td>
</tr>
<tr>
<td></td>
<td>E-mail: <a href="mailto:lim.peter@houston.va.gov">lim.peter@houston.va.gov</a></td>
</tr>
<tr>
<td>Notes</td>
<td>NLM identifier NCT00037895</td>
</tr>
</tbody>
</table>
### Comparison 1. Cardiorespiratory Training vs Control

<table>
<thead>
<tr>
<th>Outcome or subgroup title</th>
<th>No. of studies</th>
<th>No. of participants</th>
<th>Statistical method</th>
<th>Effect size</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Disability</td>
<td>2</td>
<td>35</td>
<td>Std. Mean Difference (IV, Random, 95% CI)</td>
<td>-0.06 [-0.76, 0.65]</td>
</tr>
<tr>
<td>1.1 During usual care</td>
<td>0</td>
<td>0</td>
<td>Std. Mean Difference (IV, Random, 95% CI)</td>
<td>Not estimable</td>
</tr>
<tr>
<td>1.2 After usual care</td>
<td>2</td>
<td>35</td>
<td>Std. Mean Difference (IV, Random, 95% CI)</td>
<td>-0.06 [-0.76, 0.65]</td>
</tr>
<tr>
<td>2 Fitness - Peak oxygen uptake (ml/kg/min)</td>
<td>2</td>
<td>54</td>
<td>Mean Difference (IV, Random, 95% CI)</td>
<td>2.51 [-0.20, 5.23]</td>
</tr>
<tr>
<td>2.1 During usual care</td>
<td>1</td>
<td>12</td>
<td>Mean Difference (IV, Random, 95% CI)</td>
<td>2.89 [-0.86, 6.62]</td>
</tr>
<tr>
<td>2.2 After usual care</td>
<td>1</td>
<td>42</td>
<td>Mean Difference (IV, Random, 95% CI)</td>
<td>2.02 [-1.85, 6.05]</td>
</tr>
<tr>
<td>3 Fitness - Maximum cycling work rate (Watts)</td>
<td>2</td>
<td>55</td>
<td>Mean Difference (IV, Random, 95% CI)</td>
<td>14.13 [-11.76, 40.02]</td>
</tr>
<tr>
<td>3.1 During usual care</td>
<td>1</td>
<td>13</td>
<td>Mean Difference (IV, Random, 95% CI)</td>
<td>4.16 [-35.55, 43.87]</td>
</tr>
<tr>
<td>3.2 After usual care</td>
<td>1</td>
<td>42</td>
<td>Mean Difference (IV, Random, 95% CI)</td>
<td>21.50 [-12.64, 55.64]</td>
</tr>
<tr>
<td>4 Mobility - Functional Ambulation Categories</td>
<td>3</td>
<td>94</td>
<td>Mean Difference (IV, Random, 95% CI)</td>
<td>0.60 [0.14, 1.06]</td>
</tr>
<tr>
<td>4.1 During usual care</td>
<td>3</td>
<td>94</td>
<td>Mean Difference (IV, Random, 95% CI)</td>
<td>0.60 [0.14, 1.06]</td>
</tr>
<tr>
<td>4.2 After usual care</td>
<td>0</td>
<td>0</td>
<td>Mean Difference (IV, Random, 95% CI)</td>
<td>Not estimable</td>
</tr>
<tr>
<td>5 Mobility - Maximum Walking Speed (m/sec over 5-10 metres)</td>
<td>4</td>
<td>114</td>
<td>Std. Mean Difference (IV, Random, 95% CI)</td>
<td>0.42 [0.04, 0.79]</td>
</tr>
<tr>
<td>5.1 During usual care</td>
<td>4</td>
<td>114</td>
<td>Std. Mean Difference (IV, Random, 95% CI)</td>
<td>0.42 [0.04, 0.79]</td>
</tr>
<tr>
<td>5.2 After usual care</td>
<td>0</td>
<td>0</td>
<td>Std. Mean Difference (IV, Random, 95% CI)</td>
<td>Not estimable</td>
</tr>
<tr>
<td>6 Mobility - Chosen Walking Speed (m/sec)</td>
<td>2</td>
<td>33</td>
<td>Std. Mean Difference (IV, Random, 95% CI)</td>
<td>-0.07 [-1.07, 0.93]</td>
</tr>
<tr>
<td>6.1 During usual care</td>
<td>2</td>
<td>33</td>
<td>Std. Mean Difference (IV, Random, 95% CI)</td>
<td>-0.07 [-1.07, 0.93]</td>
</tr>
<tr>
<td>6.2 After usual care</td>
<td>0</td>
<td>0</td>
<td>Std. Mean Difference (IV, Random, 95% CI)</td>
<td>Not estimable</td>
</tr>
</tbody>
</table>

### Comparison 3. Mixed Training (Cardiorespiratory + Strength) vs Control

<table>
<thead>
<tr>
<th>Outcome or subgroup title</th>
<th>No. of studies</th>
<th>No. of participants</th>
<th>Statistical method</th>
<th>Effect size</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Mobility - Chosen walking Speed (m/sec)</td>
<td>3</td>
<td>42</td>
<td>Std. Mean Difference (IV, Random, 95% CI)</td>
<td>0.26 [-0.35, 0.87]</td>
</tr>
<tr>
<td>1.1 During usual care</td>
<td>0</td>
<td>0</td>
<td>Std. Mean Difference (IV, Random, 95% CI)</td>
<td>Not estimable</td>
</tr>
<tr>
<td>1.2 After usual care</td>
<td>3</td>
<td>42</td>
<td>Std. Mean Difference (IV, Random, 95% CI)</td>
<td>0.26 [-0.35, 0.87]</td>
</tr>
<tr>
<td>2 Health related quality of life</td>
<td>2</td>
<td>33</td>
<td>Std. Mean Difference (IV, Random, 95% CI)</td>
<td>-0.29 [-1.37, 0.80]</td>
</tr>
<tr>
<td>2.1 During usual care</td>
<td>0</td>
<td>0</td>
<td>Std. Mean Difference (IV, Random, 95% CI)</td>
<td>Not estimable</td>
</tr>
<tr>
<td>2.2 After usual care</td>
<td>2</td>
<td>33</td>
<td>Std. Mean Difference (IV, Random, 95% CI)</td>
<td>-0.29 [-1.37, 0.80]</td>
</tr>
</tbody>
</table>
### Analysis 1.1. Comparison 1 Cardiorespiratory Training vs Control, Outcome 1 Disability.

**Review:** Physical fitness training for stroke patients  
**Comparison:** Cardiorespiratory Training vs Control  
**Outcome:** Disability

<table>
<thead>
<tr>
<th>Study or subgroup</th>
<th>Treatment</th>
<th>Control</th>
<th>Std. Mean Difference</th>
<th>Weight</th>
<th>Std. Mean Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N</td>
<td>Mean(SD)</td>
<td>N</td>
<td>Mean(SD)</td>
<td>IV(Random,95% CI)</td>
</tr>
<tr>
<td>1 During usual care</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Subtotal (95% CI)</td>
<td>0</td>
<td>0</td>
<td>0.0 %</td>
<td>0.0 [ 0.0, 0.0 ]</td>
<td></td>
</tr>
</tbody>
</table>
| Heterogeneity: not applicable  
Test for overall effect: not applicable  
2 After usual care |          |         |          |        |                    |                    |
| Cuviello-Palmer 1988 | 10 | 10.52 (11.5) | 12 | 12.29 (12.4) | 70.3 % | -0.14 [-0.98, 0.70] |
| Duncan 1998 | 3 | 3.2 (6.3) | 10 | 2.3 (5.5) | 29.7 % | 0.15 [-1.14, 1.44] |
| Subtotal (95% CI) | 13 | 22 | 100.0 % | -0.06 [-0.76, 0.65] |        |                    |
| Heterogeneity: Tau² = 0.0; Chi² = 0.14, df = 1 (P = 0.71); I² =0.0%  
Test for overall effect: Z = 0.15 (P = 0.88)  
Total (95% CI) | 13 | 22 | 100.0 % | -0.06 [-0.76, 0.65] |        |                    |
| Heterogeneity: Tau² = 0.0; Chi² = 0.14, df = 1 (P = 0.71); I² =0.0%  
Test for overall effect: Z = 0.15 (P = 0.88) |          |         |          |        |                    |                    |
### Analysis 1.2. Comparison 1 Cardiorespiratory Training vs Control, Outcome 2 Fitness - Peak oxygen uptake (ml/kg/min).

**Review:** Physical fitness training for stroke patients

**Comparison:** 1 Cardiorespiratory Training vs Control

**Outcome:** 2 Fitness - Peak oxygen uptake (ml/kg/min)

<table>
<thead>
<tr>
<th>Study or subgroup</th>
<th>Treatment</th>
<th>Control</th>
<th>Mean Difference</th>
<th>Weight</th>
<th>Mean Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N Mean(SD)</td>
<td>N Mean(SD)</td>
<td>IV,Random,95% CI</td>
<td>IV,Random,95% CI</td>
<td></td>
</tr>
<tr>
<td>1 During usual care</td>
<td>6 2.98 (3.1)</td>
<td>6 0.1 (3.5)</td>
<td>52.7% [ -0.86, 6.62 ]</td>
<td>2.88</td>
<td></td>
</tr>
</tbody>
</table>

**Subtotal (95% CI)**: 6 6

Test for overall effect: Z = 1.51 (P = 0.13)

Heterogeneity: not applicable

2 After usual care

<table>
<thead>
<tr>
<th>Study or subgroup</th>
<th>Treatment</th>
<th>Control</th>
<th>Mean Difference</th>
<th>Weight</th>
<th>Mean Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N Mean(SD)</td>
<td>N Mean(SD)</td>
<td>IV,Random,95% CI</td>
<td>IV,Random,95% CI</td>
<td></td>
</tr>
<tr>
<td>Patempa 1995</td>
<td>19 2.2 (6.5)</td>
<td>23 0.1 (6.5)</td>
<td>47.3% [ -1.85, 6.05 ]</td>
<td>2.10</td>
<td></td>
</tr>
</tbody>
</table>

**Subtotal (95% CI)**: 19 23

Test for overall effect: Z = 1.04 (P = 0.30)

**Total (95% CI)**: 25 29

Heterogeneity: Tau² = 0.0; Chi² = 0.08, df = 1 (P = 0.78); I² =0.0%

Test for overall effect: Z = 1.81 (P = 0.070)
## Review: Physical fitness training for stroke patients

### Comparison: 1 Cardiorespiratory Training vs Control

#### Outcome: 2 Fitness - Peak oxygen uptake (ml/kg/min)

<table>
<thead>
<tr>
<th>Study or subgroup</th>
<th>Treatment</th>
<th>Control</th>
<th>Mean Difference</th>
<th>Weight</th>
<th>Mean Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N Mean(SD)</td>
<td>N Mean(SD)</td>
<td>IV(Random,95% CI)</td>
<td>IV(Random,95% CI)</td>
<td></td>
</tr>
<tr>
<td>2 After usual care</td>
<td>19 2.2 (6.5)</td>
<td>23 0.1 (6.5)</td>
<td>47.3 % 2.10 [ -1.85, 6.05 ]</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Potempa 1995</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Subtotal (95% CI)</td>
<td>19</td>
<td>23</td>
<td>47.3 % 2.10 [ -1.85, 6.05 ]</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Heterogeneity: not applicable

Test for overall effect: Z = 1.04 (P = 0.30)

### Analysis 1.3. Comparison 1 Cardiorespiratory Training vs Control, Outcome 3 Fitness - Maximum cycling work rate (Watts)

#### Review: Physical fitness training for stroke patients

#### Comparison: 1 Cardiorespiratory Training vs Control

#### Outcome: 3 Fitness - Maximum cycling work rate (Watts)

<table>
<thead>
<tr>
<th>Study or subgroup</th>
<th>Treatment</th>
<th>Control</th>
<th>Mean Difference</th>
<th>Weight</th>
<th>Mean Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N Mean(SD)</td>
<td>N Mean(SD)</td>
<td>IV(Random,95% CI)</td>
<td>IV(Random,95% CI)</td>
<td></td>
</tr>
<tr>
<td>1 During usual care</td>
<td>6 20.83 (43.5)</td>
<td>7 16.67 (25.8)</td>
<td>42.5 % 4.16 [ -35.55, 43.87 ]</td>
<td></td>
<td></td>
</tr>
<tr>
<td>da Cunha 2002</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Subtotal (95% CI)</td>
<td>6</td>
<td>7</td>
<td>42.5 % 4.16 [ -35.55, 43.87 ]</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Heterogeneity: not applicable

Test for overall effect: Z = 0.21 (P = 0.84)

<table>
<thead>
<tr>
<th>Study or subgroup</th>
<th>Treatment</th>
<th>Control</th>
<th>Mean Difference</th>
<th>Weight</th>
<th>Mean Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N Mean(SD)</td>
<td>N Mean(SD)</td>
<td>IV(Random,95% CI)</td>
<td>IV(Random,95% CI)</td>
<td></td>
</tr>
<tr>
<td>2 After usual care</td>
<td>19 28.9 (64.7)</td>
<td>23 7.4 (43.7)</td>
<td>57.5 % 21.50 [ -12.64, 55.64 ]</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Potempa 1995</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Subtotal (95% CI)</td>
<td>19</td>
<td>23</td>
<td>57.5 % 21.50 [ -12.64, 55.64 ]</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Heterogeneity: not applicable

Test for overall effect: Z = 1.23 (P = 0.22)

| Total (95% CI) | 25 30 | 100.0 % 14.13 [ -11.76, 40.02 ] |
|               |      | | |

Heterogeneity: Tau² = 0.0; Ch² = 0.42, df = 1 (P = 0.52); P =0.0%

Test for overall effect: Z = 1.07 (P = 0.28)
### Review: Physical fitness training for stroke patients

**Comparison:** 1 Cardiorespiratory Training vs Control

**Outcome:** 3 Fitness - Maximum cycling work rate (Watts)

<table>
<thead>
<tr>
<th>Study or subgroup</th>
<th>Treatment</th>
<th>Control</th>
<th>Mean Difference</th>
<th>Weight</th>
<th>Mean Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N (Mean(SD))</td>
<td>N (Mean(SD))</td>
<td>IV, Random, 95% CI</td>
<td></td>
<td>IV, Random, 95% CI</td>
</tr>
<tr>
<td>1 During usual care</td>
<td>6 (20.83 (43.5))</td>
<td>7 (16.67 (25.8))</td>
<td>42.5 % 4.16 [-35.55, 43.87]</td>
<td>4.16 [ -35.55, 43.87 ]</td>
<td></td>
</tr>
<tr>
<td><strong>Subtotal (95% CI)</strong></td>
<td><strong>6</strong></td>
<td><strong>7</strong></td>
<td><strong>42.5 %</strong></td>
<td><strong>4.16</strong></td>
<td><strong>-35.55, 43.87</strong></td>
</tr>
<tr>
<td>Heterogeneity: not applicable</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Test for overall effect: Z = 0.21 (P = 0.84)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Study or subgroup</th>
<th>Treatment</th>
<th>Control</th>
<th>Mean Difference</th>
<th>Weight</th>
<th>Mean Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N (Mean(SD))</td>
<td>N (Mean(SD))</td>
<td>IV, Random, 95% CI</td>
<td></td>
<td>IV, Random, 95% CI</td>
</tr>
<tr>
<td>2 After usual care</td>
<td>19 (28.9 (64.7))</td>
<td>23 (7.4 (43.7))</td>
<td>57.5 % 21.50 [-12.64, 55.64]</td>
<td>21.50 [ -12.64, 55.64 ]</td>
<td></td>
</tr>
<tr>
<td><strong>Subtotal (95% CI)</strong></td>
<td><strong>19</strong></td>
<td><strong>23</strong></td>
<td><strong>57.5 %</strong></td>
<td><strong>21.50</strong></td>
<td><strong>-12.64, 55.64</strong></td>
</tr>
<tr>
<td>Heterogeneity: not applicable</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Test for overall effect: Z = 1.23 (P = 0.22)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

---

**Physical fitness training for stroke patients (Review)**

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### Analysis 1.4. Comparison 1 Cardiorespiratory Training vs Control, Outcome 4 Mobility - Functional Ambulation Categories.

**Review:** Physical fitness training for stroke patients  
**Comparison:** Cardiorespiratory Training vs Control  
**Outcome:** 4 Mobility - Functional Ambulation Categories

<table>
<thead>
<tr>
<th>Study or subgroup</th>
<th>Treatment</th>
<th>Control</th>
<th>Mean Difference</th>
<th>Weight</th>
<th>Mean Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N</td>
<td>Mean(SD)</td>
<td></td>
<td>IV, Random, 95% CI</td>
<td>IV, Random, 95% CI</td>
</tr>
<tr>
<td>1 During usual care</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>da Cunha 2002</td>
<td>7</td>
<td>1.3 (1.7)</td>
<td>7</td>
<td>0.9 (2.1)</td>
<td>5.4 % 0.40 [-1.60, 2.40]</td>
</tr>
<tr>
<td>Pohl 2002a</td>
<td>20</td>
<td>1.3 (1.8)</td>
<td>0</td>
<td>0.4 (1)</td>
<td>26.4 % 0.90 [0.00, 1.80]</td>
</tr>
<tr>
<td>Pohl 2002b</td>
<td>20</td>
<td>0.9 (0.8)</td>
<td>20</td>
<td>0.4 (1)</td>
<td>68.2 % 0.50 [-0.06, 1.06]</td>
</tr>
<tr>
<td><strong>Subtotal (95% CI)</strong></td>
<td>47</td>
<td>47</td>
<td></td>
<td></td>
<td>100.0 % 0.60 [0.14, 1.06]</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2 After usual care</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>0</td>
<td>0</td>
<td></td>
<td></td>
<td>0.0 % 0.0 [0.0, 0.0]</td>
</tr>
<tr>
<td><strong>Subtotal (95% CI)</strong></td>
<td>0</td>
<td>0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Total (95% CI)</strong></td>
<td>47</td>
<td>47</td>
<td></td>
<td></td>
<td>100.0 % 0.60 [0.14, 1.06]</td>
</tr>
</tbody>
</table>

Heterogeneity: \( \tau^2 = 0.0; \ Chi^2 = 0.58, df = 2 (P = 0.75); I^2 = 0.0\%

Test for overall effect: \( Z = 2.54 (P = 0.011) \)

Heterogeneity: not applicable

Test for overall effect: not applicable
Review: Physical fitness training for stroke patients
Comparison: 1 Cardiorespiratory Training vs Control
Outcome: 4 Mobility - Functional Ambulation Categories

<table>
<thead>
<tr>
<th>Study or subgroup</th>
<th>Treatment</th>
<th>Control</th>
<th>Mean Difference</th>
<th>Weight</th>
<th>Mean Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N</td>
<td>Mean(SD)</td>
<td></td>
<td></td>
<td>IV,Random,95% CI</td>
</tr>
<tr>
<td>1 During usual care</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>da Cunha 2002</td>
<td>7</td>
<td>1.3 (1.7)</td>
<td></td>
<td>5.4 %</td>
<td>0.40 [-1.60, 2.40 ]</td>
</tr>
<tr>
<td>Pohl 2002a</td>
<td>20</td>
<td>1.3 (1.8)</td>
<td></td>
<td>26.4 %</td>
<td>0.90 [ 0.00, 1.80 ]</td>
</tr>
<tr>
<td>Pohl 2002b</td>
<td>20</td>
<td>0.9 (0.8)</td>
<td></td>
<td>68.2 %</td>
<td>0.50 [-0.06, 1.06 ]</td>
</tr>
<tr>
<td><strong>Subtotal (95% CI)</strong></td>
<td><strong>47</strong></td>
<td><strong>47</strong></td>
<td></td>
<td><strong>100.0 %</strong></td>
<td><strong>0.60 [ 0.14, 1.06 ]</strong></td>
</tr>
</tbody>
</table>

Heterogeneity: \( \tau^2 = 0.0; \chi^2 = 0.58, \text{df} = 2 (P = 0.75); I^2 = 0.0\%
Test for overall effect: \( Z = 2.54 (P = 0.011) \)

---

Analysis 1.5. Comparison 1 Cardiorespiratory Training vs Control, Outcome 5 Mobility - Maximum Walking Speed (m/sec over 5-10 metres).

Review: Physical fitness training for stroke patients
Comparison: 1 Cardiorespiratory Training vs Control
Outcome: 5 Mobility - Maximum Walking Speed (m/sec over 5-10 metres)

<table>
<thead>
<tr>
<th>Study or subgroup</th>
<th>Treatment</th>
<th>Control</th>
<th>Mean Difference</th>
<th>Weight</th>
<th>Mean Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N</td>
<td>Mean(SD)</td>
<td></td>
<td></td>
<td>IV,Random,95% CI</td>
</tr>
<tr>
<td>1 During usual care</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>da Cunha 2002</td>
<td>7</td>
<td>0.23 (0.4)</td>
<td></td>
<td>12.6 %</td>
<td>0.19 [-0.86, 1.24 ]</td>
</tr>
<tr>
<td>Glasser 1986</td>
<td>10</td>
<td>0.29 (2.15)</td>
<td></td>
<td>18.2 %</td>
<td>0.05 [-0.82, 0.93 ]</td>
</tr>
<tr>
<td>Pohl 2002a</td>
<td>20</td>
<td>0.56 (0.8)</td>
<td></td>
<td>35.9 %</td>
<td>0.31 [-0.32, 0.93 ]</td>
</tr>
<tr>
<td>Pohl 2002b</td>
<td>20</td>
<td>1.02 (0.9)</td>
<td></td>
<td>33.3 %</td>
<td>0.82 [ 0.17, 1.47 ]</td>
</tr>
<tr>
<td><strong>Subtotal (95% CI)</strong></td>
<td><strong>57</strong></td>
<td><strong>57</strong></td>
<td></td>
<td><strong>100.0 %</strong></td>
<td><strong>0.42 [ 0.04, 0.79 ]</strong></td>
</tr>
</tbody>
</table>

Heterogeneity: \( \tau^2 = 0.0; \chi^2 = 2.43, \text{df} = 3 (P = 0.49); I^2 = 0.0\%
Test for overall effect: \( Z = 2.18 (P = 0.029) \)

2 After usual care

<table>
<thead>
<tr>
<th>Study or subgroup</th>
<th>Treatment</th>
<th>Control</th>
<th>Mean Difference</th>
<th>Weight</th>
<th>Mean Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N</td>
<td>Mean(SD)</td>
<td></td>
<td></td>
<td>IV,Random,95% CI</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Subtotal (95% CI)</strong></td>
<td><strong>0</strong></td>
<td><strong>0</strong></td>
<td></td>
<td><strong>0.0 %</strong></td>
<td><strong>0.0 [ 0.0, 0.0 ]</strong></td>
</tr>
</tbody>
</table>

(Continued . . .)
### Physical fitness training for stroke patients (Review)

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#### Review: Physical fitness training for stroke patients

Comparison: 1 Cardiorespiratory Training vs Control

Outcome: 5 Mobility - Maximum Walking Speed (m/sec over 5-10 metres)

<table>
<thead>
<tr>
<th>Study or subgroup</th>
<th>Treatment</th>
<th>Control</th>
<th>Std. Mean Difference</th>
<th>Weight</th>
<th>Std. Mean Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N Mean(SD)</td>
<td>N Mean(SD)</td>
<td>IV,Random,95% CI</td>
<td></td>
<td>IV,Random,95% CI</td>
</tr>
<tr>
<td>I During usual care</td>
<td>7 0.23 (0.4)</td>
<td>7 0.15 (0.4)</td>
<td></td>
<td>12.6 %</td>
<td>0.19 [ -0.86, 1.24 ]</td>
</tr>
<tr>
<td>Glasser 1986</td>
<td>10 0.29 (2.15)</td>
<td>10 0.2 (0.85)</td>
<td></td>
<td>18.2 %</td>
<td>0.05 [ -0.82, 0.93 ]</td>
</tr>
<tr>
<td>Pohl 2002a</td>
<td>20 0.56 (0.8)</td>
<td>20 0.31 (0.8)</td>
<td></td>
<td>35.9 %</td>
<td>0.31 [ -0.32, 0.93 ]</td>
</tr>
<tr>
<td>Pohl 2002b</td>
<td>20 1.02 (0.9)</td>
<td>20 0.31 (0.8)</td>
<td></td>
<td>33.3 %</td>
<td>0.82 [ 0.17, 1.47 ]</td>
</tr>
<tr>
<td><strong>Subtotal (95% CI)</strong></td>
<td>57</td>
<td>57</td>
<td></td>
<td>100.0 %</td>
<td>0.42 [ 0.04, 0.79 ]</td>
</tr>
</tbody>
</table>

Heterogeneity: not applicable
Test for overall effect: not applicable

Heterogeneity: Tau² = 0.0; Chi² = 2.43, df = 3 (P = 0.49); I² =0.0%
Test for overall effect: Z = 2.18 (P = 0.029)
### Analysis 1.6. Comparison 1 Cardiorespiratory Training vs Control, Outcome 6 Mobility - Chosen Walking Speed (m/sec).

**Review:** Physical fitness training for stroke patients

**Comparison:** Cardiorespiratory Training vs Control

**Outcome:** Mobility - Chosen Walking Speed (m/sec)

<table>
<thead>
<tr>
<th>Study or subgroup</th>
<th>Treatment</th>
<th>Control</th>
<th>Std. Mean Difference IV(Random,95% CI)</th>
<th>Weight</th>
<th>Std. Mean Difference IV(Random,95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Total (95% CI)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1 During usual care</td>
<td>Cuvello-Palmer 1988</td>
<td>10</td>
<td>0.04 (0.2)</td>
<td>10</td>
<td>0.15 (0.2)</td>
</tr>
<tr>
<td></td>
<td>da Cunha 2002</td>
<td>6</td>
<td>0.18 (0.21)</td>
<td>7</td>
<td>0.09 (0.12)</td>
</tr>
<tr>
<td><strong>Subtotal (95% CI)</strong></td>
<td>16</td>
<td>17</td>
<td>100.0 %</td>
<td>-0.07 [-1.07, 0.93]</td>
<td></td>
</tr>
<tr>
<td>2 After usual care</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Total (95% CI)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Heterogeneity:</strong> Tau^2 = 0.26; Chi^2 = 1.99, df = 1 (P = 0.16); I^2 = 50%</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Test for overall effect: Z = 0.13 (P = 0.89)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Review:** Physical fitness training for stroke patients

**Comparison:** Cardiorespiratory Training vs Control

**Outcome:** Mobility - Chosen Walking Speed (m/sec)

<table>
<thead>
<tr>
<th>Study or subgroup</th>
<th>Treatment</th>
<th>Control</th>
<th>Std. Mean Difference IV(Random,95% CI)</th>
<th>Weight</th>
<th>Std. Mean Difference IV(Random,95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Total (95% CI)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1 During usual care</td>
<td>Cuvello-Palmer 1988</td>
<td>10</td>
<td>0.04 (0.2)</td>
<td>10</td>
<td>0.15 (0.2)</td>
</tr>
<tr>
<td></td>
<td>da Cunha 2002</td>
<td>6</td>
<td>0.18 (0.21)</td>
<td>7</td>
<td>0.09 (0.12)</td>
</tr>
<tr>
<td><strong>Subtotal (95% CI)</strong></td>
<td>16</td>
<td>17</td>
<td>100.0 %</td>
<td>-0.07 [-1.07, 0.93]</td>
<td></td>
</tr>
<tr>
<td><strong>Heterogeneity:</strong> Tau^2 = 0.26; Chi^2 = 1.99, df = 1 (P = 0.16); I^2 = 50%</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Test for overall effect: Z = 0.13 (P = 0.89)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
**Analysis 3.1. Comparison 3 Mixed Training (Cardiorespiratory + Strength) vs Control, Outcome 1 Mobility - Chosen walking Speed (m/sec).**

Review: Physical fitness training for stroke patients
Comparison: 3 Mixed Training (Cardiorespiratory + Strength) vs Control
Outcome: 1 Mobility - Chosen walking Speed (m/sec)

<table>
<thead>
<tr>
<th>Study or subgroup</th>
<th>Treatment</th>
<th>Control</th>
<th>Std. Mean Difference</th>
<th>Weight</th>
<th>Std. Mean Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N (Mean(SD))</td>
<td>N (Mean(SD))</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1 During usual care</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Subtotal (95% CI)</td>
<td>0 (0)</td>
<td>0 (0)</td>
<td>0.0 %</td>
<td>0.0 [ 0.0, 0.0 ]</td>
<td></td>
</tr>
<tr>
<td>Heterogeneity: not applicable</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Test for overall effect: not applicable</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2 After usual care</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dean 2000</td>
<td>5 (0.12 (0.5))</td>
<td>4 (0.01 (0.62))</td>
<td>21.5 %</td>
<td>0.18 [-1.14, 1.50 ]</td>
<td></td>
</tr>
<tr>
<td>Duncan 1998</td>
<td>10 (0.16 (0.41))</td>
<td>10 (0.09 (0.45))</td>
<td>48.4 %</td>
<td>0.16 [-0.72, 1.03 ]</td>
<td></td>
</tr>
<tr>
<td>Teixeira 1999</td>
<td>6 (0.24 (0.5))</td>
<td>7 (-0.02 (0.5))</td>
<td>30.1 %</td>
<td>0.48 [-0.63, 1.60 ]</td>
<td></td>
</tr>
<tr>
<td>Subtotal (95% CI)</td>
<td>21 (0.26 (0.62))</td>
<td>21 (0.14 (0.62))</td>
<td>100.0 %</td>
<td>0.26 [-0.35, 0.87 ]</td>
<td></td>
</tr>
<tr>
<td>Heterogeneity: Tau² = 0.0; Chi² = 2.0, df = 2 (P = 0.89); I² =0.0%</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Test for overall effect: Z = 0.83 (P = 0.41)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total (95% CI)</td>
<td>21 (0.26 (0.62))</td>
<td>21 (0.14 (0.62))</td>
<td>100.0 %</td>
<td>0.26 [-0.35, 0.87 ]</td>
<td></td>
</tr>
<tr>
<td>Heterogeneity: Tau² = 0.0; Chi² = 2.0, df = 2 (P = 0.89); I² =0.0%</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Test for overall effect: Z = 0.83 (P = 0.41)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Favours control Favours treatment
### Analysis 3.2. Comparison 3 Mixed Training (Cardiorespiratory + Strength) vs Control, Outcome 2 Health related quality of life.

**Review:** Physical fitness training for stroke patients

**Comparison:** 3 Mixed Training (Cardiorespiratory + Strength) vs Control

**Outcome:** 2 Health related quality of life

<table>
<thead>
<tr>
<th>Study or subgroup</th>
<th>Treatment</th>
<th>Control</th>
<th>Std. Mean Difference</th>
<th>Weight</th>
<th>Std. Mean Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N Mean(SD)</td>
<td>N Mean(SD)</td>
<td>IV,Random,95% CI</td>
<td>IV,Random,95% CI</td>
<td></td>
</tr>
<tr>
<td><strong>2 After usual care</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dean 2000</td>
<td>5 0.12 (0.5)</td>
<td>4 0.01 (0.62)</td>
<td></td>
<td>21.5 % 0.18 [-1.14, 1.50]</td>
<td></td>
</tr>
<tr>
<td>Duncan 1998</td>
<td>10 0.16 (0.41)</td>
<td>10 0.09 (0.45)</td>
<td></td>
<td>48.4 % 0.16 [-0.72, 1.03]</td>
<td></td>
</tr>
<tr>
<td>Teixeira 1999</td>
<td>6 0.24 (0.5)</td>
<td>7 -0.02 (0.5)</td>
<td></td>
<td>30.1 % 0.48 [-0.63, 1.60]</td>
<td></td>
</tr>
<tr>
<td><strong>Subtotal (95% CI)</strong></td>
<td>21</td>
<td>21</td>
<td></td>
<td>100.0 % 0.26 [-0.35, 0.87]</td>
<td></td>
</tr>
</tbody>
</table>

Heterogeneity: $\tau^2 = 0.0; \chi^2 = 2.22, df = 2 (P = 0.89); I^2 = 0.0$

Test for overall effect: $Z = 0.83 (P = 0.41)$

---

Heterogeneity: not applicable

Test for overall effect: not applicable

<table>
<thead>
<tr>
<th>Study or subgroup</th>
<th>Treatment</th>
<th>Control</th>
<th>Std. Mean Difference</th>
<th>Weight</th>
<th>Std. Mean Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N Mean(SD)</td>
<td>N Mean(SD)</td>
<td>IV,Random,95% CI</td>
<td>IV,Random,95% CI</td>
<td></td>
</tr>
<tr>
<td><strong>1 During usual care</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Subtotal (95% CI)</strong></td>
<td>0</td>
<td>0</td>
<td>0.0 % 0.0 [ 0.0, 0.0 ]</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

---

Heterogeneity: $\tau^2 = 0.34; \chi^2 = 2.23, df = 1 (P = 0.14); I^2 = 55$

Test for overall effect: $Z = 0.52 (P = 0.60)$

<table>
<thead>
<tr>
<th>Study or subgroup</th>
<th>Treatment</th>
<th>Control</th>
<th>Std. Mean Difference</th>
<th>Weight</th>
<th>Std. Mean Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N Mean(SD)</td>
<td>N Mean(SD)</td>
<td>IV,Random,95% CI</td>
<td>IV,Random,95% CI</td>
<td></td>
</tr>
<tr>
<td><strong>2 After usual care</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Duncan 1998</td>
<td>10 15.5 (43.3)</td>
<td>10 7.5 (32.6)</td>
<td></td>
<td>56.2 % 0.20 [-0.68, 1.08]</td>
<td></td>
</tr>
<tr>
<td>Teixeira 1999</td>
<td>6 -18.16 (8.14)</td>
<td>7 -1.6 (6.5)</td>
<td></td>
<td>43.8 % -0.91 [-2.08, 0.26]</td>
<td></td>
</tr>
<tr>
<td><strong>Subtotal (95% CI)</strong></td>
<td>16</td>
<td>17</td>
<td>100.0 % -0.29 [-1.37, 0.80]</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

---

Heterogeneity: $\tau^2 = 0.34; \chi^2 = 2.23, df = 1 (P = 0.14); I^2 = 55$

Test for overall effect: $Z = 0.52 (P = 0.60)$

<table>
<thead>
<tr>
<th>Study or subgroup</th>
<th>Treatment</th>
<th>Control</th>
<th>Std. Mean Difference</th>
<th>Weight</th>
<th>Std. Mean Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N Mean(SD)</td>
<td>N Mean(SD)</td>
<td>IV,Random,95% CI</td>
<td>IV,Random,95% CI</td>
<td></td>
</tr>
<tr>
<td><strong>Total (95% CI)</strong></td>
<td>16</td>
<td>17</td>
<td>100.0 % -0.29 [-1.37, 0.80]</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

---

Heterogeneity: $\tau^2 = 0.34; \chi^2 = 2.23, df = 1 (P = 0.14); I^2 = 55$

Test for overall effect: $Z = 0.52 (P = 0.60)$
Review: Physical fitness training for stroke patients

Comparison: 3 Mixed Training (Cardiorespiratory + Strength) vs Control

Outcome: 2 Health related quality of life

<table>
<thead>
<tr>
<th>Study or subgroup</th>
<th>Treatment</th>
<th>Control</th>
<th>Std. Mean Difference</th>
<th>Weight</th>
<th>Std. Mean Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td>N</td>
<td>Mean(SD)</td>
<td>N</td>
<td>Mean(SD)</td>
<td>IV,Random,95% CI</td>
<td>IV,Random,95% CI</td>
</tr>
<tr>
<td>2 After usual care</td>
<td>Duncan 1998</td>
<td>10</td>
<td>15.5 (43.3)</td>
<td>10</td>
<td>7.5 (32.6)</td>
</tr>
<tr>
<td>Teixeira 1999</td>
<td>6</td>
<td>-8.16 (8.14)</td>
<td>7</td>
<td>-1 (6.5)</td>
<td>43.8 %</td>
</tr>
<tr>
<td><strong>Subtotal (95% CI)</strong></td>
<td>16</td>
<td>17</td>
<td><strong>100.0 %</strong></td>
<td><strong>-0.29 [-1.37, 0.80]</strong></td>
<td></td>
</tr>
</tbody>
</table>

Heterogeneity: Tau² = 0.34; Chi² = 2.23, df = 1 (P = 0.14); I² = 55%
Test for overall effect: Z = 0.52 (P = 0.60)

---

**APPENDICES**

**Appendix 1. MEDLINE search strategy**

1. exp cerebrovascular disorders/
2. (stroke$ or cva$ or cerebrovascular or cerebral vascular).tw.
3. ((cerebral or cerebellar or brain$ or verteobasilar) adj5 (infarct$ or isch?emi$ or thrombo$ or emboli$ or apoplexy)).tw.
4. ((cerebral or brain$ or subarachnoid) adj5 (haemorrhage or hemorrhage or haematoma or hematoma or bleed$)).tw.
5. hemiplegia/ or brain injuries/
6. (hemipleg$ or hemipar$ or poststroke or post-stroke or brain injur$).tw.
7. or/1-6
8. exercise/
9. exercise therapy/
10. exercise tolerance/
11. exercise test/
12. exertion/
13. physical fitness/
14. physical endurance/
15. physical therapy/
16. locomotion/
17. early ambulation/
18. sports/ or weight lifting/ or bicycling/ or running/ or swimming/ or walking/ or sports equipment/
19. leisure activities/ or recreation/
20. isometric contraction/ or isotonic contraction/
21. (physical adj3 (exercise$ or therapi$ or conditioning or activity$ or fitness)).tw.
22. (exercise adj3 (train$ or intervention$ or protocol$ or program$ or therapi$ or activit$ or regim$)).tw.
23. (fitness adj3 (train$ or intervention$ or protocol$ or program$ or therapi$ or activit$ or regim$)).tw.

---

Physical fitness training for stroke patients (Review)
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24. ((training or conditioning) adj3 (intervention$ or protocol$ or program$ or activit$ or regim$)).tw.
25. (sport$ or recreation$ or leisure or cycl$ or bicycl$ or treadmill$ or run$ or swim$ or walk$).tw.
26. ((endurance or aerobic or cardio$) adj3 (fitness or train$ or intervention$ or protocol$ or program$ or therap$ or activit$ or regim$)).tw.
27. (muscle strengthening or progressive resist$).tw.
28. ((weight or strength$ or resistance) adj (train$ or lift$ or exercise$)).tw.
29. ((isometric or isotonic or eccentric or concentric) adj (contraction$ or exercise$)).tw.
30. or/8-29
31. randomized controlled trial.pt.
32. randomized controlled trials/
33. controlled clinical trial.pt.
34. controlled clinical trials/
35. random allocation/
36. single-blind method/
37. clinical trial.pt.
38. exp clinical trials/
39. (clin$ adj5 trial$).tw.
40. (single adj5 (blind$ or mask$)).tw
41. placebos/
42. placebo$.tw.
43. random$.tw.
44. research design/
45. multicenter study.pt.
46. intervention studies/
47. cross-over studies/
48. control$.tw.
49. alternate treatment.tw.
50. latin square.tw.
51. comparative study/
52. exp evaluation studies/
53. follow-up studies/
54. prospective studies/
55. prospective.tw.
56. counterbalance$.tw.
57. versus.tw.
58. or/31-57
59. 7 and 30 and 58
60. animal/ not (human/ and animal/)
61. heat stroke/ or heat stroke.tw.
62. 59 not (60 or 61)

WHAT'S NEW

Last assessed as up-to-date: 15 October 2003.
HISTORY
Review first published: Issue 1, 2004

CONTRIBUTIONS OF AUTHORS
DS wrote and performed the literature searches, screened the titles and abstracts, applied inclusion criteria and methodological quality assessments; extracted and analysed data and entered this into RevMan; analysed and interpreted data; wrote and entered text into RevMan.

GG applied inclusion criteria and methodological quality assessments; extracted and interpreted data; wrote text of the review and provided critical comment on interim drafts of the review.

GM applied inclusion criteria and methodological quality assessments; extracted and interpreted data: wrote text of the review and provided critical comment on interim drafts of the review.

AY reviewed and provided critical comment on interim drafts of the review.

DECLARATIONS OF INTEREST
None known

INDEX TERMS
Medical Subject Headings (MeSH)
*Exercise Therapy; *Physical Fitness; Randomized Controlled Trials as Topic; Stroke [*rehabilitation]

MeSH check words
Humans