

# How effective are physical activity interventions for alleviating depressive symptoms in older people? A systematic review

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**Background:** The benefits of physical exercise in reducing clinically defined depression in the general population have been established, although a review of the evidence for older adults is needed.

**Objectives:** To assess the efficacy of physical exercise for the treatment of depressive symptoms in older adults (>60 years).

**Data sources:** We searched: MEDLINE (1966–May 2008); EMBASE (1980–May 2008); Cumulative Index to Nursing & Allied Health Literature (CINAHL; 1982–May 2008); PsycINFO (1966–May 2008), The Cochrane Library (Issue 2, 2008), and National Research Register (NRR; Issue 2, 2008).

**Review methods:** Randomized controlled trials and quasi-experimental studies of physical exercise interventions for depression were included where 80% or more of participants were >60 years. Abstracts were assessed to determine whether they met specified inclusion criteria. Primary analysis focused on the prevalence of diagnosable depressive disorder following intervention. Secondary outcome was depression or mood scores on standardized scales.

**Results:** Eleven randomized controlled trials with a total of 641 participants were included in the review. Short-term positive outcome for depression or depressive symptoms was found in nine studies, although the mode, intensity and duration of intervention varied across studies. Medium- to long-term effects of intervention were less clear.

**Conclusion:** Physical exercise programmes obtain clinically relevant outcomes in the treatment of depressive symptoms in depressed older people. Exercise, though not appropriate for all in this population, may improve mood in this group. Further research is needed to establish medium- to long-term effects and cost-effectiveness.

## Introduction

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Depression is common in old age,<sup>1,2</sup> and is often associated with a range of social, demographic and physical factors.<sup>3</sup> Depression is a treatable condition, although if left untreated, there is evidence of

an increased risk of morbidity<sup>4</sup> and mortality,<sup>5,6</sup> with an associated economic and societal burden.<sup>7</sup>

Effective treatments for depression in older age include antidepressants, electroconvulsive therapy, cognitive behaviour therapy, psychodynamic psychotherapy, reminiscence therapy, problem-solving therapy, bibliotherapy (for mild to moderate depression) and exercise.<sup>8</sup> However, depression in older adults often goes undiagnosed or may be inadequately treated.<sup>9–11</sup>

Although some psychological treatments for depression can be effective<sup>12</sup> they can be demanding on resources. For example, while antidepressant treatments are effective for some, they may also have undesirable side-effects and can be associated with an increased risk of falls.<sup>13</sup> Concordance also remains a significant issue.<sup>14</sup> Exercise has been proposed as an alternative treatment over the past decade<sup>15</sup> and such interventions are showing promise for this age group.

The link between physical activity and health is well-documented in diverse populations<sup>16</sup> with moderate exercise associated with reduced cardiovascular risk, body mass index and blood pressure, improved respiration, psychological health and pain management<sup>17</sup> and also reduced clinically defined depression.<sup>18,19</sup>

Studies have shown that increasing physical activity in older age is important due to the range of associated health benefits such as improving balance, strength and gait endurance and may positively affect quality of life and depression for older people also.<sup>20</sup> Hypothesized mechanisms for the beneficial effects of exercise on mental health include biological explanations, self-esteem and mastery and the distraction hypothesis.<sup>21</sup>

Increasing physical activity in the population is important for older people given the established health benefits of a more active lifestyle. Physical exercise is an achievable means by which the progression of mobility limitation and further disability may be slowed or even prevented, both within the general population and specifically for older adults with or without chronic conditions. Further, first episode depression after the age of 60 has a 70% risk of recurrence within two years of remission<sup>22</sup> and exercise promotion may therefore be a sustainable method for continued treatment in the long term.

It is already known that specifically, exercise has benefits for clinically depressed people in primary care.<sup>23</sup> Research has suggested the potential psychological benefits of exercise training for older, non-depressed adults and these include improvements in cognitive function, mood and well-being.<sup>24–26</sup> There are fewer reports of research on participatory exercise interventions as treatment for depressed older adults. Although a previous review has identified a short-term effect of physical exercise in reducing clinical depression and depressive symptoms in studies published prior to April 2005,<sup>27</sup> a current review of the quality of the available evidence and effects of such interventions in both the short and long term is required. Thus the present paper aims to assess the efficacy of physical exercise interventions for alleviating depressive symptoms in depressed older people (aged >60 years).

## Method

### Identification of relevant studies

#### *Electronic databases*

Studies in any language and any type, including journal articles, book chapters, dissertations and conference abstracts, were searched and identified in the following electronic databases: MEDLINE (1966–May 2008); EMBASE (1980–May 2008); Cumulative Index to Nursing & Allied Health Literature (CINAHL; 1982–May 2008); PsycINFO (1966–May 2008), The Cochrane Library (Issue 2, 2008) and National Research Register (NRR; Issue 2, 2008).

#### *Key search terms*

A broad search strategy was developed under the following key terms: 'physical activity', 'older people', and 'depressive symptoms'. To maximize the search in the databases, various synonyms and combinations of the search terms were used. Search terms for 'physical activity' included 'physical activity' and 'exercise'. Search terms for 'older people' included 'older people', 'older adults', 'elderly', 'aging', 'ageing', and 'gerontology'. Search terms for 'depressive symptoms' included 'depression', 'depressed', 'depressive', and 'mood' (see Appendix for an example of search strategy).

Reference lists of articles identified through the database searches were examined in order to identify further relevant studies. Bibliographies of systematic and non-systematic review articles were also examined for further relevant studies.

#### *Criteria for inclusion*

Studies were included for the review if they fulfilled the following criteria. First, the study described a randomized controlled trial or quasi-experimental study design in which participants had been assigned to either an intervention group or a control group. Second, the intervention described had an exercise component, which was delivered by someone with explicitly stated training. Third, the study was explicitly on older adults where over 80% of participants were recorded as being 60 years of age or more. A previous systematic review of treatments for depression in older age focused on participants aged 60 and over<sup>8</sup> and so this was adopted as the age cut-off point in this review. Fourth, participants were diagnosed on recruitment with depressive symptoms (including major depression, a depressive disorder, or dysthymia) via a psychiatric interview, standardized mood measures or a treating clinician. Fifth, participants were screened to exclude individuals with dementia in order to avoid the confounding effects of the condition, which may have resulted in difficulty adhering to the exercise intervention. Studies were excluded where participants were not depressed at recruitment, or the sole purpose of the intervention was to provide information or education, or occupational therapy unless there was a clearly defined exercise intervention component. There were no restrictions on the basis of age, gender or other participant individual characteristic. There was no restriction on the eligibility of studies on the basis of sample size, duration of follow-up or publication status. Studies including mixed patient populations were not excluded from review as long as they all had a diagnosis of depressive symptoms at recruitment.

#### *Excluded studies*

Excluded studies and the reasons for their exclusion are presented in Table 1.<sup>28-46</sup> The primary

reasons for exclusion were that participants were not from an older population or were not depressed at baseline, the exercise intervention was not structured, or there were no appropriate outcome measures.

#### **Review process**

The reviewers independently extracted, cross-checked and reported data using standardized data extraction forms recommended by the Scottish Intercollegiate Guidelines Network (SIGN) (available at <http://www.sign.ac.uk/>). Disagreements were resolved by discussion. Data regarding the participants' characteristics, research design, intervention and effect size were collected. The methodological quality of the studies was then assessed using the Critical Appraisal Skills Programme (CASP) tool (available at <http://www.phru.nhs.uk/Pages/PHD/resources.htm>) for randomized controlled trials and the guidelines set by the SIGN.

## **Results**

#### **Included studies**

Based on the literature search, 4385 abstracts were identified and irrelevant citations were discarded on the basis of title and abstract. Twenty-nine articles were relevant to the study aims and full texts of these were retrieved for further examination. Throughout the screening process, contacts were made to authors for further details of the characteristics of participants. Ten studies met the inclusion criteria and were included for the review. One additional study was identified through the reference lists of the selected articles. All of the identified articles were in English. Details of the study selection process are presented in Figure 1.

#### **Participant characteristics**

##### *Sample characteristics*

The sample size of the studies varied considerably from 14 to 138. The mean age of participants ranged from 65 to 82.4 years. The male to female ratio ranged from 1:4.4<sup>47</sup> to 1:1.<sup>48</sup> One study did

**Table 1** Articles excluded and reason for exclusion

	Study	Reason for exclusion
1)	Babyak <i>et al.</i> , 2000	Less than 80% of participants over 60
2)	Bartholomew <i>et al.</i> , 2005	Participants not elder population
3)	Blumenthal <i>et al.</i> , 1999	Less than 80% of participants over 60
4)	Hembree, 2001	Participants not depressed at baseline
5)	Hume, 2001	Commentary of an exercise intervention study
6)	Knubben <i>et al.</i> , 2007	Participants not elder population
7)	Kovach-Anta, 1998	Participants not depressed at baseline
8)	Legrand <i>et al.</i> , 2007	Participants not elder population
9)	Llewellyn-Jones <i>et al.</i> , 1999	Intervention not structured
10)	McMurdo, 2001	No outcome data reported
11)	Miser, 2000	Less than 80% of participants over 60
12)	Motl <i>et al.</i> , 2005	Participants not depressed at baseline
13)	Parkinson, 2006	Participants not depressed at baseline
14)	Price, 2006	Commentary of an exercise intervention study
15)	Raj, 2004	Commentary of an exercise intervention study
16)	Shin, 1999	Participants not depressed at baseline
17)	Veale, 1992	Not elder population
18)	Williams <i>et al.</i> , 1997	Participants not depressed at baseline
19)	Zou, 2005	No exercise component

not provide any information regarding gender of the participants.<sup>49</sup> The full characteristics of the participants are presented in Table 2.

#### *Depression diagnosis*

Participants were either diagnosed as fulfilling the Diagnostic and Statistical Manual of Mental Disorders, fourth edition (DSM-IV) criteria for depression or dysthymia, or were screened for depressive symptoms using standardized measurements such as the Diagnostic Interview Schedule, Hamilton Rating Scale for Depression (HRS), Center for Epidemiological Studies Depression Scale (CES-D), Geriatric Depression Scale (GDS) and Beck Depression Inventory (BDI). In eight studies where information about participant's use of medical treatment was available, six studies stated that participants were not receiving pharmacologic medication prior to the study.<sup>49–54</sup> In one study, participants were receiving pharmacological treatment for at least six weeks prior to the study but with no evidence of a sustained response and they continued to receive pharmacological treatment throughout the study.<sup>55</sup> In another study, participants were on medication but had no change of medication or its dosage prior to the study.<sup>56</sup>

#### **Study characteristics**

All of the included studies described randomized controlled trials. The characteristics of the selected studies are presented in Table 2.

#### *Mode of intervention*

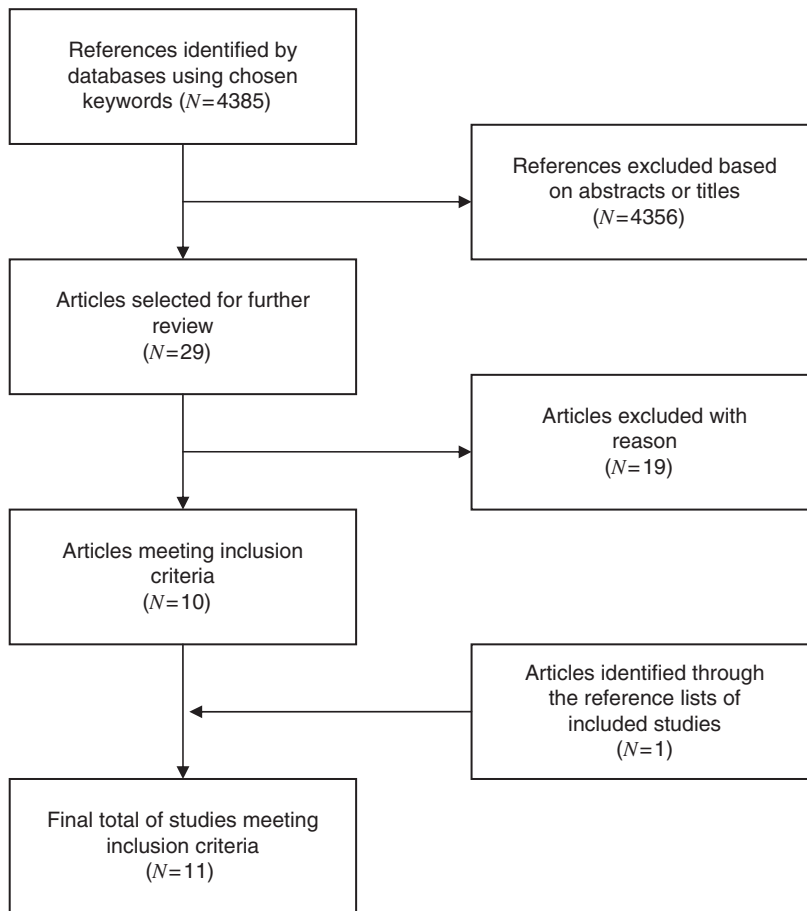
The mode of physical activity intervention described included walking,<sup>49</sup> aerobics,<sup>47,50</sup> Tai Chi,<sup>48</sup> Qigong (a formulated set of practice involving the coordination of body movement and breathing techniques),<sup>56</sup> and weight-bearing or progressive resistance training.<sup>47,50–55</sup>

#### *Intensity and duration*

The training intensities in the studies varied greatly; however in most studies, participants engaged in the designated physical activity three times per week. The duration of the intervention session varied from 20 to 60 minutes, and the duration of the intervention period varied considerably from 6 to 19 weeks. Seven studies reported follow-up assessment varying from 4 weeks to 26 months.<sup>47,50,52–53,55–57</sup>

#### *Setting*

Participants were outpatients recruited from primary care, psychiatric services, local nursing or



**Figure 1** QUORUM flowchart of study selection process.

care homes, religious organizations, volunteer databases or media advertisements.

#### *Outcome measures*

The primary outcome focused on the proportion of patients who were no longer diagnosed as depressed according to diagnostic criteria as applied by the study authors at follow-up or depressive symptoms as measured on standardized validated scales including the Hamilton Rating Scale for Depression,<sup>58</sup> Geriatric Depression Scale,<sup>59</sup> Beck Depression Inventory,<sup>60</sup> Center for Epidemiological Studies Depression Scale<sup>61</sup> and the mental health scale of the Medical Outcome Study SF-36 Scale.<sup>62</sup>

Outcomes included immediate post treatment, medium term (3–12 months) and long term (>12 months).

#### *Quality assessment*

Although all included studies were randomized controlled trials, only five studies reported the allocation concealment method.<sup>50,52,53,55,57</sup> Blinding of investigator was not mentioned in four studies, however in the remaining seven studies,<sup>47,48,51,54–57</sup> the investigator was kept blinded about participants' treatment condition. Four studies reported differences in some of the participants' baseline measures,<sup>51,55–57</sup> with two studies reporting greater proportion of

**Table 2** Characteristics and results of selected studies

Bibliographic citation	Study type	Number of patients	Patient characteristics	Intervention	Comparison	Length of follow-up	Primary outcome measures	Effect of exercise
Brenes <i>et al.</i> (2007) <sup>50</sup>	RCT	37 (38% male, 62% female)	Volunteers with minor depression (as assessed by the patient health questionnaire-9) recruited through newsletters, ads, flyers and local nursing homes. Mean age 74.5	A facility-based exercise regime 3 days per week for 16 weeks. Each session lasted for 60 minutes and included both aerobic and resistance training. Exercise took part in a group format and all sessions were supervised by a certified American College of Sports Medicine exercise leader	Medication group: Received open-label sertraline. Participants met with a physician at weeks 2, 6, 10 and 14 to evaluate treatment response and side-effects. Usual care: Met with research staff at weeks 2, 6, 10 and 14 to discuss general health status	NR	Emotional Functioning (HRS, GDS, and the Mental Health Scale of the SF-36)	Participants in the exercise and sertraline conditions showed declines in clinician-rated depression severity (HRS), while participants in the usual care condition showed a slight increase in HRS. No significant difference was found between groups in self-reported depression measures (GDS and SF-36). Although the main effect of interventions on HRS was not significant while controlling for baseline symptoms and function, there was a trend for both exercise and sertraline to be superior to usual care in reducing depression severity (exercise $P=0.09$ , effect size 0.96; sertraline $P=0.06$ , effect size 1.56)
Chou <i>et al.</i> (2004) <sup>48</sup>	RCT	14 (50% male, 50% female)	Volunteers who fulfilled the DSM-IV diagnostic criteria for either unipolar major depression or dysthymia, and scored 16 or higher on the Chinese version of the CES-D. Mean age 76.4	Tai Chi sessions 3 times a week for 45 min. Intervention lasted for 3 months	Received the intervention after the post-intervention assessment	NR	Depression: CES-D	Participants in the intervention showed significantly more improvement on depression compared to the control group ( $P<0.001$ )
Ciechanowski <i>et al.</i> (2004) <sup>57</sup>	RCT	138 (21% male; 79% female)	Volunteers with DSM-IV minor depression or dysthymia. Mean age 73. 36% were taking antidepressants at baseline	Involved 8, 50-min sessions over 19 weeks and monthly telephone contact by trained therapist. It consisted of problem-solving treatment, social and physical activation, and potential recommendations to patients' physicians regarding antidepressant medications. At weeks 3–4 patients were encouraged to develop a regular physical activity programme of 30 min at least 5 days a week	Received usual care	12 months	Depression: HSC	Participants in intervention group had significant improvement in HSC at 6 months and 12 months. They were more likely to have at least a 50% reduction in depressive symptoms (43% vs 15%), and to achieve complete remission from depression (36% vs 12%) at 12 months

Mather <i>et al.</i> (2002) <sup>55</sup>	RCT	86 (31.4% male, 68.6% female)	Depressed outpatients who scored 10 or more on the GDS. Mean age 64.95. Participants were in receipt of a therapeutic dose of antidepressant therapy for at least 6 weeks but with no evidence of a sustained response	Exercise classes comprising weight-bearing exercise performed to music, led by an instructor and elements of endurance, muscle strengthening and stretching. Participants were asked to attend two weekly 45-min classes for 10 weeks	Attended health education talks twice a week for a period of 10 weeks	24 weeks	Depression: HRS and GDS	There was significantly higher proportion of the intervention group experienced a greater than 30% decline in depression according to HRS (65% vs 33%, $P < .05$ ) at post-intervention. However, both groups showed significant improvement in GDS at post-intervention and 24-week follow-up and there were no difference between the groups
McNeil <i>et al.</i> (1991) <sup>49</sup>		30	Moderately depressed older adults as assessed using the BDI. Mean age 72.5. Participants were not currently receiving treatment for emotional problems	Participants walked outside near their residence for initially 20 min but increased over the 6 weeks to 40 min. Three walking sessions were held each week, two with an undergraduate psychology student, and one alone. Participants were instructed to walk at a vigorous, but not overtaxing, pace	1) Social contact control: consisted of two home visits each week for 6 weeks by an undergraduate psychology student. 2) Wait-list control: participants were told their treatment would be delayed for 6 weeks, after which they could choose either walking or social contact programme	NR	Depression: BDI	Both exercise and social contact group showed significant reductions in both the total and the psychological subscale of the BDI. However, only exercise group showed significant reduction in somatic symptoms ( $P < 0.05$ )
Penninx <i>et al.</i> (2002) <sup>47</sup>	RCT	98 (18.4% male, 81.6% female)	Community-dwelling adults with knee osteoarthritis who scored above the CES-D cutoff for high depressive symptomatology Mean age 68.5	Aerobic Exercise Programme – 3 month facility-based walking programme supervised by an exercise leader 3 times per week for 1 h and 15 month home-based walking programme Resistance Exercise Programme – 3-month supervised facility-based programme with 3, 1 h sessions per week and a 15-month home-based programme	They received monthly education sessions by a nurse on issues related to arthritis management for 3 months with bimonthly follow-up	18 months	Depression: CES-D	Compared with control group, depression appeared to decrease over time among the aerobic exercise group but not the resistance exercise group
Sims <i>et al.</i> (2006) <sup>51</sup>	RCT	32 (34.4% male, 65.6% female)	Participants were recruited by General practices (mean age 74.28). They scored 11 more on the GDS. Participants were not currently taking antidepressants or other psychiatric diagnosis	Three weekly exercise sessions for 10 weeks. Involved moderate intensity strengthening exercises using weights for the major upper and lower limb muscle groups, increased as tolerated	Received information about exercise and local exercise options	6 months	Depression: GDS	There was no difference between groups at 10-week follow-up. At 6 months, there was a trend for the intervention groups to have lower GDS scores but this was not statistically significant. More participants in the intervention (57%) had a reduction in depressive symptom compared to control group (44%)

(Continued)

**Table 2** Continued

Bibliographic citation	Study type	Number of patients	Patient characteristics	Intervention	Comparison	Length of follow-up	Primary outcome measures	Effect of exercise
Singh <i>et al.</i> (2005) <sup>54</sup>	RCT	60 (45% male, 55% female)	Volunteers who fulfilled the DSM-IV diagnostic criteria for major depression, minor depression, or dysthymia, and had a GDS score of >14 Mean age 69.3 Participants were not prescribed antidepressant drugs within the last 3 months	High intensity group: They had a regimen supervised high intensity progressive resistance training of the large muscle group, 3 days per week for 8 weeks. Resistance was set at 80% of the one repetition maximum (1RM) on each machine. Each session lasted about 60 minutes followed by 5 minutes of stretching. Low intensity: They had the exact same regimen as high intensity group, except they were trained 20% 1RM and not progressed.	Received usual care	NR	Depression: HRS and GDS	Improvements were significantly larger in the high intensity group than in the other two groups for GDS ( $P < 0.05$ ). A 50% reduction in the HRS was achieved in 61% of the high intensity, 29% of the low intensity, and 21% of the GP care group
Singh <i>et al.</i> (1997) <sup>52</sup>	RCT	32 (37.5% male, 62.5% female)	Volunteers with clinically major or minor depression or dysthymia. Who scored at least >12 on BDI, which is the lower boundary for mild depression Mean age 71.3 Participants were not on antidepressant drugs within the last 3 months	Participants attended a highly-intensity progressive resistance training (PRT) of the large muscle groups 3 days per week for 10 week. Exercises included chest press, lat pulldown, leg press, knee extension, and knee flexion. For each machine, the resistance was set at 80% of the one repetition maximum. Participants performed 3 sets of 8 repetitions on each machine. Each session lasted about 45 min and was supervised	Interactive health education programme of lectures and videos followed by discussion twice a week	NR	Depression: BDI, GDS, and HRS	PRT significantly reduced all depression measures in intervention group compared to control group. A total of 59% of the exercise group had a response to treatment, which was defined by a 50% reduction in HRS score, vs 26% of controls ( $P = 0.067$ )
Singh <i>et al.</i> (2001) <sup>53</sup>	RCT	32 (37% male, 63% female)	Volunteers with major or minor depression or dysthymia who scored 12 more on the BDI and fulfilled the DSM-IV diagnostic criteria for either unipolar major or minor depression or dysthymia Mean age 71.3 Participants were not on antidepressant drugs within the last 3 months	Participants engaged in 10 weeks of supervised weight-lifting exercise followed by 10 weeks of unsupervised exercise. Supervised exercise employed high-intensity progressive resistance training of large muscle groups 3 days a week. For each machine, the resistance was set at 80% of the one-repetition maximum, and participants performed three sets of eight repetitions	Health education lectures and videos for 10 weeks	26 months	Depression: BDI	The BDI was significantly reduced at both 20 weeks and 26 months of follow-up in intervention group compared with controls ( $P < 0.05-0.001$ )



Tsang <i>et al.</i> (2006) <sup>56</sup>	RCT	82 (19.5% male, 80.8% female)	Volunteers diagnosed with depression or obvious features of depression as indicated by the GDS. Mean age 82.37	Participants had no change of medication or its dosage within 4 weeks prior to intervention and throughout the intervention period	Involved practising Baduanjin under the supervision of a trained Qigong practitioner for 16 weeks 3 times a week with each session lasting for 30–45 min. They were asked to practise daily on their own for 15 min	A newspaper reading group run by a qualified therapist with the same intensity as the intervention group	8 weeks	Depressive mood: GDS	Intervention group showed significant improvement in mood between baseline and midway of the intervention and post-treatment. However no significant difference was found between baseline and 4-week and 8-week follow-up
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HRS, Hamilton Rating Scale for Depression; GDS, Geriatric Depression Scale; CES-D, Center for Epidemiological Studies Depression Scale; HSC, Hopkins Symptom Checklist; BDI, Beck Depression Inventory.

participants with dysthymia<sup>57</sup> or depression<sup>56</sup> in the intervention group, and the other two reporting greater proportion of female participants in the intervention group.<sup>51,55</sup> Three studies reported no drop-outs,<sup>49,52,55</sup> and one study did not provide information about drop-out rates.<sup>50</sup> In the remaining seven studies, the attrition rate ranged from 5% to 23.5%. The use of intention-to-treat analysis was described in five studies.<sup>47,48,51,57,53</sup> The full results of the quality assessment are presented in Table 3.

### Effect of exercise on depressive symptoms

#### *Immediately post intervention*

Findings of the studies are presented in Table 2. Out of the 11 studies reviewed, findings on the immediate post-intervention effect of exercise intervention were available in seven studies. Five yielded significant positive results for exercise intervention in improving depression or depressive symptoms. These studies showed that participants who were in the exercise intervention group showed significant reductions in depression or depressive measures<sup>48,49,52,56</sup> at the end of the intervention compared with participants in the no treatment control group. One study showed that participants who were assigned to a higher intensity of progressive resistance training showed significantly higher levels of improvement in depression compared with those in a low-intensity progressive resistance training condition, or a control group.<sup>54</sup> On the other hand, one study found that although participants in the exercise conditions showed declines in clinician-rated depression severity compared with the control group and results were comparable with those who received medication, no significant differences were found in self-reported depression measures.<sup>50</sup> Another study of older people who were on antidepressant treatment but were not responsive to it found that although there was significantly higher proportion of the participants in the intervention group who experienced a greater than 30% decline in depression as measured by the Hamilton Rating Scale for Depression at post intervention, both groups showed

**Table 3** Quality assessment of selected studies

Bibliographic citation	Randomized assignment	Concealment method used	Investigator kept blind	Groups were similar at baseline	Drop-out	Intention-to-treat analysis
Brenes <i>et al.</i> (2007) <sup>50</sup>	Y	Y	Y	Y	Not reported	Y
Chou <i>et al.</i> (2004) <sup>48</sup>	Y	Not reported	Y	Y	5% for usual care, 6.9% for intervention	Y
Ciechanowski <i>et al.</i> (2004) <sup>57</sup>	Y	Y	Not reported	Intervention group has significantly more dysthymia than the usual care group and less neuroticism	0	Not reported
Mather <i>et al.</i> (2002) <sup>55</sup>	Y	Y	Y	There was significantly higher proportion of women in the exercise group	0	NA
McNeil <i>et al.</i> (1991) <sup>49</sup>	Y	Not reported	Not reported	Y	0	NA
Penninx <i>et al.</i> (2002) <sup>47</sup>	Y	Not reported	Y	Not reported	23.5%	Y
Sims <i>et al.</i> (2006) <sup>51</sup>	Y	Not reported	Y	There was significantly greater proportion of women in the intervention group	15.8%	Y
Singh <i>et al.</i> (1997) <sup>52</sup>	Y	Y	Not reported	Y	0%	NA
Singh <i>et al.</i> (2001) <sup>53</sup>	Y	Y	Not reported	Y	6%	Y
Singh <i>et al.</i> (2005) <sup>54</sup>	Y	Not reported	Y	Y	10%	Not reported
Tsang <i>et al.</i> (2006) <sup>56</sup>	Y	Not reported	Y	There were significantly greater proportion of participants with depression in the intervention group than the control group	14.3% for intervention, 17% for control group	Not reported

significant improvement in depression as measured by the Geriatric Depression Scale.<sup>55</sup>

#### *Medium term (3–12 months)*

Findings on the medium-term effect of exercise intervention were available in six studies. Ciechanowski *et al.*<sup>57</sup> reported that participants in the intervention group showed significant improvement in depression at six months and 12 months follow-up. They were also more likely to have at least a 50% reduction in depressive symptoms, and to achieve complete remission from depression at 12 months. Singh *et al.*<sup>53</sup> found that participants in the exercise group showed significant reduction in depression at 20 weeks follow-up compared with controls. On the other hand, in one study among participants who were not responsive to antidepressant treatment, there were no difference between the intervention and control groups at 24 months follow-up.<sup>55</sup> One study with Qigong intervention showed that while there were significant improvements in depression midway through the intervention and at the end of exercise intervention, this was not maintained at the four-week and eight-week follow-up.<sup>56</sup> Another study comparing the effects of aerobic and resistance exercise found that a significant reduction in depression score was showed in only aerobic exercise but not the resistance exercise condition at three and nine months follow-up.<sup>47</sup> Sims *et al.*<sup>51</sup> also reported no significant difference in depression score between intervention and control groups at 10 weeks and six months follow-up. In summary, there is limited or conflicting evidence of benefit of exercise in the medium term.

#### *Long term (>12 months)*

Findings on the long-term effect of exercise intervention were available in only two studies with mixed results. Singh *et al.*<sup>53</sup> found that depression score significantly reduced in the intervention group at 26 months follow-up compared with controls. On the other hand, Penninx *et al.*<sup>47</sup> reported significant reduction in depression score in the aerobic exercise group but not in the resistance exercise group at 18 months follow-up.<sup>47</sup>

## Discussion

Most of the studies had significant positive findings in terms of reductions in depression or depressive symptoms, or increased remission from depression immediately after exercise intervention, when compared with controls. The few remaining studies identified non-significant trends towards positive outcomes or positive outcomes over the study period for both intervention and control groups. More than half the studies which measured medium-term outcomes demonstrated a positive effect of exercise on depression outcomes. Other studies found no medium-term effect or that positive effects varied according to exercise mode of intervention (e.g. aerobic/resistance). Most studies did not measure the long-term outcomes of intervention yet those that did showed positive outcomes, although longer term effects were found for aerobic exercise but not maintained for resistance exercise modalities. We therefore conclude that exercise intervention exerts a clinically relevant effect on depressive symptoms in older people.

Direct comparison between studies is difficult since studies varied greatly in sample characteristics, nature of control comparison group (e.g. group attendance versus usual care), mode of intervention, intensity and duration of exercise, outcome measures used and length of follow-up. Although evidence from well-designed research studies is clearly limited, the findings do suggest that both aerobic exercise and resistance training programmes may be beneficial in improving mood in older people with depression.

There are several limitations of the present review that should be noted. Comparable with most systematic reviews, there remains a possibility that some articles may have been overlooked, particularly for studies examining exercise interventions without explicitly addressing older adults with depression or depressive symptoms in their abstract or title. Nevertheless, a range of databases have been searched and articles that did not explicitly mention older adults with depression or depressive symptoms in their title or abstracts were retained in the first screening and their full text was reviewed before a decision was made. In addition, there remains a risk of

publication bias, as negative or insignificant results might be less likely to be published. In addition, as most of the studies engaged participants with exercise in a group format, no conclusion could be made as to whether the benefits were due to social or group effect, or physical exercise *per se*. Therefore, these findings must be interpreted with caution. Finally, it was hoped that a meta-analysis would be feasible, although this was not undertaken firstly due to constraints of time and funding, and secondly it was decided that the trials included were too heterogeneous for a statistical pooling to be meaningful.

Evidence of cost-effectiveness of exercise interventions for the treatment of depressive symptoms would be of benefit for decision-making regarding service use and delivery. However, most of the studies included did not investigate the cost-effectiveness of exercise as a treatment modality for depressive symptoms. More well-designed research studies are needed to clarify the effectiveness of different intervention modalities for older people and to further investigate the medium- and long-term impact of exercise programmes in this group.

Exercise is currently under-used as a treatment for depression although exercise therapies are becoming increasingly available through organized referral schemes in primary care. However, these are not well-utilized and general practitioners (GPs) report low usage of the services with only 15% of GPs who know about the services frequently referring their depressed patients.<sup>63</sup> Exercise may be as effective as medication yet has many additional health benefits including reduced risk of heart disease, stroke, high blood pressure, some cancers, type 2 diabetes, osteoporosis and obesity.<sup>22</sup> This makes exercise appropriate for patients with a combination of physical and mental health problems without the stigma sometimes associated with antidepressant medication and the 'talking therapies'.

Furthermore, exercise habits can become part of a healthy lifestyle pattern which not only has obvious physical and mental health benefits but can provide individuals with a sense of control over their own recovery, which is important since depression is often associated with hopelessness.<sup>63</sup> Exercise for older people with depression can be structured or unstructured, with participation

initiated by individuals, social and volunteer groups or primary care referral.

Although there are issues with attrition from exercise programmes which require some level of commitment from participants, exercise has long been identified as a popular treatment for depression by patients<sup>64,65</sup> and treatment completion rates in exercise referral schemes are often higher than those for medication.<sup>63</sup> From a resource perspective, exercise therapy involves referring patients to other health professionals. This could potentially share out the burden of patient care which may be attractive to practitioners.

#### Clinical messages

- Exercise may reduce depression or depressive symptoms in older people, with immediate and clinically relevant effects.
- Longer term outcome, mode, duration and intensity of intervention needs further investigation.
- Exercise may be useful as a supplementary treatment for depression in older people.

#### Competing interests

None declared.

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## Appendix – Example of search strategy

Search strategy from MEDLINE (1966–2008)	
1	physical activity.mp.
2	exercise.mp.
3	1 or 2
4	older people.mp.
5	older adults.mp. [mp = title, original title, abstract, name of substance word, subject heading word]
6	elderly.mp. [mp = title, original title, abstract, name of substance word, subject heading word]
7	aging.mp. [mp = title, original title, abstract, name of substance word, subject heading word]
8	ageing.mp. [mp = title, original title, abstract, name of substance word, subject heading word]
9	gerontology.mp. [mp = title, original title, abstract, name of substance word, subject heading word]
10	4 or 5 or 6 or 7 or 9
11	depressed.mp. [mp = title, original title, abstract, name of substance word, subject heading word]
12	mood.mp. [mp = title, original title, abstract, name of substance word, subject heading word]
13	depression.mp. [mp = title, original title, abstract, name of substance word, subject heading word]
14	depressive.mp.
15	11 or 12 or 13 or 14
16	3 and 10 and 15

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