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# Physical activity and behaviour in dementia

## *A review of the literature and implications for psychosocial intervention in primary care*

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**Abstract** Physical activity can have a positive impact on cognition and well-being in older people. This article reviews and evaluates the effects of planned physical activity programmes on mood, sleep and functional ability in people with dementia. A total of 27 studies between 1974 and 2005 were found. Of these, four included participants living at home, two involved participants who were living either at home or in care homes and 21 included participants living solely in care homes. Since psychosocial intervention can reduce family caregiver burden, the break down of home-care and associated rates of institutionalization, the indirect effects of these physical activity programmes on the family caregiver are also explored. The scope for developing physical activity programmes for people with dementia in primary care using families and volunteers is discussed.

**Keywords** caregiver burden; disruptive behaviour; functional ability; physical activity intervention; sleep

Reduced physical activity can be an indirect consequence of dementia since motor function is affected in many of the dementias. For example, in Alzheimer's disease (AD), extra pyramidal 'Parkinsonian' symptoms (rigidity, tremor and bradykinesia) have been observed (Prehogan & Cohen, 2004) and even in their absence impaired balance and reduced speed of walking is reported (O'Keefe et al., 1996; Pettersson, Engardt, & Wahlund, 2002). In Vascular dementia (VaD), walking speed is slower than in AD (Tanaka et al., 1995) and in subcortical ischaemic vascular dementia (SIVD), gait disturbances such as decreased step length and gait apraxia with co-existing extrapyramidal symptoms are noted (Román, Erkinjuntti,

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Wallin, Pantoni, & Chui, 2002). Patients with Frontotemporal dementia (FTD) do not initially present with gait disturbances, but akinesia has been reported in the temporal variant of FTD (semantic dementia), in some frontal-variant patients (Rosen et al., 2002) and involuntary trunk movements have been noticed in relatively early stages of FTD compared with AD patients (Mendez, Shapira, & Miller, 2005). Impairment in motor activity leading to reduced physical activity in people with dementia may therefore compromise the convincing and potentially protective influences of physical activity and/or exercise on cognition (Colcombe & Kramer, 2003; Fratiglioni, Paillard-Borg, & Winblad, 2004), mood (Arent, Landers, & Etnier, 2000) and sleep (Montgomery & Dennis, 2004). Physical activity may also reduce the risk of developing dementia, since older males with low walking rates (less than 0.25 mile a day), showed a 1.8-fold increased risk of dementia compared with those that walked more than two miles a day (Abbott et al., 2004) and women with high levels of baseline physical activity had a lower risk of cognitive deterioration (Yaffe, Barnes, Nevitt, Lui, & Covinsky, 2001).

Given that exercise and physical activity may minimize the risk of disability due to behaviour, sleep or mood disorders in dementia, the aim of the present article is to examine the influence of exercise on affective behaviour, sleep, and functional ability in people with dementia. A recent review of randomized controlled studies (Heyn, Abreu, & Ottenbacher, 2004) examined whether exercise has beneficial effects on health-related physical fitness, cardiovascular fitness, strength, flexibility, cognitive function, physical function and behaviour in older people with cognitive impairment and dementia. They report that exercise improves physical and cognitive function as well as positive behaviour. However, the actual detail they present on the effects of exercise training on behaviour is only brief and it is not possible to reach clear conclusions on what is needed for planned exercise to have a positive effect on the behaviour of people with dementia. Since behavioural problems often predict family caregiver burden (Donaldson, Tarrier, & Burns, 1998) and the breakdown of care at home (Schur & Whitlatch, 2003), we will focus in detail on the effects of exercise on behaviour, in other words, affect, sleep and activities of daily life (ADL). Given the relatively few studies in this field, we include the range of experimental designs including smaller within-subject experiments.

## Method

Literature searches were performed in the Pubmed, Web of Science, PsycINFO, and BioMed Central computerized databases, concluding in

October 2005. The key words used in the search included *physical activity*, *exercise*, *physical therapy*, *fitness training* in combination with *behavioural problems*, *disruptive behaviour*, *mood*, *depression*, *anxiety*, *aggression*, *agitation*, *grief*, *happiness*, *apathy*, *emotional problems*, *personality*, *quality of life*, *sleep*, *restlessness*, *wandering*, *general health*, *functional ability*, *ADL*. These were combined with *dementia*, *demented*, *Alzheimer's disease*, *nursing home residents*, *cognitive impairment*, *cognitively impaired*, *mild cognitive impairment*. The inclusion criteria were: (1) studies that reported on participants having some degree of cognitive impairment or a diagnosis of dementia; (2) ambulant nursing home residents with a score of less than 23/24 on the Mini-Mental State Examination (MMSE) (Folstein, Folstein, & Mchugh, 1975) as this is the standard cut-off point for cognitive impairment (Grut, Fratiglioni, & Winblad, 1993); (3) studies offering an intervention with exercise as a primary focus; (4) outcome measures assessing behaviour, mood, sleep or functional ability. Studies were excluded if specific details indicated that not all participants were cognitively impaired.

During the search, titles and abstracts were thoroughly screened to exclude those that were not experimental interventions. This initial search yielded 70 articles, which were read to determine the presence of inclusion and exclusion criteria described above. A total of 27 studies met our inclusion criteria for this review. In order to evaluate the studies on their methodological quality, we applied criteria that have been used in pharmacological treatment trials (Miyasaki, Martin, Suchowersky, Weiner, & Lang, 2002). These criteria classify intervention studies into three categories, broadly defined as:

- Class I: Prospective, randomized, controlled clinical trials in a representative population with masked outcome assessment. All Class I studies have (1) clearly defined outcome measures; (2) clearly defined in- and exclusion criteria; (3) adequate accounting for drop-outs with numbers significantly low to have minimal potential for bias; and (4) presented relevant baseline characteristics that were substantially equivalent among groups;
- Class II: Prospective matched group cohort studies in a representative population with masked outcome assessment that meets the criteria (1), (2), (3) and (4) or a randomized controlled trial that lacks one criteria;
- Class III: All other controlled trials.

Interventions can then be evaluated against the number of Class I, II or III studies, in levels of recommendation: A, B, C, or U. Level A indicates that an intervention is established in being effective, ineffective or harmful, level B indicates an intervention to be probably effective, ineffective, or harmful

and level C to be possibly effective, ineffective or harmful. Level U indicates the data being inadequate or conflicting (see Miyasaki et al., 2002).

## Results

The 27 selected studies were dated between 1974 and 2005 and generated a sample size of 1160 participants who completed follow-up. Twenty-one studies included participants living solely in care homes, four included participants living at home, two included participants living either at home or in care homes. The appendix outlines the characteristics and outcome of studies reviewed.

### Effects of physical activity on affective behaviour

Seventeen studies were found for the effects of exercise on affect (see appendix), of which 10 included people living in a care home, five included community-dwelling people and two included both people living in a care home and people that were community-dwelling. According to the classification of Miyasaki et al. (2002), five were Class I, four Class II and three were Class III studies. The remaining five used within-subjects designs and three of these did not report statistical analysis.

Class I studies showed inconsistent findings: two report positive outcomes (Alessi, Yoon, Schnelle, Al Samarrai, & Cruise, 1999; McCurry, Gibbons, Logsdon, Vitiello, & Teri, 2005), while the rest showed no change. There are particular differences between the interventions compared that might explain these inconsistent results, which are otherwise seen as level U (Miyasaki et al., 2002). For example, Alessi et al. (2005) applied the intervention for only five consecutive days, which may have been too short a period to generate positive results. The other two Class I studies that report no effect on mood (Mulrow et al., 1994; Van de Winckel, Feys, De Weerdt, & Dom, 2004) offered an intervention that did not involve walking. Therefore we suggest that walking might be the key physical activity needed to demonstrate positive effects on mood.

The four Class II studies also showed inconsistent results. One study included community-dwelling AD patients where exercise was implemented by caregivers that led to improved mood (Teri et al., 2003). Another study (Hopman-Rock, Staats, Tak, & Droes, 1999) reported an increase in positive group behaviour (e.g. being more helpful to others) *only* in those with relatively mild cognitive problems. One possible explanation for why this improvement was not observed in patients with more severe cognitive impairment might be that the group with mild cognitive problems benefited from the social aspects of the exercise intervention which in turn impacted on their mood. Another Class II study (Schnelle,

MacRae, Ouslander, Simmons, & Nitta, 1995) found a decrease of agitation in both groups, implying no additional benefit of the exercises on agitation, and MacRae et al. (1996) found no significant change in outcome. However, both studies offered an exercise intervention of relatively short duration, in other words, 13 minutes and 14.5 to 23.8 minutes respectively.

Class III studies also showed mixed results. Two showed a decrease in verbal aggression (Holmberg, 1997; Landi, Russo, & Bernabei, 2004), whereas one reported an increase in depression in institutionalized patients probably because of increased levels of awareness in participants (Powell, 1974).

Four of the five within-subjects exercise studies showed a positive effect on mood (Arkin, 1999, 2001, 2003; Heyn, 2003). In the fifth study (Rolland et al., 2000) the exercise intervention was implemented by caregivers and led to a decrease of behavioural problems, but families themselves reported no reduction on their perceived burden. Thus whilst exercise may have reduced behavioural problems in patients with dementia, it was apparently not enough to have a direct impact on family caregiver burden.

Of the three studies that lacked statistical analysis, one offered an exercise intervention that resulted in decreased swearing (Meddaugh, 1987) and two focused on behaviour during an exercise activity. Rolling walker sessions resulted in a positive effect on mood and agitation (Trudeau, Biddle, & Volicer, 2003) and interventions carried out by family caregivers noted that a walking activity resulted in increased tenderness of communication between caregiver and patient, whilst a dance event led to an increase in tenderness of communication as well as an improvement in emotional responses (Palo-Bengtsson & Ekman, 2002).

In sum, taking the methodological quality of the studies and differences between interventions into consideration, we conclude that sustained walking in particular may benefit affective behaviour (mood) and where measures are taken *during* a physical activity there are consistent reports that participants also appreciate physical activity.

## Effects of physical activity on sleep

Effects of exercise on sleep were examined in six studies (see appendix). In five studies, participants lived in care homes and for one they were community-dwelling. Five could be subdivided into the three classes of Miyasaki et al. (2002). The sixth used a within-subjects design. All Class I studies made use of an objective measurement of sleep, in other words, wrist activity monitors.

Crucially, all three Class I studies (Alessi et al., 1999; Alessi et al., 2005; McCurry et al., 2005) showed a beneficial effect of the exercise intervention on sleep, in other words, increased night-time sleep and reduced night-time

awakenings. This consistency in findings classifies exercise as level A (Miyasaki et al., 2002): in other words, established as effective for sleep in this population. It is noteworthy that in one of the three studies (McCurry et al., 2005) for community-dwelling AD patients, the intervention was carried out by the family caregiver. The Class II study (Alessi et al., 1995) used the same exercise intervention as the previous Class I study (Alessi et al. 1999), but no positive effect on sleep was shown. This apparent inconsistency might be explained by differences in the participant groups at baseline in that the percentage of sleep in the Class I study (Alessi et al., 1999) improved from 51 percent to 62.5 percent and the duration of sleep episodes increased from 11 minutes to 16 minutes, whilst in the earlier study (Alessi et al., 1995), participants had better sleep at baseline, in other words, 70 percent with sleep episodes of 16 minutes. This might explain the larger effect of exercise on sleep in the second study by Alessi and colleagues (1999) and suggests that people with poor sleep may show better outcomes than those with relatively mild sleep disturbance. Both the Class III study (Namazi, Zadorozny, & Gwinnup, 1995) as well as the study that used a within-subjects design (Robb, 1985) found a decrease of night-time restlessness.

Taken together, physical activity appears to have a beneficial impact on the quality of sleep.

## Effects of physical activity on functional ability

Six studies were found on the effects of exercise on the performance of ADL (see appendix), all of which used participants living in a care home. These could be subdivided into one Class I study, three Class II studies and one Class III study. The remaining study used a within-subjects design. The only Class I study in this area (Baum, Jarjoura, Polen, Faur, & Rutecki, 2003) showed a positive effect of the exercise programme on functional ability. This finding leads to the classification of exercise as level A (Miyasaki et al., 2002): established as effective for functional ability in this population. The three Class II studies showed inconsistent results. One study (Meuleman, Brechue, Kubilis, & Lowenthal, 2000) only showed a positive effect on functional ability in the most dysfunctional at baseline. Two Class II studies (Cott, Dawson, Sidani, & Wells, 2002; Mulrow et al., 1994) did not show a beneficial effect. Similarly, both a Class III study (Francese, Sorrell, & Butler, 1997) and within-subjects design (Rolland et al., 2000) did not show any benefit of exercise on the performance of ADL. Compared to the Class I study that showed a positive outcome (Baum et al., 2003), all other exercise interventions were of a shorter duration (one hour versus 30 or 30–45 minutes) and used a shorter treatment period (six months versus 4–16 weeks). Thus a long-term exercise programme seems to be necessary to improve outcomes on functional ability.

Taken together, physical activity may have positive effects on functional ability in care home residents, but only when a long-lasting exercise programme is applied.

## Discussion and conclusion

Of the 27 relevant studies, most focused on the effects of an exercise programme on affective behaviour, although some also examined effects on other behaviour such as sleep. The reported studies on the effects on mood show inconsistent findings. However, taking methodological quality into consideration and comparing the type of interventions, it can be concluded that some types of exercise can have a beneficial influence on affective behaviour. An exercise programme that is performed several times a week, for at least 30 minutes and that includes *walking* seems to have a positive impact on mood. Studies examining the effects of physical activity on sleep were few, but showed positive effects on both sleep quantity and quality, particularly in people with mild sleep disturbance. It is noteworthy that Class I studies, using objective sleep outcome measures (Alessi et al., 1999, 2005; McCurry et al., 2005), involved frequent exercise sessions throughout the week (daily or several times a day). Studies that examined the effects of exercise on functional ability demonstrated one methodologically sound study with positive results (Baum et al., 2003), whereas other showed no change. Analysis of the various intervention parameters suggest that an exercise programme should be offered over at least a six-month period with an exercise duration session of one hour three times a week (Baum et al., 2003). All studies were carried out in care homes and rehabilitation is often driven by experience, in other words, environmental conditions and training (Döbrössy & Dunnett, 2001). Thus, in order to benefit the decrease in ADL that is characteristic for people with dementia (Avila, Bottino, Carvalho, Santos, Seral, & Miotto, 2004), the effects of an exercise intervention on ADL may be enhanced for care home residents when combined with training in maximizing functional skills.

All specific behaviours that were outcome measures in the intervention studies reviewed in the present article are known for the effects they can have on the burden of primary caregivers. More specifically, disruptive behaviour (i.e. depression, agitation and irritability) is seen to have a more devastating impact on caregivers, as compared with cognitive problems (Donaldson et al., 1998). Other disruptive behaviours such as sleep disturbances (i.e. nightly restlessness and wandering) also contribute to caregiver distress (Hope et al., 2001) and are a predictor of institutionalization (Schur & Whitlatch, 2003). The severity of disability in ADL is also a significant predictor of institutionalization because of the increased burden that is placed on the

caregiver (Lindsay & Anderson, 2004). Exercise interventions reviewed in this article have generally resulted in positive effects on all of the above-mentioned types of behaviour and caregivers may be able to successfully implement the intervention *themselves* (McCurry et al., 2005; Palo-Bengtsson & Ekman, 2002; Rolland et al., 2000; Teri et al., 2003). Family caregivers may also benefit directly from an exercise programme (King, Baumann, O'Sullivan, Wilcox, & Castro, 2002). A moderate-intensity endurance exercise programme (brisk walking) for about 35 minutes, three or four times a week, for 12 weeks was performed by 45 female caregivers, compared with 40 female caregiver controls who participated in a telephone-based nutrition education programme consisting of 15 telephone sessions during 12 weeks. The exercise group showed improvements in stress-induced cardiovascular reactivity and self-reported sleep quality. Both groups were found to experience decreased psychological distress (King et al., 2002).

Thus psychosocial interventions in primary care that include an exercise programme such as active walking is recommended for both people with dementia and family caregivers, who can thus engage in meaningful activity together. The effects of physical activity and exercise on the subjective experience of caregivers (Andrén & Elmståhl, 2005), maintenance of care at home (Yaffe et al., 2002) and the economical burden of dementia (Trabucchi, 1999), requires further prospective evaluation. The studies reviewed suggest that:

- exercise programmes should include a walking activity and take at least 30 minutes in order to benefit mood;
- exercise should be offered frequently during the week, irrespective of duration, to achieve a positive impact on sleep;
- care home residents need a long-term exercise programme with extensive sessions if a positive impact on their ADL, is to be achieved.

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Appendix **Characteristics of studies examining the effects of physical activity on behaviour, sleep and functional ability in cognitively impaired older people, classified according to the criteria of Miyasaki et al., 2002**

| Authors | Participants/Setting | Programme | Measures | Outcome |
|---|---|---|---|---|
| Class I studies | | | | |
| Van de Winckel et al., 2004 | Female patients with dementia living in a psychiatric hospital<br>15 intervention,<br>Mean MMSE = 12.9<br>10 control,<br>Mean MMSE = 10.8<br>Randomized trial | Intervention: Daily 30-min seated exercise programme, containing upper and lower body strengthening, balance, trunk movements and flexibility straining, supported by music for three months, by a therapist<br>Control: Daily conversation in the same frequency, by the same therapist | Behavioural questionnaire<br>Test administration was blinded | No change in behaviour |
| Mulrow et al., 1994 | Nursing home residents<br>92 intervention,<br>Mean MMSE = 21.3<br>88 control,<br>Mean MMSE = 21.5<br>Randomized trial | Intervention: Three times a week exercise to music training, containing range-of-motion exercises, balance, transfer and endurance training for 30–45 min, for four months, by research physiotherapist<br>Control: Social visits in the same frequency | Physical function measures<br>Mood questionnaire<br>ADL scale and IADL scale<br>Test administration was blinded, except for the ADL scale (Class II) | ↑ Physical function<br>No change in feelings of depression<br>No change in ADL or IADL (Class II) |
| Alessi et al., 1999 | Nursing home residents<br>15 intervention,<br>Mean MMSE = 13.6<br>14 control,<br>Mean MMSE = 13.1<br>Randomized trial | Intervention: Sit-to-stand repetitions/transferring and walking/wheelchair propulsion for five min every two hours for five days a week next to a night-time programme to decrease noise and sleep-disruptive nursing care practices, by research personnel<br>Control: Night-time programme | Physical function measures<br>Daytime observations (sleep and agitation)<br>Sleep monitors<br>Test administrators were blinded to the study questions | No change in physical function<br>↑ night-time sleep<br>↓ agitation |
| Alessi et al., 2005 | Nursing home residents<br>58 intervention,<br>Mean MMSE = 11.9<br>50 control,<br>Mean MMSE = 10.6<br>Randomized trial | Intervention: Multidimensional intervention including efforts to minimize night time noise and light, efforts to encourage participants to remain out of bed during the day, 30 min of sunlight exposure and a three-time-a-day low-level physical activity programme (as for Alessi et al., 1995), for five days, by research staff<br>Control: Usual care conditions | Day-time observations (sleep and agitation)<br>Sleep monitors<br>Test administrators were blinded to the study questions | ↓ night-time awakenings<br>↓ day-time sleep<br>No change in agitation |

Appendix **continued**

| Authors | Participants/Setting | Programme | Measures | Outcome |
|---|---|---|---|---|
| Class I studies (continued) | | | | |
| McCurry et al., 2005 | Community-dwelling AD patients<br>13 intervention,<br>Mean MMSE = 11.9<br>16 control,<br>Mean MMSE = 10.6<br>Randomized trial | Intervention: Comprehensive programme involving (1) recommendations about sleep hygiene and behaviour management for the caregiver, (2) daily walks for 30 min, (3) increased light exposure by use of a light box for two months, by caregivers<br>Control: Recommendations about sleep hygiene and behaviour management for the caregiver | Sleep questionnaires<br>Mood questionnaires<br>Sleep monitors<br>Test administration was blinded or performed by the caregivers | ↓ night time awakenings<br>↓ total time awake at night<br>↓ level of depression |
| Baum et al., 2003 | Nursing home residents<br>11 intervention,<br>Mean MMSE = 21<br>9 control,<br>Mean MMSE = 22<br>Randomized trial | Intervention: Exercise programme containing seated strength and range of motion exercises for one hour, three times a week, for six months, by an exercise physiologist<br>Control: Recreational therapy in the same frequency, by an art therapist or social worker | Functional ability measures<br>Test administration was blinded | ↑ functional balance<br>↑ ADL |
| Class II studies | | | | |
| Teri et al., 2003 | Community-dwelling AD patients<br>76 intervention,<br>Mean MMSE = 17.6<br>77 control,<br>Mean MMSE = 15.9<br>Randomized trial | Intervention: Aerobic/endurance activities, strength, balance and flexibility training for three months, duration of 30 min a day, by caregivers<br>Control: Routine medical care | Physical function measures<br>Mood questionnaires<br>Unclear whether test administration was blinded | ↑ physical function<br>↑ mood |
| Hopman-Rock et al., 1999 | Nursing home residents<br>45 intervention<br>47 control<br>Randomized trial | Intervention: Twice weekly 'psychomotor activation (PAP)' for 45 min during six months, by activity leaders. PAP consists of sporting activities, games and hobby activities to stimulate both cognitive and psychosocial function<br>Control: Usual activities | Behavioural questionnaires<br>Unclear whether test administration was blinded | ↑ positive group behaviour in those with mild problems |

Appendix **continued**

Class II studies (continued)

| Authors | Participants/Setting | Programme | Measures | Outcome |
|---|---|---|---|---|
| MacRae et al., 1996 | Nursing home residents<br>19 intervention<br>12 control<br>Randomized trial | Intervention: five days a week walking programme for 12 weeks, increasing duration by 10% each week (from 14.5 to 22 min), by a research assistant<br>Control: Weekly social visits for 22 weeks, by a research assistant | Walk endurance capacity<br>Physical activity level<br>Mobility measures<br>Quality of life questionnaires<br>Test administration was not blinded | ↑ walking endurance capacity<br>No significant change in other measures<br>Slight ↑ feelings of depression |
| Schnelle et al., 1995 | Nursing home residents<br>36 intervention<br>40 control<br>Randomized trial | Intervention: Mean of 13 min of daily walking or wheeling exercises and sit to stands, next to a behavioural intervention consisting of extra incontinence care, verbal interaction and one to two stands and one transfer if toileted, for eight weeks, by research staff<br>Control: The same behavioural intervention for a mean of eight min, for eight weeks, by research staff | Physical activity measures<br>Frequency of agitation<br>Test administration not blinded | ↑ physical activity and mobility endurance<br>↓ agitation in *both* groups |
| Alessi et al., 1995 | Nursing home residents<br>33 intervention,<br>Mean MMSE = 12.3<br>32 control,<br>Mean MMSE = 13.8<br>Information about randomization is absent | Intervention: Sit-to-stand repetitions/transferring and walking/wheelchair propulsion for five min every two hours for five days a week, by research personnel<br>Control: Rowing and walking/wheelchair propulsion for 30 min three times a week for nine weeks | Physical function measures<br>Daytime observations<br>Sleep monitors<br>Test administration was blinded | ↑ mobility endurance<br>No change in sleep measures |
| Meuleman et al., 2000 | Nursing home residents<br>26 intervention,<br>Mean MMSE = 23.9<br>32 control,<br>Mean MMSE = 23.0<br>Randomized trial | Intervention: Three-times-a-week resistance training and two-times-a-week endurance training for four to eight weeks, by a physical therapist and aide. Endurance training increased from an initial 10 min to 30 min<br>Control: No study-provided intervention | Strength and endurance measures<br>Functional ability (ADL measure)<br>Test administration was not blinded | ↑ strength<br>↑ functional ability in those most dysfunctional at baseline |

Appendix **continued**

| Authors | Participants/Setting | Programme | Measures | Outcome |
|---|---|---|---|---|
| Class II studies (continued) | | | | |
| Cott et al., 2002 | Nursing home residents with AD<br>30 intervention<br>25 social visit control<br>19 control<br>Randomized trial | Intervention: Walking and talking in pairs for 30 min, five days a week for 16 weeks, by a research assistant<br>Social visit control: Conversation while sitting in pairs, in the same frequency, by research assistant<br>Control: No study-provided intervention | Communication measures<br>Ambulation<br>Functional status (mental disorganization or confusion, physical disability, socially irritating behaviour disengagement<br>Test administration was not blinded | No change in communication<br>No change in ambulation<br>No change in functional status |
| Class III studies | | | | |
| Holmberg, 1997 | Nursing home residents<br>N = 11; MMSE = 0–16<br>Participants served as own controls | Walking for 1.5 hours (including movements of rest) for three days per week, by volunteers | Frequency of aggression<br>Blinded rating | ↓ aggression |
| Landi et al., 2004 | Nursing home residents with AD<br>15 intervention<br>15 control<br>Randomized trial | Intervention: Aerobics/endurance activities, strength and balance training for four weeks, unclear by whom<br>Control: Same type of health and medical assistance as in the intervention group | Assessment tool including clinical items and clinical diagnoses<br>Unclear whether test administration was blinded | ↓ physical and verbal abuse<br>↓ antipsychotic and hypnotic medication |
| Powell, 1974 | Geriatric mental patients<br>10 intervention<br>10 social therapy<br>10 control<br>Randomized trial | Intervention: one hour a day, five days a week exercise therapy, involving walking and callisthenics, for 12 weeks, by two activity therapists<br>Social therapy: Arts and crafts work, music therapy and games playing in the same frequency, by the same two activity therapists<br>Control: No study-provided intervention | Behavioural questionnaires<br>Unclear whether test administration was blinded | ↑ Behavioural problems |

Appendix **continued**

| Class III studies (continued) | | | | |
|---|---|---|---|---|
| Authors | Participants/Setting | Programme | Measures | Outcome |
| Namazi et al., 1995 | Nursing home residents with AD<br>11 intervention,<br>Mean MMSE = 13.7<br>11 control,<br>Mean MMSE = 12.5<br>Information about randomization is absent | Intervention: 40-min mild exercise/movement programme, seven days a week for four weeks, by students<br>Control: Social activity programme, including reading and poetry, in the same frequency | Sleep behaviour log<br>Test administration was blinded | ↓ night-time restless behaviour |
| Francese et al., 1997 | Nursing home residents with AD<br>six intervention<br>five control<br>Information about randomization is absent | Exercise programme using balls and canes, accompanied by music for 20 min, three times a week for seven weeks, researcher and volunteers | Strength measure<br>Balance measure<br>ADL scale<br>Unclear whether test administration was blinded | ↑ strength<br>↑ balance<br>No change in ADL |
| Within subjects (pre-post) analyses | | | | |
| Arkin, 1999 | Community dwelling AD patients<br>*N* = 14 | Twice weekly aerobics and weights for 10 or 20 weeks for a mean of 30 min, by students | Fitness measures<br>Mood questionnaires<br>Unclear whether test administration was blinded | ↑ fitness<br>↑ mood |
| Arkin, 2001 | Community dwelling AD patients and nursing home residents with AD<br>*N* = 11, Mean MMSE = 23 | Twice weekly physical fitness training of increasing duration for a mean of 30 min for two × 10 weeks, by students | Fitness measures<br>Mood questionnaires<br>Unclear whether test administration was blinded | ↑ fitness<br>↑ mood |
| Arkin, 2003 | Community dwelling AD patients<br>*N* = 24, MMSE 15–29 | As for Arkin 2001, plus 10 recreational sessions | Fitness measures<br>Mood questionnaires<br>Unclear whether test administration was blinded | ↑ fitness<br>↑ mood |

Appendix **continued**

| Authors | Participants/Setting | Programme | Measures | Outcome |
|---|---|---|---|---|
| Within subjects (pre-post) analyses (continued) | | | | |
| Heyn, 2003 | Nursing home residents<br>*N* = 13, Mean MMSE = 7.3 | Multi-sensory exercise programme (flexibility, aerobics, strength straining, relaxation techniques) accompanied by music and including storytelling/imagery three times per week for three months, duration increasing from 15 to 70 min, by an exercise physiologist | Mood questionnaire<br>Test administration not blinded | ↑ mood for 8 participants<br>5 showed no improvement |
| Rolland et al., 2000 | Nursing home residents with AD<br>*N* = 23; Mean MMSE = 16.3 | Walking and riding a cycle ergometer on alternate days, for a mean of seven weeks, duration of 10–80 min, by caregivers | Autonomy (ADL scale and IADL scale)<br>Behavioural questionnaire<br>Family burden questionnaire<br>Unclear whether test administration was blinded | No change in autonomy<br>↓ behavioural problems<br>No change in perceived family burden |
| Robb, 1985 | Male nursing home residents<br>*N* = 20 | 12-week exercise programme, unclear by whom | No information on specific measures used | ↓ wandering during the night<br>No change in daytime wandering<br>No change in physical fitness |
| Within subjects (no proper statistical analysis) | | | | |
| Trudeau et al., 2003 | Nursing home residents with AD<br>*N* = 6 | Rolling walker sessions (mean of 69 min), freely experiencing the environment, by a researcher | Observations of agitation and mood during intervention<br>Blinded test administration impossible | ↓ agitation<br>↑ mood |
| Palo-Bengtsson & Ekman, 2002 | Nursing home residents with dementia and one community-dwelling person with dementia<br>*N* = 6 | 45-min dance events once a month or daily walks for 20–45 min, by caregivers | Observation of (1) the engaged body, (2) the care-givers' understanding, encouragement, and response to the patient, (3) mutual tenderness and communion, and (4) environmental conditions during intervention<br>Blinded test administration impossible | More emotional responses during the dance events<br>↑ tenderness in communication in *both* groups |
| Meddaugh, 1987 | *N* = 9; Nursing home residents | Mean 1.5 sessions a week of exercise to music for nine weeks, by a student | Descriptions of social interaction, ability to do the exercises, acceptable and unacceptable behaviour | ↑ ability to perform exercises<br>↓ swearing by one participant<br>some participants smiled at each other now and then |

AD = Alzheimer's disease; ADL = Activities of Daily Life; IADL = Instrumental Activities of Daily Life; MMSE = Mini-Mental State Examination

## Biographical notes

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