

Effectivity of physical activity interventions on the cognitive function of dementia patients. A systematic review

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1. Abstract

Objective: The aim of this research is to systematically review over the last five years the use of any form of physical exercise on the cognitive function of people diagnosed with dementia, and to determine which intervention has the strongest effect. **Design:** Randomized controlled trials were identified in PubMed between February 15, 2012 and February 15, 2007, according to predefined inclusion criteria. The author extracted predetermined data, assessed the quality of the methods used by the PEDRo Scale, and performed a qualitative analysis on the found studies. **Results:** Eleven studies were included. The quality of the methods in the examined studies varied from reasonable to good. The participants in the identified studies differed widely in terms of mean age, gender distribution, as well as baseline cognitive level. Six of the selected studies used the same outcome measure, namely the Mini Mental State Evaluation (MMSE), of which mean outcomes of the experimental groups varied between +2.94 and -1. Of the six studies that used the MMSE as outcome measure four found a positive effect and two found a negative effect. Two of the six studies which used the MMSE as outcome measure explicitly reported a significant (positive) effect. One used a specific progressive exercise program, the other used a multimodal intervention (Taiji exercises, combined with cognitive-behavioural therapies and support group visits). **Conclusions:** The analysis identified five studies reporting a positive effect on cognitive function, two reporting a stabilizing effect and four reporting no effect. Of the six studies that used the same outcome measure, the specific progressive exercise program elicited the biggest effect, with MMSE scores improving 30 percent over 12 months. Caution should be taken when generalizing these results, as the studies that found positive effects were of overall low quality (mean PEDRo score: 4.2).

2. Introduction

There is no shortage of attention for the problems caused by various forms of dementia and ways to prevent or treat these diseases. Earlier this year, the subject has even reached the political agenda, with the Obama administration signing off on a set of measures intended to tackle the prevalence of Alzheimer's disease (Kearney, 2012). The fact that the disease has raised the concern of politicians is not surprising, when considering that currently 25%-30% of the people over 85 years old in developed countries are diagnosed with dementia (Ferri et al., 2005). The expectation that the prevalence of dementia will increase four-fold from the beginning of the century to the year 2040 (Ferri, et al., 2005), makes this issue even more pressing. Consequently, it is expected that as the world population ages, the societal costs related to old age dementia will increase immensely.

To control the costs of the treatment and prevention of dementia, scientists from around the world are looking for treatments that are not only effective, but also cost-effective. Physical activity as a treatment to prevent and decrease the progression of dementia is widely assumed to fit into this category (Arcoverde

et al., 2008; Baker et al., 2010; Edwards, Gardiner, Ritchie, Baldwin, & Sands, 2008; Kramer & Erickson, 2007; Kramer, Erickson, & Colcombe, 2006; Netz, Axelrad, & Argov, 2007; Santana-Sosa, Barriopedro, López-Mojares, Pérez, & Lucia, 2008; Taylor et al., 2004). While there is solid data on preventing the onset of cognitive decline through physical activity (Angevaren et al., 2008), the data is less clear cut when it comes to treating the symptoms of dementia through physical activity after onset of the disease. It's not the quantity of studies that's the problem but it's mainly the quality of the measurement instruments used in the studies.

Of the systematic reviews that were read in preparation of the current study, the most recent query was held in December of 2010 (Littbrand, et al., 2011), and all of them called for more high quality studies (Christofolletti, Oliani, Gobbi, & Stella, 2007; Deslandes et al., 2009; Littbrand, et al., 2011; McDonnell, et al., 2011; Rolland, Abellan van Kan, & Vellas, 2008; Uffelen, et al., 2008).

The scope of the current study is two-fold, to check whether or not the call of previous review authors has been heeded. And more specifically: What effects do various physical interventions have on the cognitive function of people diagnosed with dementia, and which intervention has the strongest effect.

3. Methods

Literature Search

A systematic literature search was carried out in February 2012 using the Pubmed database. The query that was used, was: (dement* AND (exercise [OR] fitness [OR] train* [OR] cycling [OR] swim* [OR] gym* [OR] walk* [OR] danc* [OR] yoga [OR] "tai chi" "physio therapy" [OR] "physical therapy" [OR] sport*) AND (cogn* [OR] impair* [OR] memory) OR (alzheimer AND (exercise [OR] fitness [OR] train* [OR] "physio therapy" [OR] "physical therapy" [OR] cycling [OR] swim* [OR] gym* [OR] walk* [OR] danc* [OR] yoga [OR] "tai chi" [OR] sport*) AND (cogn* [OR] impair* [OR] memory)). Because this analysis focuses on different physical interventions, the search string was intentionally kept broad (including such interventions as dancing, yoga and tai chi), and not limited to physical therapy interventions. Limitations that were set on the Pubmed query were:

Type of Article: Clinical Trial, Meta-analysis, Randomized Clinical Trial, Review & Practical Guidelines

Language: English & Dutch

Time of publication: Between 15 February 2007 and 15 February 2012

Again, concerning the type of article, the focus of the search was intentionally kept broad. Because the author would supplement the electronic searches by cross checking reference lists in relevant papers. The initial query resulted in 107 articles.

Study Selection

To be included in this systematic review, the found articles had to meet the following predetermined criteria: (1) the study is a controlled trial that included people that were diagnosed with dementia; (2) the effect of physical exercise was evaluated and was compared with a control activity; and (3) the effect on cognitive functions was evaluated through clinometrics at baseline and follow ups.

The author reviewed the titles and abstracts of the papers that were identified in the electronic searches. Studies that did not meet the inclusion criteria were removed from the analysis. This resulted in 103 articles being discarded, leaving four controlled trials. Checking reference lists of relevant papers resulted in another 32 potentially useful articles, of which full text copies were obtained. Of these, seven were ultimately included, bringing the full number of articles to be analyzed on 11.

4. Data extraction and Quality Assessment

Quality

All of the studies that were part of the analysis were scored on the PEDRo scale (Moseley, 2002), to evaluate the quality of the used methods. Table 1 gives an overview of the analyzed studies and their respective scores on the PEDRo scale. The PEDRo Scale is an easy to use instrument to measure both the internal validity and the quality of the statistical information of randomized clinical trials. The PEDRo Scale consists of 11 items, which can be scored either 0 or 1. Adding up the scores of the individual items, articles can get a score between 0 and 10. A PEDRo score between 0-3 means that the study is of bad quality, a score between 4-5 means that the study is of reasonable quality, a score between 6-8 means that the study is of good quality and a score between 9-10 means that the study is of very good quality (Van Peppen et al., 2004).

Participants

Information on number of participants, distribution of sex and age, as well as the level of cognitive function was extracted. Brief descriptions of these characteristics can be found in Table 2, giving an overview of the analyzed studies.

Intervention

As far as these details were provided in the texts, the type of physical exercise, its frequency, the duration of session, time period, the use of progression in physical exercise, and the use of individual adjustments of the intervention were identified. Table 2 provides an overview of the characteristics of the used interventions.

Outcome Measures

In the inclusion procedure of this review, the author specifically chose studies in which the outcome measure cognition was measured through clinimetrics. Because many different outcome measures were found, only six of the studies were comparable. An overview of used outcome measures is described in the results section.

Analysis

Given the research question, the author looked primarily at the measured effects of the different interventions. Secondly, the relation between the different outcome measures and the used interventions was analyzed. However, as described above, many of the outcome measures could not be compared to one another. Consequently, data pooling was not performed. Instead, the current study focuses on a qualitative analysis, with attention in particular to the studies with comparable outcome measures. Beyond the data that's described in the results section, Table 1 provides an overall breakdown of the ultimate outcomes of the studies (whether a physical intervention has a positive, negative or perhaps a stabilizing effect on the cognitive symptoms of dementia). In the end, methodological quality as quantified by the PEDRo scores in Table 1, are used to weight the different outcomes against each other.

5. Results

Study Characteristics

Quality

The methodological quality of the selected studies varies significantly, ranging from PEDRo scores between 4 (reasonable quality) and 7 (good quality). Ultimately five of the selected studies (Dechamps et al., 2010; Eggermont, Knol, Hol, Swaab, & Scherder, 2009; Eggermont, Swaab, Hol, & Scherder, 2009; Venturelli, Scarsini, & Schena, 2011) have good methodological quality, the remaining six studies (Burgener, Yang Yang, Gilbert, & Marsh-Yant, 2008; Christofletti et al., 2008; Hokkanen et al., 2008; Kemoun et al., 2010; Kwak, Um, Son, & Kim, 2008; Yáguez, Shaw, Morris, & Matthews, 2011) have

reasonable quality.

Participants

The study by Dechamps, et al. (Dechamps, et al., 2010) included the highest number of participants, N= 160. The study by Venturelli, et al. (Venturelli, et al., 2011) included the fewest, N= 21. The mean age ranged between 85.4 years (Eggermont, Swaab, et al., 2009) and 52 years (Venturelli, et al., 2011). And the proportion of woman ranged from 100% (Kwak, et al., 2008) to 47% (Burgener, et al., 2008). Three studies did not report the mean age of participants (Eggermont, Knol, et al., 2009; Kemoun, et al., 2010; Schwenk, Zieschang, Oster, & Hauer, 2010).

The level of cognitive function among the participants, assessed by the Mini-Mental State Examination (score range 0-30), ranged from mean scores of 26.3 (Yágüez, et al., 2011) to mean scores of 12 (Venturelli, et al., 2011). While most studies had an homogenous group of participants concerning pathophysiology, one study had a heterogeneous group (Dechamps, et al., 2010). The study of Dechamps, et al. (Dechamps, et al., 2010) had a subgroup of 58.7% of the total participants, which were diagnosed with any form of dementia. These people were distributed randomly across the experimental groups and control group (Dechamps, et al., 2010).

Intervention

All of the interventions were supervised by either a caregiver or a professional. Four studies evaluated group exercise (Burgener, et al., 2008; Dechamps, et al., 2010; Hokkanen, et al., 2008; Yágüez, et al., 2011), while seven studies evaluated individual activities (Christofolletti, et al., 2008; Eggermont, Knol, et al., 2009; Eggermont, Swaab, et al., 2009; Kemoun, et al., 2010; Kwak, et al., 2008; Schwenk, et al., 2010; Venturelli, et al., 2011). Interventions ranged from Taiji (Burgener, et al., 2008; Dechamps, et al., 2010), exercises based on strength (Christofolletti, et al., 2008) or balance (Dechamps, et al., 2010; Schwenk, et al., 2010), simple mixed movement programs (for more extensive descriptions, see Table 2) (Dechamps, et al., 2010; Kwak, et al., 2008; Yágüez, et al., 2011), hand movement programs (Eggermont, Knol, et al., 2009), walking groups (Eggermont, Swaab, et al., 2009; Kemoun, et al., 2010; Venturelli, et al., 2011), dance and movement therapy (Hokkanen, et al., 2008), to dual-task-based exercise (Schwenk, et al., 2010). Furthermore, the selected studies varied between single intervention approaches (Eggermont, Knol, et al., 2009; Eggermont, Swaab, et al., 2009; Hokkanen, et al., 2008; Kemoun, et al., 2010; Kwak, et al., 2008; Schwenk, et al., 2010; Venturelli, et al., 2011; Yágüez, et al., 2011) and combined intervention approaches (Burgener, et al., 2008; Christofolletti, et al., 2008; Dechamps, et al., 2010). Of these combined intervention approaches one used an experimental condition that combined physical interventions with cognitive interventions (Burgener, et al., 2008), and did not control for physical interventions without cognitive interventions.

There was a wide range of frequency, duration of session, and length of intervention period in the twelve selected studies: 1-7 times per week, 30-120 minutes per session, and 6 weeks to 12 months, respectively. (Burgener, et al., 2008; Christofolletti, et al., 2008; Dechamps, et al., 2010; Eggermont, Knol, et al., 2009; Eggermont, Swaab, et al., 2009; Hokkanen, et al., 2008; Kemoun, et al., 2010; Kwak, et al., 2008; Schwenk, et al., 2010; Venturelli, et al., 2011; Yágüez, et al., 2011) Some kind of progression was reported in three studies (Dechamps, et al., 2010; Kwak, et al., 2008; Schwenk, et al., 2010). Of these, two were studies evaluating simple mixed aerobic movement programs (Dechamps, et al., 2010; Kwak, et al., 2008) and one evaluated dual-task-based exercise (Schwenk, et al., 2010). For an overview of the experimental conditions see Table 2.

Outcome Measures

All of the selected studies evaluated more than only the effects of the intervention on cognitive function (Eggermont, Knol, et al., 2009; Eggermont, Swaab, et al., 2009; Hokkanen, et al., 2008; Kemoun, et al., 2010; Kwak, et al., 2008; Schwenk, et al., 2010; Venturelli, et al., 2011; Yágüez, et al., 2011). For the purpose of the current study however, it was decided to only review outcome measures that assess cognition. Six of the selected studies used the Mini Mental State Evaluation (MMSE) as their primary outcome measure (Burgener, et al., 2008; Christofolletti, et al., 2008; Dechamps, et al., 2010; Hokkanen, et al., 2008; Kwak, et al., 2008; Venturelli, et al., 2011). The MMSE is an easy-to-use measure of mental status and a screening tool for dementia. The MMSE consists of giving subjects 11 questions or

commands (Burgener, et al., 2008). The range of possible scores on the MMSE lies between 0 and 30, with scores below 24 suggesting dementia (Burgener, et al., 2008). The reliability of the MMSE has consistently been reported as high (Burgener, et al., 2008). The MMSE provides an objective measure of mental ability, with the participant's written or verbal response to each question being used to rate each question as either correct or incorrect (Burgener, et al., 2008). Besides the above mentioned studies that use the MMSE as an outcome measure, there are only two other studies that can be compared to each other, because of the used outcome measures (Eggermont, Knol, et al., 2009; Eggermont, Swaab, et al., 2009). These studies both use a battery of cognitive tests, which largely overlap, as cognitive outcome measures (Eggermont, Knol, et al., 2009; Eggermont, Swaab, et al., 2009). The authors of both studies (Eggermont, Knol, et al., 2009; Eggermont, Swaab, et al., 2009) use tests that come from larger test batteries, such as the Rivermead Behavioural Memory Test, which includes Face Recognition and Picture Recognition. Other tests like the Digit Span and the Reversed Digit Span, are borrowed from the larger revised Wechsler Memory Scale (Eggermont, Knol, et al., 2009; Eggermont, Swaab, et al., 2009). While other studies also used tests that originate from the revised Wechsler Memory Scale and the Rivermead Behavioural Memory Test (Christofolletti, et al., 2008; Hokkanen, et al., 2008), none of them specifically notes the mean scores of the individual tests. Other outcome measures that were used but could not be meaningfully compared are the Neuropsychiatric Inventory (NPI) (Dechamps, et al., 2010), the French ERFC (Rapid Evaluation of Cognitive Function) (Kemoun, et al., 2010), the Nurses' Observation Scale for Geriatric Patients (NOSGER) (Hokkanen, et al., 2008), The Cambridge Neuropsychological Test Automated Battery (CANTAB) (Yágüez, et al., 2011), and the Brief Cognitive Screening Battery (Christofolletti, et al., 2008).

Effect of the physical exercise on dementia

As described under the heading 'Outcome Measures', the measured effects of six of the selected studies could be compared to one another by means of similar outcome measure, namely the MMSE. Of the studies measuring cognitive function through the MMSE, mean effect scores varied from +2.94 (Kwak, et al., 2008) to -1 (Venturelli, et al., 2011) in the experimental groups, and +2.2 (Christofolletti, et al., 2008) to -6 (Venturelli, et al., 2011) in the control groups. In two of the studies the effects are significant (Burgener, et al., 2008; Kwak, et al., 2008), in four they are not (Christofolletti, et al., 2008; Dechamps, et al., 2010; Hokkanen, et al., 2008; Venturelli, et al., 2011). Of the two studies that found significant effects the measured effects were +0.4 (Burgener, et al., 2008) and +4.54 (Kwak, et al., 2008). On a 30 point scale, this means that the intervention used by Kwak, et al. improved with thirty percent (from 14.53 to 19.07, staying within the range that is categorized as moderate dementia).

Of the other two studies that can be compared through similar outcome measures, the authors have pooled the measures of the individual tests into a single cognition domain (Eggermont, Knol, et al., 2009; Eggermont, Swaab, et al., 2009). In both cases no significant effect was found on cognition through time (Eggermont, Knol, et al., 2009; Eggermont, Swaab, et al., 2009).

Whilst not being able to meaningfully compare all effect sizes, Table 1 gives a broad overview of the different outcomes of the selected studies. In this, we see that three of the studies found a positive effect of their interventions on overall cognitive function (Burgener, et al., 2008; Kemoun, et al., 2010; Kwak, et al., 2008), plus two which find positive effects on specific cognitive domains (Hokkanen, et al., 2008; Yágüez, et al., 2011). Two of the studies report a stabilizing effect (meaning that cognitive outcome measures were unchanged at the follow up measurements) (Christofolletti, et al., 2008; Venturelli, et al., 2011). Though one of these only found this effect on certain outcome measures (Christofolletti, et al., 2008). Lastly, four studies reported no effect on cognitive function (Dechamps, et al., 2010; Eggermont, Knol, et al., 2009; Eggermont, Swaab, et al., 2009; Schwenk, et al., 2010).

Synthesis of Results

In the previous paragraphs it has become apparent that it is not possible to measure which intervention yields the biggest effects of all the selected studies. However, when we exclusively focus on the six studies that measure overall cognitive function through the MMSE (Burgener, et al., 2008; Christofolletti,

et al., 2008; Dechamps, et al., 2010; Hokkanen, et al., 2008; Kwak, et al., 2008; Venturelli, et al., 2011), it becomes apparent that two interventions may stabilize the cognitive decline in people with dementia (Christofolletti, et al., 2008; Venturelli, et al., 2011). These interventions are: an interdisciplinary program consisting of physical therapy, combined with occupational therapy and physical education {Christofolletti, 2008 #28}; and an individual walking program arm-to-arm with a caregiver {Venturelli, 2011 #38}. Another two studies even improve cognitive function (Burgener, et al., 2008; Kwak, et al., 2008). The first intervention consists of Taiji in combination with cognitive behavioural therapy and support group visits {Burgener, 2008 #30}; the other is a regular progressive exercise program, which throughout a year progresses exercise intensity from 60 minutes, two times per week on an estimated 30 percent of the maximum oxygen intake, to exercising three times per week on an estimated 60 percent of the maximum oxygen intake {Kwak, 2008 #29}. Of these two interventions, the regular exercise program of Kwak, et al. (Kwak, et al., 2008) is the most effective.

Overall, five of the selected studies report a positive effect (Burgener, et al., 2008; Kemoun, et al., 2010; Kwak, et al., 2008; Yágüez, et al., 2011), while four studies report no effect (Dechamps, et al., 2010; Eggermont, Knol, et al., 2009; Eggermont, Swaab, et al., 2009; Schwenk, et al., 2010). However, when we weigh these studies with their score on the PEDRo Scale, it becomes apparent that the studies that found no effect are generally of higher quality.

Table 1. Overview of studies and PEDRo scores in order of effects		
Positive effect	Stabilizing effect	No effect
Kwak, et al. PEDRo score: 5*	Christofolletti, et al. (effects on cognition were only found on the domains of the Clock Drawing Test and Semantic Verbal Fluency Test) PEDRo score: 5	Dechamps, et al. PEDRo score: 7
Yágüez, et al. (effects on cognition were only found on the domains of sustained attention, visual memory and working memory) PEDRo score: 4	Venturelli, et al. PEDRo score: 6	Eggermont, Knol, et al. PEDRo score: 7*
Hokkanen, et al. (effects on cognition were only found on visuospatial ability and planning) PEDRo score: 4		Eggermont, Swaab, et al. PEDRo score: 7
Kemoun, et al. PEDRo score: 4		Schwenk, et al. PEDRo score: 6
Burgener, et al. PEDRo score: 4		
Mean PEDRo score: 4.2	Mean PEDRo score: 5.5	Mean PEDRo score: 6.67
* Articles not yet rated by PEDRo, used rating was compiled by author himself, by scoring the individual items of the PEDRo scale for these articles.		

Table 2. An overview of research populations and interventions used in the experimental groups		
Study	Participants	Physical Intervention
Burgener, et al.	54 participants diagnosed with various kinds of irreversible dementia and a score <2.0 on the Clinical Dementia Rating Scale ⁴⁹ indicating an early to early-middle disease stage.	(N=24) Multimodal: Taiji exercises (strength and balance training, relaxation exercises), combined with cognitive-behavioural therapies and support group. Frequency: 3 times per week* Duration: 60 minutes* Time period: 40 weeks*
Christofaletti, et al.	54 participants diagnosed with dementia, based on ICD-10 ¹¹ Classification of Mental and Behavioral Disorders, and confirmed by the patient's performance on the Mini-Mental State Examination and on Katz Activities Daily Living Scale.)	(N=17) A. Interdisciplinary program comprising physiotherapy, occupational therapy and physical education. Frequency: 5 times per week Duration: 2 hours Time period: 6 months (N=17) B. Individual physical exercise, concentrated on specific exercises that stimulated strength, balance, and cognition supervised by a physical therapist. Frequency: 3 times per week Duration: 60 minutes Time period: 6 months
Dechamps, et al.	160 participants who were able to understand basic motor commands and to move from one position to another). ^{**}	A. (N=51) Adapted Tai Chi exercise program for the elderly, which emphasizes body sensation, awareness of multidirectional weight shifting, body alignment, and multisegmental movement coordination. Deep breathing and muscular reinforcement exercises were also integrated. Frequency: 4 times per week Duration: 30 minutes Time period: 6 months B. (N=49) Cognition-Action program, consisting of a warm-up while participants were seated in a circle. Lower limb movements alternated with upper body exercises and were followed by stretching and resistance exercises. Also standing exercises and ball passing exercises were integrated. The sessions ended with deep-breathing exercises and relaxation techniques. Frequency: 2 times per week Duration: 30 minutes, progressing to 40 minutes Time period: 6 months
Eggermont, Knol et al.	61 participants diagnosed with dementia through criteria of the Diagnostic and Statistical Manual, 4th edition (DSM-IV).	(N=30) Hand movement program, in which participants performed hand movements (e.g. finger movements, pinching a soft ball, or handling a rubber ring) group wise. Frequency: 5 times per week Duration: 30 minutes Time period: 6 weeks
Eggermont, Swaab et al.	97 participants with a reported diagnosis of dementia and able to walk for short distances with or without a walking aid.	(N=51) Walking group, in which participants walked at a self-selected speed. Short moments of rest were included, if necessary. Frequency: 5 times per week Duration: 30 minutes Time period: 6 weeks

Hokkanen, et al.	29 participants were randomly recruited from dementia nursing home. 14 had Alzheimer's disease, 8 had vascular dementia, and 7 had undefined types of dementia.	(N=19) Dance and movement therapy, which combines music, light exercise, and sensory stimulation. The sessions had the same structure each time: warm-up, theme development, and closure. Frequency: 1 time per week Duration: 30 to 45 minutes Time period: 9 weeks
Kemoun, et al.	31 participants diagnosed with Alzheimer-type dementia by a neurologist according to DSM IV criteria, with a MMSE score lower than 23, and able to walk 10 meter without technical assistance.	(N=16) Physical training program consisting of walking, stamina exercises and activities (dancing/stepping with emphasis on patient enjoyment). Frequency: 3 times per week Duration: 60 minutes Time period: 15 weeks
Kwak, et al.	30 participants, who were diagnosed by a physician with Alzheimer-type or other dementia, with a MMSE score above 10, free from any medical condition that would limit participation in light to moderate intensity exercise (i.e., walking) and not engaged in regular physical activity in the previous 6 months.	(N=15) Progressive exercise program, consisting of warming up through a chair exercise, followed by a workout (upper extremity/ lower extremity/ shoulder wheel/ restorator/ Thera-Band/ parallel bar/ overhead pulley/ staircase/ swiss ball/ vibrator) and a cooling down consisting of stretching exercises. Frequency: 2-3 times per week Duration: 30 minutes, progressing to 60 minutes Time period: 12 months
Schwenk, et al.	61 participants with dementia confirmed with established international criteria, (MMSE score 17–26), with no severe neurologic, cardiovascular, metabolic, or psychiatric disorders.	(N=26) Dual-task–based exercise training and additional progressive resistance-balance and functional-balance training. During functional-balance exercises, concurrent motor (e.g., throwing or catching a ball) or cognitive (e.g., arithmetic tasks, repeating names of animals) tasks were performed within group training for 15 minutes. Frequency: 2 times per week Duration: 2 hours Time period: 12 weeks
Venturelli, et al.	21 participants with an MMSE score between 5 and 15, without mobility limitations and in the later stages of Alzheimer disease, according to the clinical dementia rating scale.	(N=11) Walking program, starting with short informal chat, followed by 30 minutes of walking, arm in arm with caregiver. During the walking session, the caregiver was instructed to encourage the participant to maintain the fastest walking speed possible. Frequency: 4 times per week Duration: at least 30 minutes Time period: 6 months
Yáguez, et al.	27 participants diagnosed with Alzheimer's type dementia, based on the ICD-10 diagnostic criteria and an MMSE score between 12 and 29.	(N=15) The program contained a total of 15 exercises (e.g. stretching different parts of the body, circular movements of the extremities and isometric tensions of muscles groups). The exercises were performed sitting or standing as required. Frequency: 1 time per week Duration: 2 hours, and a 30 minute break Time period: 6 weeks
* Described parameters are for Taiji part of the intervention only. Cognitive behavioural therapy and support groups were alternately visited weekly, for 90 minutes.		

6. Discussion

The current study shows that, drawing on RCT's exclusively from the last five years, there is evidence in favour of using exercise as a treatment on cognitive function. Five studies report a positive effect, additionally two studies report a stabilizing effect. Against this, there are four studies that find no effect.

Interpreting the results of the selected studies is complicated by the fact that there seems to be no significant similarity between the interventions that elicited either positive or no effects. For instance, the interventions that elicited no effect varied between Taiji and simple movements (for a more extensive description, see Table 2)(Dechamps, et al., 2010), hand movements (Eggermont, Knol, et al., 2009), exclusively walking (Eggermont, Swaab, et al., 2009) and dual-task-based exercise training plus progressive resistance training and balance (Schwenk, et al., 2010)). Used interventions that brought about a positive effect were progressive and fixed movement programs (for a more extensive description, see Table 2) (Kwak, et al., 2008; Yágüez, et al., 2011), dance and movement therapy (Hokkanen, et al., 2008), walking, stamina and activity training (Kemoun, et al., 2010) and Taiji with cognitive behavioural therapy and support group visits(Burgener, et al., 2008).

As described in the systematic reviews by McDonnell, et al. (McDonnell, Smith, & Mackintosh, 2011), Littbrand, et al. (Littbrand, Stenvall, & Rosendahl, 2011), and Van Uffelen, et al. (Uffelen, Chin A Paw, Hopman-Rock, & Mechelen, 2008) most of the trials that were analyzed had very small sample sizes; they did not reflect on whether or not the data set had sufficient power to detect a change between groups in primary outcome measures; and overall they used a low quality method; furthermore, they displayed a large variety in study populations, exercise protocols, intensity of the intervention, and outcome measures, so much so that this complicated the interpretation of the results (Littbrand, et al., 2011; McDonnell, et al., 2011; Uffelen, et al., 2008). These, and other systematic reviews (Christoforetti, et al., 2007; Deslandes, et al., 2009; Littbrand, et al., 2011; McDonnell, et al., 2011; Rolland, et al., 2008; Uffelen, et al., 2008), call for more high quality studies. This need has not been fulfilled in the two year gap between the current study and the most recent systematic review (Littbrand, et al., 2011).

In the current study, the quality of the used methods of the selected RCT's has been assessed through the PEDRo Scale. While conventional use dictates a cut off point for studies scoring less than six points on the PEDRo Scale to be excluded (Moseley, 2002), the author decided to use these studies anyway, because only five studies would otherwise remain to be analyzed. This decision resulted in PEDRo scores of the included RCT's that varied between 4 and 7. While this means that the lowest quality studies can still be categorized as reasonable, it raises the question if the same effects would have been measured if the used method had been of higher quality.

Apart from better methodological quality it is recommended that individual researchers strive for a stronger form of overall homogeneity in their research. Whether it's the primary outcome measures, the intervention period or frequency, or the mean age and baseline cognitive function of the participants, all should be chosen according to some kind of standard, to enhance the comparability of participants, interventions, outcome measures and effects. For, as Yu, et al. write: *"...it is unlikely that the effects of 3 months of moderate intensity cycling and one year of comprehensive exercise are comparable in their physiological effects and impact on cognitive function"* (Fang Yu, 2011). Also, to effectively evaluate the effects of physical exercise on cognitive function, studies preferably should use either a single intervention setup, or when using a combined intervention setup (combining physical and other interventions), an experimental group should be set up, which controls for the non-physical intervention. In the current study, this was not done by Burgener et al. (Burgener, et al., 2008), which made it impossible to distinguish between the effects of the physical part of the intervention and the other parts. On the other hand Christoforetti, et al. used two experimental groups and one control group (Christoforetti, et al., 2008). One experimental group received a multimodal intervention consisting of physical therapy, occupational therapy and physical education, while the other received physical therapy focussing on strength and balance, this effectively controlled for the other modalities in the first experimental group (Christoforetti, et al., 2008).

Furthermore, it's important that more effort is put into determining what the standards in this field of research should be. The cornerstone of any research into the effects of physical exercise on cognitive function in people with dementia should be evidence based knowledge about: what level of aerobic exercise training is needed for achieving cognitive improvement; what cognitive domains and measures are more sensitive to aerobic exercise training in older demented adults; and do intrapersonal and

extrapersonal covariates such as cognitive status and stage of dementia mediate the potential for improvement in cognitive function (Fang Yu, 2011). To answer these questions larger studies are needed. Larger studies means more statistical power, and this could only be of benefit to the research. Out of pragmatic reasons (this was one of the few outcome measures that were comparable), the current study used the Mini Mental State Evaluation (MMSE) as an important outcome measure. While it's found that this is a reliable, easy to use and easy to interpret test, it too has its shortcomings. Burgener, et al. (Burgener, et al., 2008) describe the MMSE as not being specific enough and also, that it's prone to a learning effect in follow up measurements. At the moment however, there is no agreement on which test or battery of tests is better suited to measure the full range of cognitive function. Nevertheless it should be advised to use a more standardized outcome measure for cognitive function and use this in trials with varying interventions, so as to make the outcomes comparable to one another and consequently compare effect sizes. This is the corner stone of researching effect sizes.

The current study has not examined the applicability of interventions in a population of people diagnosed with dementia. However, applicability is very important in working with specifically this group of patients. Patients with dementia are prone to falls and generally unsafe behaviour, as well as showing a low level of compliance (Rolland, et al., 2008). This is a subject that has recently been studied by such authors as Littbrand, et al. (Littbrand, et al., 2011) and Yu, et al. (Fang Yu, 2011). Littbrand, et al. conclude that they can only find evidence for the applicability of combined functional weight-bearing exercises (Littbrand, et al., 2011), while Yu reports of successful interventions using recliner bicycles (Fang Yu, 2011).

7. Conclusion

This systematic literature review shows that since 2007 clinically randomized trials provide evidence for the use of physical activities or exercise interventions to slow down the cognitive symptoms of dementia. Five studies found a positive effect on cognitive function, and additionally two found stabilizing effects. Interventions that showed a positive effect ranged from progressive and fixed movement programs (see Table 2 for a more extensive description), dance and movement therapy, walking, as well as stamina and functional activity training to Taiji exercises, combined with cognitive-behavioural therapies and support group visits. However, the current study also identified four studies which reported no effect on cognitive function. These studies are generally of a better methodological quality..

Because of the heterogeneous setup of the twelve selected studies, it was difficult to interpret the findings of the studies in light of each other. Of the six studies that used the same outcome measure, two showed a significant positive effect. These successful interventions are (1) a specific progressive exercise program and (2) Taiji exercises, combined with cognitive-behavioural therapies and support group visits. The first intervention elicited the biggest effect, with scores on the Mini Mental State Evaluation increasing with 30% over a period of twelve months.

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