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MUSIC CUED EXERCISES FOR PEOPLE LIVING WITH DEMENTIA: A SYSTEMATIC REVIEW

[*1]Yasmine S Gomaa, M.Sc.
[2]Joanne E Wittwer, Ph.D
[3]Rebecca J Grenfell, M.Sc.
[4]Salah A Sawan, Ph.D
[5]Meg E Morris, Ph.D

ABSTRACT

Background: Dementia can be associated with motor and non-motor disorders such as cognitive impairment, depression, and behavioral disturbance. The symptoms typically progress gradually over time. Music-cued exercises have been of therapeutic interest in recent years, especially to enable people with chronic neurological diseases to move more easily and to experience greater well-being. Objective: To investigate whether music-cued exercises are more effective than usual care for the management of motor and non-motor symptoms in people living with dementia.

Methods: Systematic searching of the international literature was conducted in January 2018. Keywords were searched through electronic databases including MEDLINE, CINAHL, Embase, PsycINFO, PubMed, Scopus, the Web of Science, Science Direct, Wiley online library, and JOVE. The Cochrane collaboration tool was used to assess the risk of bias of the randomized controlled trials (RCTs). The Downs and Black checklist assessed the quality of non-RCTs.

Results: Twelve studies met the eligibility criteria, including 4 RCTs. Three investigated the effects of music-cued exercises on motor performance, four examined non-motor outcomes, four quantified the level of exercise participation, and one examined both motor and non-motor outcomes. The included studies were of modest to low quality.

Conclusion: There is growing evidence for the beneficial effects of music-cued exercises for people living with dementia. Enjoyable music and physical exercises matched to rhythmical music appear to have benefits for some individuals. The dosage of music-cued exercise is a key determinant of the motor and non-motor outcomes in people living with a variety of forms of dementia.

Keywords: Dementia, Alzheimer's disease, Music, Exercise, Physiotherapy.

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[2]Physiotherapy Discipline | La Trobe Centre for Sport and Exercise Medicine Research | School of Allied Health | La Trobe University | Vic | 3086 | Australia. T: +61 3 9479 5808. E-mail: J.Wittwer@latrobe.edu.au
[3]School of Allied Health | La Trobe University | Vic | 3086 |Australia. T: +61354343434. E-mail: Bec.Grenfell@sjog.org.au
[4]Professor of Physical Therapy for Neuromuscular Disorders and its Surgery, Faculty of Physical Therapy, Cairo University, Egypt. Dean of Physical Therapy, Misr University for Science and Technology, Egypt. T: +20 122 407 2373.
E-mail: sawans2001@yahoo.com
[5]Health scope and La Trobe Centre for Sport and Exercise Medicine Research, School of Allied Health, La Trobe University, Melbourne, Victoria, Australia.
E-mail: m.morris@latrobe.edu.au

CORRESPONDING AUTHOR

[*1]Yasmine S Gomaa, M.Sc.

Visiting scholar| School of Allied Health | La Trobe University | Vic | 3086 | Australia
T: +61 3 9479 6080.
E-mail: y.gomaa@latrobe.edu.au

INTRODUCTION

Dementia is a chronic neurological disorder and one of the main causes of disability and reduced quality of life in older people throughout the world [1,2]. There are various forms of dementia, such as Alzheimer's disease, Lewy body dementia, frontotemporal dementia and vascular dementia [3]. Dementia can be associated with a progressive deterioration in multiple brain functions [4]. It can sometimes affect cognition, behavior and other psychological functions, and frequently limits mobility [4-6]. The risk of dementia increases with age [7]. The incidence also increases steeply over the age of 85 years [8, 9]. In the United States of America, an estimated 5.5 million people have Alzheimer's disease and this expected to grow to around 14 million by 2050 [2]. The worldwide incidence of dementia is estimated to rise to 135 million people by 2050 [10].

People living with dementia may need assistance with performing daily activities such as dressing, self-care, working and walking [11-13]. The risk of developing secondary complications also increases. Pneumonia is one of the most common secondary complications and a key cause of mortality in the advanced stages of the disease [14,15]. Deterioration in motor function can also occur in the early stages [6, 16, 17]. Movement slowness, gait disturbance, postural instability and falls are common [6, 16, 18, 19].

Exercise and physical activities are associated with short-term improvements in motor performance and functional abilities in some individuals living with dementia [20-24]. Selected non-pharmacological interventions have shown promising results for symptomatic management [25,26]. In particular, music-cued exercises appear to enhance cognitive, behavioral and psychological function in some people, especially in the early stages [20, 27-29]. Individuals with dementia can find it challenging to participate in exercise programs over extended periods of time [30]. Apathy, reduced motivation, lethargy and poor short-term memory are common barriers to engagement in exercises [30, 31]. Physical activities accompanied by music can be motivating and appear to have benefits for improving symptoms in some people, especially in the early to middle stages of the disease [32, 33].

The role of music in enhancing cognitive and behavioral functions in people with dementia has been reported [34-36]. Music can motivate people living with dementia to move more and exercise for longer [37-40]. Musical memory in many people with dementia remains preserved, even in the latter stages[41,42]. For example, lobule IV of the cerebellum is involved in tasks related to cognition, movement [43], and the processing of music [44, 45]. Activation of this area increases with music playing during physical activities and is argued to enhance movement, memory and motor learning [46, 47]. The motivational aspects of music can also facilitate synchronization of movement to the beat [47]. Jacobsen et al. 2015 [42] reported the ventral pre-supplementary motor area and caudal anterior cingulate gyrus to be responsible for long-term musical memory. These regions appear to be amongst the last to degenerate in dementia, which could help to explain the beneficial responses of some people living with dementia to familiar music [42]. To gain advantages of music when combined with movement, it appears to be particularly helpful to follow a strong and clear rhythm [48]. There is preliminary evidence that external rhythms can enhance motor performance, especially when a person enjoys moving to music [38, 48, 49].

This review evaluates studies on the effects of music-cued exercises for people living with dementia. Two main questions were addressed:

(1) Does music-cued exercise have more beneficial effects on motor and non-motor signs of dementia compared to usual care?

(2) What are the motor and non-motor outcomes of music-cued exercises?

METHODS

The protocol for this systematic review was published in 2017 (DOI: 10.15621/ijphy/2017/v4i1/136167) [50]. The review complied with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines [51]. Meta-analysis was not applicable due to lack of homogeneity of the studies reviewed and the limited number of eligible studies.

Eligibility criteria

Study design

Studies included RCTs, quasi-randomized trials, and controlled clinical trials. Comparative studies that did not have randomization, case-controlled studies and cohort studies were also considered. Studies were excluded if clinical reports, single case studies, monographs or protocols, and if they were not published in English.

Participants

The sample included people diagnosed with dementia of any type, any stage or any severity. All ages, medications, and comorbidities were included.

Intervention

Studies were included if they used any type of music, combined with any form of physical exercise and any duration of the exercise intervention. They were excluded if music was used alone, or as mental practice or when music was utilized with activities other than physical exercises.

Comparator

The studies were included if the interventions were compared with control conditions, such as usual care or usual physical activities.

Outcomes

The motor outcomes included variables related to gait, mobility, and balance. Non-motor outcomes such as depression, anxiety, behavior and other psychological and cognitive impairments were also reviewed.

Information sources

A search was conducted in January 2018 involving major electronic databases related to health, physical therapy,

exercises, art therapy, music, and engineering. Included databases were MEDLINE, CINAHL, PubMed, AMED, Embase, PEDro, PsycINFO, Scopus, the web of science, Cochrane central register of controlled trials, Science Direct, Wiley online library, and JOVE. Searching of the grey literature and the reference lists of relevant articles also occurred.

Search strategy

Two groups of keywords were selected. The first was dementia OR Alzheimer(s), and the second group included keywords related to music (e.g., rhythm and auditory) and exercise (e.g., movement, mobility, training). The search was limited to English language studies within the last 30 years. An example of the search strategy for MEDLINE (OVID) is in Appendix 1. The resulting citations from the search were downloaded to EndNote© (52) which was firstly used to delete duplicates.

Study identification and selection

Eligibility criteria were applied to the title and abstract of every citation followed by full-text screening for final filtering of citations.

Data collection process and data items

A data extraction sheet was developed by the authors. Data were extracted by two reviewers (YG and RG). Any disagreements between reviewers were resolved by discussion until consensus was reached. The information extracted from each study included: (i) general characteristics of the study such as the title, authors, source of publication and type of the study; (ii) participant characteristics, such as age, gender, type and severity of dementia, and co-morbidities; (iii) intervention characteristics included the type of music, criteria for selection, type and dosage of exercise, co-interventions and the duration of each session; (iv) outcome assessment included the outcome, and its type (motor or non-motor), the measurement tools and the length of follow-up period.

Methodological quality assessment

The Cochrane Collaboration tool [53] was used to assess the quality and risk of bias for the RCTs. The modified Downs and Black checklist [54] was used to assess the quality of non-RCTs. The same two reviewers (YG and RG) conducted the quality appraisal of the included studies independently.

RESULTS

Study selection

The initial search of databases yielded 3187 citations. After removing duplicates, 1824 citations remained, and the titles and abstracts were screened for eligibility. Screening resulted in the removal of 1803 articles because they did not meet the inclusion criteria. The full texts of the remaining 21 articles were screened, excluding a further nine articles. The final yield was 12 articles meeting the inclusion criteria (figure 1). Hand searching and grey literature searching did not yield any additional eligible studies.

Study characteristics

Methods and design

Of the 12 included studies, four were RCTs [55-58] and eight used other designs such as repeated measures and cross-over designs [38, 59-65]. The study duration was not mentioned in the trial by Clair and O'Konski (2006) [62]. For the other trials, the duration of the studies ranged from three weeks to six months, except for Wittwer et al. 2013 [61], which was a one-session study with a repeated measures design (table 1). Only one study reported a follow-up test after treatment [58].

Participants

The total number of participants was 595. All were over 65 years of age. The included studies involved participants of both sexes except for the study by Van de Winckel et al. (2004) [56], who only tested females. Alzheimer's disease was the most common dementia type, and all levels of severity were included (table 1). Co-morbidities were not documented, except for the study by Cheung et al. (2016) [58] for which participants with symptoms of anxiety were selected.

Intervention

Investigations were conducted in different countries. Six were from the United States of America, and the others were from Australia, Belgium, China, Japan, Taiwan, and the United Kingdom (table 1).

The criteria for choosing suitable music centered on the rhythm and tempo, as well as participant preferences. Music was instrumental or vocal. It included popular music genres like wartime music, folk music, blues, country, jazz, pop and music from the 1920s-1950s. The types of physical exercise included seated exercises, movement in standing, flexibility exercises, walking and strengthening. One study used other interventions (body awareness and functional mobility training) in addition to the music-cued exercises [64]. The frequency ranged from daily sessions to once per week, and the duration of sessions was 15-40 minutes. The music selection criteria and physical exercise components are summarized in table 2.

Outcomes

Four studies measured cognitive, behavioral and other psychological sequelae (56-58, 60). Another four assessed the level of exercise participation (38, 59, 63, 65). Three studies measured motor outcomes, including gait parameters (61, 62) and mobility skills (Southampton Assessment of Mobility) (64). One trial measured both motor (e.g., activities of daily living) and non-motor outcomes (e.g., cognition and behavior) (55). Outcomes summarized in table 3.

Risk of bias within the studies

Three RCTs showed a moderately high risk of bias [55-57] and one had a low risk of bias according to the Cochrane criteria [58] (table 4). The overall risk of bias was judged according to the relative importance of each domain. The RCTs with a high risk of bias had only one domain answered with "no," however, these domains were critical and

affected the overall risk of bias. For example, in the study by Sung et al. (2006) [57], the assessment was performed by the nursing staff who provided daily care for the participants. This prevented blinding of the outcome assessors and increased the risk of bias. For the non-RCTs, the maximum score obtained on the modified Downs and Black checklist [54] was 15/28. Studies with an overall score of less than 50% or ≤ 14 are regarded as a poor quality study [66-69]. In the current review, one study scored 15 [60] (table 5).

Key results for individual trials

Some data related to the results of individual trials were not reported. For example, the means and standard deviations were not reported in the studies by Cheung et al. 2016 [58] and Hanson et al. (1996) [65]. Therefore, a qualitative summary for each of these is presented in table 3.

Motor effects of music-cued exercise

The three studies investigating the effects of music-cued exercises on motor performance were non-RCTs [61, 62, 64] with comparatively low quality (modified Downs and Black scores ranged from 9-14). Two trials measured gait variables after performing music-cued, metronome-cued and un-cued gait training [61, 62]. The design of one depended on implementing an ambulatory program under three conditions (rhythmic music, metronome, and no auditory stimulation) interchangeably over nine sessions [62]. The other [61] tracked the changes over the very short period (one session). Both of these trials reported no significant changes associated with music-cued exercises. One study measured general mobility using the Southampton Assessment of Mobility scale [64] and showed significant improvement in mobility with music-cued exercises, despite participants having severe dementia.

Non-motor effects of music cued exercises

Four trials investigated the effect of music-cued exercise on non-motor signs [56-58, 60] and one measured various non-motor outcomes in addition to movement disorders [55]. Four were RCTs [55-58], and one was a repeated measure experimental design [60]. Three RCTs had high levels of bias, and the non-RCT had a score of 15/28 on the Downs and Black checklist, indicating fair quality [66-69]. Several studies measured cognitive and behavioral changes in response to music-cued exercises, compared to control groups [56, 57, 60] or other interventions [55, 58].

The non-motor results varied widely. For example, in the trial by Moore (2010) [60], no significant improvements in agitated behavior were seen in response to music-cued exercises. In contrast, the study by Sung et al. (2006) [57] showed large reductions in agitation with music-cued exercises, when familiar and preferred music was delivered for four weeks. In a trial by Van de Winckel et al. (2004) [56], folk songs were used with exercises (e.g., upper and lower extremity exercises, strengthening and balance) in daily sessions for three months. They showed significant improvement in cognition measured by Mini-Mental State Examination (MMSE). There was no improvement in behavior, including depression, when compared to the control group. In contrast, Cheung et al. (2016) [58] showed improvements in depression in response to movement (e.g., batting balloons and waving ribbons) with popular and religious music. The studies showed significant improvements in cognitive and behavioral functions within the music with exercise groups, yet varied in significance when compared with other groups.

Satoh et al. (2017) [55] investigated both motor and non-motor signs. It mainly measured non-motor outcomes including cognition and behavior using a wide range of neuropsychological test batteries. It also considered motor outcomes associated with the functional independence measure (FIM). This trial had the longest session duration (40 min) and the longest overall duration (six months) among the included studies. The exact music used was not reported. The trial did not involve comparison with a control group, and most of the outcomes showed non-significant differences when music-cued movements were compared to cognitive stimulation. Only visuospatial function and atrophy in the medial temporal lobes improved in the between groups comparison. Improvements in psychomotor speed, increased medial temporal lobe volumes and preserved ADL skills were observed for the group that had music-cued exercises.

Level of participation

In the four trials investigating the level of participation, there were large differences in participant characteristics, study designs and the duration of music-cued exercises. Two used similar types of music (jazz, blues, and folk) [38, 59]. One used newly composed rhythmic music [63], and one did not mention the type of music delivered [65]. Participation levels increased in two trials [38, 59]. Clair et al. (2005) [63] did not detect improvements in participation levels across the three music activity conditions (music with movement, the rhythmic playing of music or singing). The study by Clair et al. (2005) [63] had short session duration of 15 minutes, and the frequency was once per week.

Hanson et al. (1996) [65] investigated exercise type and difficulty, and the stage of cognitive functioning on the quality of participation, generating a wide range of results. Participation levels were assigned to six categories, from most to least purposeful. The most purposeful participation occurred during music-cued movements, mainly for high demand tasks. The high demand tasks required more expressive or receptive verbal skills, included more active involvement and were more complex than those activities classified as low demand.

DISCUSSION

This systematic review and critical analysis of the literature showed a small amount of emerging evidence for the beneficial effects of music-cued exercises on the motor and non-motor disorders in people living with dementia. A key finding was that the dosage of exercise and the design of therapy programs are important determinants of the success of music-cued exercises for people with differ-

ent forms of dementia. Long duration and frequent music-cued exercise sessions appear to be most helpful and appear to enable some people with dementia to respond better to music-cued exercises [29, 70].

Most studies selected music with a clear rhythm that was matched to exercise tempo. For example, the trial by Mathews et al. (2001) [38] used original, instrumental music pieces with strong rhythmic beats for each different exercise to improve physical activity and participation. Other studies used music that met the needs and preferences of participants.

The severity of dementia did not always determine the success of the intervention. Some studies which included participants with mild to moderate dementia showed promising results [58] and others did not [63]. Contrary to expectations, some of the studies with severely affected participants resulted in beneficial effects. For example, the study by Pomeroy (1993) [64] showed significant improvements in motor performance despite severe and advanced dementia. That study was of 12 weeks duration with three classes per week, which was comparatively frequent. The inclusion of body awareness training and functional mobility training in addition to music-cued exercise could have enhanced the results. The positive findings were not solely attributed to exercising with music.

Motor performance was examined in a limited number of studies [61, 62, 64]. Two of these showed no positive results, highlighting the need for more studies investigating the effect of music and movement on mobility. Several non-motor outcomes responded well to music-cued exercises [55, 56, 58]. Significant improvements were found for some cognitive and behavioral functions (e.g., memory and depression) with music-cued exercises [56, 58]. The effects of music-cued exercises on agitation were, however, inconsistent. Sung et al. (2006) [57] showed a reduction in agitation, whereas the study by Moore (2010) [60] reported no change. Both studies used the Cohen Mansfield Agitation Inventory as an outcome measure, but the intervention dosage was slightly higher, and the study design was stronger in the RCT by Sung et al. (2006) [57]. Severe cognitive impairment can sometimes compromise the ability of people living with dementia to fully respond to music-cued exercises. Two studies assessed global cognitive functions using the MMSE (56, 58) and both showed significant improvement in the music-cued exercise group.

Regarding the level of participation, two investigations showed significant improvements [38, 59]. Hanson et al. 1996 [65] highlighted the need to consider the effects of cognitive impairment on the outcome when designing movement to music classes. The study by Clair et al. (2005) [63] showed no change in participation. This might have been associated with the relatively short duration of sessions (5 minutes for exercises to music and 10 minutes for singing and instrument playing).

Some included studies reported the benefits of incorporating visual cues, such as mimicking the therapist's movements, to enhance motor performance during music-cued exercise classes [56, 65]. Whereas verbal cues require considerable language and cognitive skills which can be impaired in dementia [56, 65], the use of visual cues appears to facilitate the automatic performance of well-learned motor skills [71, 72].

This systematic review had some limitations. More than half of the studies did not use a control group. Those that did showed significant beneficial effects of music-cued exercises [56, 57, 59, 60, 64]. However, the comparatively small number of participants and the low quality and high risk of bias in many of the studies restrict the generalizability of the results to the population of people with dementia as a whole. The eligibility criteria were broad and included studies of different designs and outcomes. Moreover, our review included only articles published in English. It is possible that people with dementia from other cultures might respond differently to musical cues and exercise classes. The absence of effect size measures and lack of homogeneity of trial design precluded meta-analysis in this systematic review.

Conclusion

The results of this systematic review show a growing body of evidence that music-cued exercises may improve some motor and non-motor impairments associated with dementia, including mobility, cognition, and level of participation. The most effective music appeared to have a clear rhythmical beat to which exercises could be synchronized. Music that people enjoyed was also important to overcome the lack of motivation and increase levels of participation. Increasing the frequency and duration of sessions was associated with better outcomes. Further high-quality studies are needed with large sample sizes, control groups, long duration, follow-up measures as well as evidence-based reliable and relevant outcome measurement tools, to corroborate these findings.

Conflicts of Interest

The authors report no conflicts of interest.

Table 1 - Characteristics of the included studies

Study	Country	Type of study	Duration of study (weeks)	Age (mean/ range)	Sex	Sample size	Group numbers	Dementia severity
Cheung et al. 2016	China	RCT	6 intervention 6 follow-up	82	M 40 F 125	165	MM 58 ML 54 SA 53	Moderate dementia (GDS stage 5 or 6)
Clair et al. 2005	USA	RMS	8	NR	M 7 F 38	45	One group	Mid-stage dementia
Clair & O'Konski 2006	USA	RMS	9 sessions, twice/week	70-92	M 4 F 24	28	One group	Late stage dementia
Hanson et al. 1996	USA	RMS	12	82	M 10 F 41	51	One group	All stages included
Johnson et al. 2012	USA	COD	6	82	M 4 F 8	12	IG: NR CG: NR	NR
Mathews et al. 2001	USA	RED	25	85	M 1 F 17	18	One group	MMSE Mean 11
Moore 2010	USA	RMS	3	86	M 18 F 66	84	IG 43 CG 41	Early to late stage dementia
Pomeroy 1993	UK	RCOD	12	65-91	NR	16	IC 8 CG 8	Severe dementia
Satoh et al 2017	Japan	RCT	24	87	M 4 F 81	85	ExM 43 CS 42	MMSE 16-26
Sung et al. 2006	Taiwan	RCT	4	IG 77 CG 78	IG: M 11, F 7 CG: M 15, F 3	36	IG 18 CG 18	Moderate to severe dementia
Van de Winckel et al. 2004	Belgium	RCT	12	IG 81 CG 82	F only	25	IG 15 CG 10	MMSE < 24/30
Wittwer et al. 2013	Australia	RMS	1	80	M 16 F 14	30	One group	Revised Addenbrooke's Cognitive Examination range, 26-79

RCT: Randomized controlled Trial. RMS: Repeated Measures Study. COD: Cross-Over Design. RED: Reversal Experimental Design. RCOD: Repeated Cross-Over Design. M: Male. F: Female. MM: Music with movement. ML: Music listening. SA: Social activity. NR: Not reported. IG: Intervention group. CG: Control group. MMSE: Mini mental state examination. ExM: Physical exercise with music. CS: Cognitive stimulation. GDS: Global Deterioration Scale. RCT: Randomized Controlled Trial. RMS: Repeated Measures Study. RED: Reversal Experimental Design. COD: Cross-Over Design. RCOD: Randomized Cross-Over Design.

Table 2 - Intervention characteristics

Study	Type of music	Music selection criteria	Type of exercise	Exercise design	Co-interventions	Number & duration of sessions
Cheung et al. 2016	Popular music from earlier in life.	Participant selected.	Movement to music using props such as balloons, ribbons, balls. Rhythmical tapping of the feet and mirroring movements shown by the teacher.	Introductory 5 min song, 20 min music-cued movements and 5 min song to end the session.	None	12 sessions (twice/week, 30 min.
Clair et al. 2005	Individually composed piano music.	Movements are rhythmic to music cues.	Activities to improve range of movement, movement quality and rhythm such as tapping the feet to music, moving upper and lower limb joints and rowing actions.	5 min moving in time to rhythmical movement, using instruments. 5 min music-cued flexibility and motor actions. 5 min songs.	None	8 sessions (once/ week), 15 min.
Clair & O'Konski 2006	Music with strong regular rhythm.	Participant preference. Music cues matched to participant gait.	Gait rehabilitation.	Locomotion in time to rhythmical music, beats from metronomes, or no music. Each participant performed every condition.	None	9 sessions (twice/week, duration NR.

Study	Type of music	Music selection criteria	Type of exercise	Exercise design	Co-interventions	Number & duration of sessions
Hanson et al. 1996	NR	NR	Three therapies (movement, rhythm & singing) with two levels of difficulty. Music-cued movements, in sitting, using arms, legs and trunk.	5 min introduction, 20 min therapy and 5 min cool down. 12 interventions with 24 music therapy elements. Elements adapted at regular intervals.	None	24 sessions (twice/week, 30 min.
Johnson et al. 2012	Age appropriate music, such as jazz, blues and folk style.	Music varies from moderate to fast, with a strong beat.	Movement to music in sitting. Mainly arm and leg movements.	20 min music session with rests between songs.	None	6 sessions (once/week), 30 min.
Mathews et al. 2001	Pre-recorded country, western, polka, folk, jazz and blues.	Strong, audible and rhythmic beat matched to movement speed. Different music for each exercise.	14 exercises in sitting, mainly for strength and flexibility.	First 4 sessions: exercises with no music. Next 10 sessions: exercises to music. Next 3: exercises with no music. Lastly 6: exercises to music.	None	25 sessions (once/week), 22 min.
Moore 2010	12 musical pieces from the 1920's and 1950's.	Familiar music.	Exercises in sitting designed to match musical selections. Upper and lower limb actions and trunk movements in time to music, sometimes with balls.	NR	None	6 sessions (twice/week, 25 min.
Pomeroy 1993	NR	NR	Body movements and actions match rhythmical musical selections. Some activities in sitting and others standing with help if required.	NR	Body awareness training. Individual focus on daily motor tasks.	36 sessions (thrice/week, 30 min.
Satoh et al 2017	NR	NR	Activities in sitting. Arms, legs, hands with rhythmical actions such as clapping. Singing.	NR	None	24 sessions (once/week), 40 min.
Sung et al. 2006	Familiar music selected by participants.	"Pleasant moderate" rhythm and tempo.	Moving in time to the music within individual capabilities.	NR	None	8 sessions (twice/week, 30 min.
Van de Winckel et al. 2004	Folklore and accordion songs.	Music matched to age.	Strength training for upper and lower limbs. Core, postural stability and flexibility exercises.	NR	None	Daily sessions, 30 min.
Wittwer et al. 2013	Music selected by participant.	Classical music with a strong, regular beat matching cadence to walking tempo.	Gait trials in laboratory setting.	4 ambulation sequences with music cue (matched to cadence). 4 with metronome cues (matched to cadence). 4 un-cued gait trials.	None	Individual session.

Table 3 - Summary of outcome measures and results

Study	Outcome Type	Outcomes measured	Measurement tools	Results							Conclusions
				MM		ML		SA		Among groups	
				Post	F/U	post	F/U	post	F/U		
Cheung et al. 2016	Non-motor	Global cognitive function Anxiety Short-term memory Verbal fluency Depression Attention	MMSE	✓	-	✓	-	-	-	-	▪ No difference between groups. ▪ Improvement in memory, global cognition and anxiety in music to movement group. ▪ Decline in effects at follow-up. ▪ MM sometimes improved cognition in dementia.
			FOME total storage	✓	✓	-	✓	-	-	-	
			FOME delayed memory	✓	✓	✓	-	-	-	-	
			DST forward	-	-	-	-	-	-	-	
			DST backward	-	-	-	-	-	-	-	
			MVFT	✓	-	-	-	-	-	-	
			RAID	✓	✓	✓	✓	-	✓	-	
			GDS	✓	✓	-	-	-	-	-	
				Rhythmic playing of music		Movement with music		Singing		mong activities	
Clair et al. 2005	Non-motor	Level of participation	4-point participation scale	-		-		-		-	▪ Overall status unchanged. ▪ Little change in participation for the three music activities.

Study	Outcome Type	Outcomes measured	Measurement tools	Results				Conclusions
				No stimulus	Music	Metronome	Among conditions	
Clair & O'Konski 2006	Motor	Gait	Cadence Speed Stride length	NR NR NR	NR NR NR	NR NR NR	- - -	▪ No differences between interventions. ▪ Participants needed less assistance during Rhythmic Auditory Stimulation.
				Task demand	Movement vs singing	Movement vs. rhythm	Among activities	
Hanson et al. 1996	Non-motor	Quality of participation	Six categories of response: (a) High response on-task (b) Low response on-task (c) Passive response (d) Passive disruption off-task (e) Active disruption off-task (f) Out of room	Low demand task High demand task	HC: - MC: - LC: - HC: ✓ MC: ✓ LC: ✓	HC: - MC: - LC: - HC: MC: - LC: -	- - - - ✓ -	▪ Purposeful participation occurred during music-cued movements. ▪ Rhythm and singing had less purposeful participation especially for high demand tasks.
				Intervention	Control	Between conditions		
Johnson et al. 2012	Non-motor	Level of participation	Session times were segmented to intervals of 30 seconds. Scored 1 for correct exercise participation. Scored zero for no participation.	NR	NR	✓		▪ Participation was greater during exercise to music.
				Intervention	Control	Between conditions		
Mathews et al. 2001	Non-motor	Percentage exercise engagement	Participants monitored for periods of 30 seconds regarding exercise engagement; then scored a plus or minus for each observation.	NR	NR	✓		▪ Engagement improved during music-cued exercises.
				Intervention	Control	Between conditions		
Moore 2010	Non-motor	Apathy Agitation Eating ability Dietary intake	FrSBe Modified CMAI FIM (eating) Food and fluids/meal (%)	NR NR NR NR	NR NR NR NR	✓ - - ✓		▪ Movement to music improved apathy and food eaten. Agitation unchanged. ▪ Movement to music had benefits.
				Intervention	Control	Between conditions		
Pomeroy 1993	Motor	Mobility skills	Southampton Assessment of Mobility scale	NR	NR	✓		▪ Gains in mobility in response to therapy.
				Intervention	Control group	Between groups		
Sung et al. 2006	Non-motor	Agitation	Modified CMA	NR	NR	✓		▪ Agitated behaviour reduced in therapy group.

Study	Outcome Type	Outcomes measured	Measurement tools	Results			Conclusions
				ExM	CS	Between Groups	
Satoh et al 2017	Motor and non-motor	Activities of daily living Cognition Behaviour Medial temporal lobe atrophy	MMSE	-	-	-	▪ Movement to music and cognitive stimulation associated with improved visuo-spatial function. ▪ Psychomotor speed increased in music with exercise group. ▪ Memory enhanced for cognitive stimulation group. ▪ Activities of daily living maintained for exercise with music group but declined in cognitive stimulation group. ▪ Atrophy of medial temporal lobes progressed in cognitive stimulation group.
			RCPM score	-	-	-	
			RCPM time	✓	-	-	
			LM-I	-	✓	-	
			LM-II	-	-	-	
			Cube	✓	✓	✓	
			WF (animal)	-	-	-	
			WF (letter)	-	-	-	
			TMT-A	✓	-	-	
			FIM (total)	-	×	-	
			FIM (motor)	-	-	-	
			FIM (cognition)	-	×	-	
			Behave-AD	-	-	-	
			VSRAD	-	-	✓	
				Intervention	Control	Between groups	
Van de Winckel et al. 2004	Non-motor	Cognition and Behaviour	MMSE	✓	-	NR	▪ Cognitive impairment improved more in experimental group. ▪ Improvement in category fluency. ▪ No change on the BOP behaviour scale.
			ADS6:				
			Picture recognition	-	-	NR	
			Orientation in time/space	-	-	NR	
			Drawing alternating sequence	-	-	NR	
			Category fluency	✓	-	NR	
			Copying figures	-	-	NR	
			Free recall	-	-	NR	
			BOP scale:				
			Need for help	-	✓	NR	
			Aggression	-	-	NR	
			Physical dysfunction	-	-	NR	
			Depressed behaviour	-	-	NR	
			Mental invalidity	-	-	NR	
			Inactivity	-	-	NR	
				Between conditions (uncued-music-metronome)			
Wittwer et al. 2013	Motor	Gait (GAITRite)	Velocity	×			▪ Rhythmic auditory cueing at comfortable speed did not improve walking. ▪ Deterioration in walking in dual task conditions was associated with impaired executive function.
			Stride length	×			
			Swing time	-			
			Stride time	-			
			Stride width	-			
			Double support %	-			
			Cadence	-			
			Stride length variability %	-			
			Stride time variability %	-			
			Swing time variability %	-			

(✓): Improvement. (-): No effect. (×): Worse. MMSE: Mini Mental State Examination. FOME: Fuld Object Memory Evaluation. DST: Digit Span Test. MVFT: Modified Fuld Verbal Fluency Test. RAID: Rating Anxiety in Dementia. GDS: Geriatric Depression Scale. F/U: Follow-Up. HC: high cognition. MC: medium cognition. LC: low cognition. NR: Not Reported. FrSBe: Modified apathy subscale of the Frontal Systems Behaviour Scale. CMAI: Cohen-Mansfield Agitation Inventory. FIM: Functional Independence Measure. ExM: Physical exercise with music. CS: Cognitive stimulation. RCPM: Japanese Raven's Colored Progressive Matrices. LM: logical memory. WF: word fluency. TMT: Trail-Making Test. AD: Alzheimer's disease. VSRAD: Voxel-based specific regional analysis system for Alzheimer's disease. ADS-6: Amsterdam Dementia Screening Test 6. BOP: Beoordelingsschaal voor Oudere PatieÈnten/Evaluation Scale for Elderly Patients.

Table 4 - Cochrane risk of bias tool results

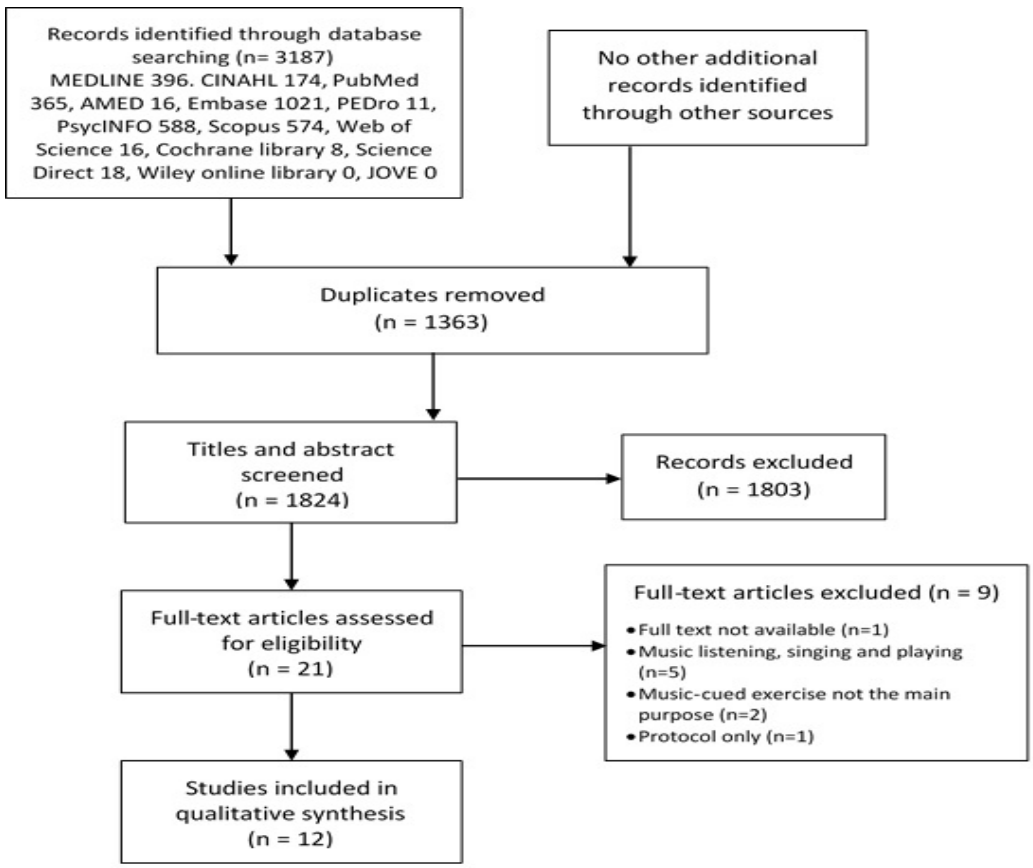
Study	Sequence generation	Allocation concealment	Blinding of participants and personnel	Blinding of outcome assessors	Incomplete outcome data	Selective outcome reporting	Other sources of bias	Quality
Cheung et al. 2016	Yes	Unclear	Unclear	Yes	Yes	Yes	Yes	Low Risk of Bias
Satoh et al. 2017	No	Unclear	Unclear	No	No	Yes	No	High Risk of Bias
Sung et al. 2006	Yes	Yes	Unclear	No	Yes	Yes	Unclear	High Risk of Bias
Van de Winckel et al. 2004	Yes	Unclear	Unclear	No	Yes	Yes	Unclear	High Risk of Bias

Table 5 - Downs and Black checklist scores for non-RCTs studies.

Study	Reporting										External validity			Internal validity-bias							Internal validity - confounding (selection bias)						Power	Total
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	
Clair et al. 2005	Yes	Yes	No	Yes	No	No	No	No	No	Yes	Yes	UTD	Yes	No	UTD	UTD	UTD	No	UTD	No	No	UTD	UTD	No	No	UTD	UTD	6
Clair & O'Konski 2006	Yes	Yes	Yes	Yes	No	Yes	Yes	No	No	Yes	Yes	UTD	No	No	UTD	UTD	UTD	Yes	UTD	No	UTD	UTD	No	No	No	UTD	UTD	9
Hanson et al. 1996	Yes	Yes	No	Yes	Yes	Yes	No	No	Yes	Yes	Yes	UTD	UTD	N	Yes	UTD	UTD	Yes	Yes	UTD	No	UTD	UTD	No	Yes	UTD	UTD	13
Johnson et al. 2012	Yes	Yes	No	Yes	No	Yes	No	No	No	Yes	Yes	UTD	Yes	UTD	Yes	UTD	UTD	Yes	UTD	UTD	Yes	UTD	Yes	No	No	UTD	UTD	11
Mathews et al. 2001	No	Yes	No	Yes	No	No	No	No	No	Yes	No	UTD	Yes	No	No	Yes	UTD	No	No	No	Yes	UTD	UTD	No	No	Yes	UTD	7
Moore 2010	Yes	Yes	Yes	Yes	No	Yes	Yes	No	No	Yes	Yes	UTD	Yes	UTD	Yes	UTD	UTD	Yes	No	Yes	No	UTD	Yes	UTD	Yes	UTD	Yes	15
Pomeroy 1993	Yes	Yes	Yes	Yes	No	Yes	No	No	No	Yes	UTD	UTD	UTD	UTD	Yes	UTD	UTD	Yes	No	Yes	UTD	UTD	Yes	UTD	Yes	UTD	UTD	11
Wittwer et al. 2013	Yes	Yes	Yes	Yes	P	Yes	Yes	No	No	Yes	UTD	Yes	UTD	No	UTD	UTD	UTD	Yes	Yes	Yes	UTD	UTD	UTD	No	Yes	UTD	Yes	14

UTD: Unable to determine. P: Partial.

Figure 1 - PRISMA flow diagram showing the flow of information for the review



REFERENCES

[1] Satizabal CL, Beiser AS, Chouraki V, Chêne G, Dufouil C, Seshadri S. Incidence of dementia over three decades in the Framingham heart study. N Engl J Med. 2016; 374(6):523-32.

[2] Alzheimer's Association. Alzheimer's disease facts and figures. Alzheimer's & Dementia. 2017; 13(4):325-73.

[3] Perini G, Carlini A, Pomati S, Alberoni M, Mariani C, Nemni R, et al. Misidentification delusions: Prevalence in different types of dementia and validation of a structured questionnaire. Alzheimer Dis Assoc Disord. 2016; 30(4):331-7.

[4] Prince M, Bryce R, Albanese E, Wimo A, Ribeiro W, Ferri CP. The global prevalence of dementia: A systematic review and metaanalysis. Alzheimers Dement. 2013; 9(1):63-75.

[5] Ellis-Smith C, Evans CJ, Bone AE, Henson LA, Dzingina M, Kane PM, et al. Measures to assess commonly experienced symptoms for people with dementia in long-term care settings: a systematic review. BMC Med. 2016; 14(1):38.

[6] Balla C, Maertens de Noordhout A, Pepin JL. Motor cortex excitability changes in mild Alzheimer's disease are reversed by Donepezil. Dement Geriatr Cogn Disord. 2014; 38(3-4):264-70.

[7] Pierce AL, Kawas CH. Dementia in the oldest old: Beyond Alzheimer disease. PLoS Med. 2017; 14(3):e1002263.

[8] Livingston G, Frankish H. A global perspective on dementia care. Lancet. 2015; 386(9997):933-4.

[9] Tom SE, Hubbard RA, Crane PK, Haneuse SJ, Bowen J, McCormick WC, et al. Characterization of dementia and Alzheimer's disease in an older population: updated incidence and life expectancy with and without dementia. Am J Public Health. 2015; 105(2):408.

[10] Prince M, Guerchet M, Prina M. Policy brief for heads of government: the global impact of dementia 2013–2050. Last accessed. 2013; 15:14.

[11] Andrieu S, Coley N, Rolland Y, Cantet C, Arnaud C, Guyonnet S, et al. Assessing Alzheimer's disease patients' quality of life: Discrepancies between patient and caregiver perspectives. Alzheimers Dement. 2016; 12(4):427-37.

[12] Giebel CM, Sutcliffe C, Stolt M, Karlsson S, Renom-Guiteras A, Soto M, et al. Deterioration of basic activities of daily living and their impact on quality of life across different cognitive stages of dementia: a European study. Int Psychogeriatr. 2014; 26(8):1283-93.

[13] Smit D, de Lange J, Willemse B, Twisk J, Pot AM. Activity involvement and quality of life of people at different stages of dementia in long term care facilities. Aging & mental health. 2016; 20(1):100-9.

[14] Mitchell SL. Advanced Dementia. N Engl J Med. 2015; 372(26):2533-40.

[15] Manabe T, Mizukami K, Akatsu H, Hashizume Y, Teramoto S, Nakamura S, et al. Prognostic factors related to dementia with Lewy bodies complicated with pneumonia: An autopsy study. Intern Med. 2016; 55(19):2771-6.

[16] Wittwer JE, Andrews PT, Webster KE, Menz HB. Timing variability during gait initiation is increased in people with Alzheimer's disease compared to controls. Dement Geriatr Cogn Disord. 2008; 26(3):277-83.

[17] Wittwer JE, Webster KE, Menz HB. A longitudinal study of measures of walking in people with Alzheimer's Disease. Gait Posture. 2010; 32(1):113-7.

[18] Sepulveda-Falla D, Barrera-Ocampo A, Hagel C, Korwitz A, Vinueza-Veloz MF, Zhou KK, et al. Familial Alzheimer's disease-associated presenilin-1 alters cerebellar activity and calcium homeostasis. J Clin Invest. 2014; 124(4):1552-67.

[19] Bak TH. Why patients with dementia need a motor examination. J Neurol Neurosurg Psychiatry. 2016; 87(11):1157.

[20] Brett L, Traynor V, Stapley P. Effects of physical exercise on health and well-being of individuals living with a dementia in nursing homes: A systematic review. J Am Med Dir Assoc. 2016; 17(2):104-16.

[21] Burton E, Cavalheri V, Adams R, Browne CO, Bovery-Spencer P, Fenton AM, et al. Effectiveness of exercise programs to reduce falls in older people with dementia living in the community: a systematic review and meta-analysis. Clin Interv Aging. 2015; 10:421-432.

[22] de Souto Barreto P, Denormandie P, Lepage B, Armaingaud D, Rapp T, Chauvin P, et al. Effects of a long-term exercise programme on functional ability in people with dementia living in nursing homes: Research protocol of the LEDEN study, a cluster randomised controlled trial. Contemp Clin Trials. 2016; 47:289-95.

[23] Toots A, Littbrand H, Lindelöf N, Wiklund R, Holmberg H, Nordström P, et al. Effects of a high-intensity functional exercise program on dependence in activities of daily living and balance in older adults with dementia. J Am Geriatr Soc. 2016; 64(1):55-64.

[24] Dawson N, Judge KS, Gerhart H. Improved functional performance in individuals with dementia after a moderate-intensity home-based exercise program: A randomized controlled trial. J Geriatr Phys Ther. 2017.

[25] Hsu TJ, Tsai HT, Hwang AC, Chen LY, Chen LK. Predictors of non-pharmacological intervention effect on cognitive function and behavioral and psychological symptoms of older people with dementia. Geriatr Gerontol Int. 2017; 17(S1):28-35.

[26] Abraha I, Rimland JM, Trotta FM, Dell'Aquila G, Cruz-Jentoft A, Petrovic M, et al. Systematic review of systematic reviews of non-pharmacological interventions to treat behavioural disturbances in older patients with dementia. The SENATOR-OnTop series. BMJ Open. 2017; 7(3):e012759.

[27] Barreto PD, Demougeot L, Pillard F, Lapeyre-Mestre M, Rolland Y. Exercise training for managing

behavioral and psychological symptoms in people with dementia: A systematic review and meta-analysis. Ageing Res Rev. 2015; 24:274-85.
[28] de Souto Barreto P, Demougeot L, Pillard F, Lapeyre-Mestre M, Rolland Y. Exercise training for managing behavioral and psychological symptoms in people with dementia: A systematic review and meta-analysis. Ageing Res Rev. 2015; 24, Part B:274-85.
[29] Hötting K, Röder B. Beneficial effects of physical exercise on neuroplasticity and cognition. Neurosci Biobehav Rev. 2013; 37(9):2243-57.
[30] Chau SA, Chung J, Herrmann N, Eizenman M, Lanctôt KL. Apathy and attentional biases in Alzheimer's disease. J Alzheimers Dis. 2016; 51(3):837.
[31] Grossi D, Santangelo G, Barbarulo AM, Vitale C, Castaldo G, Proto MG, et al. Apathy and related executive syndromes in dementia associated with Parkinson's disease and in Alzheimer's disease. Behav Neurol. 2013; 27(4):515-22.
[32] Särkämö T, Altenmüller E, Rodríguez-Fornells A, Peretz I. Editorial: music, brain, and rehabilitation: Emerging therapeutic applications and potential neural mechanisms. Front Hum Neurosci. 2016; 10.
[33] Lai CK, Lai DL, Ho JS, Wong KK, Cheung DS. Interdisciplinary collaboration in the use of a music-with-movement intervention to promote the wellbeing of people with dementia and their families: Development of an evidence-based intervention protocol. Nurs Health Sci. 2015; 18:79-84.
[34] Clark CN, Warren JD. Music, memory and mechanisms in Alzheimer's disease. Brain. 2015; 138(8):2122-5.
[35] Ueda T, Suzukamo Y, Sato M, Izumi S-I. Effects of music therapy on behavioral and psychological symptoms of dementia: A systematic review and meta-analysis. Ageing Res Rev. 2013; 12(2):628-41.
[36] Gomez G, Alonzi D, Bellantoni M, Clute K, Gomez G, Kvedar T, et al. Individualized music intervention as a non-pharmacological approach to reduce falls risk, agitation, and psychotropic drug use in persons with severe dementia. J Am Med Dir Assoc. 2017; 18(3):B23.
[37] Solé C, Mercadal-Brotons M, Galati A, De Castro M. Effects of group music therapy on quality of life, affect, and participation in people with varying levels of dementia. Journal of music therapy. 2014; 51(1):103-25.
[38] Mathews RM, Clair AA, Kosloski K. Keeping the beat: Use of rhythmic music during exercise activities for the elderly with dementia. Am J Alzheimers Dis Other Demen. 2001; 16(6):377-80.
[39] Galińska E. Music therapy in neurological rehabilitation settings. Psychiatr Pol. 2015; 49(4):835-46.
[40] Shanahan J, Morris ME, Bhriain ON, Volpe D, Richardson M, Clifford AM. Is Irish set dancing feasible for people with Parkinson's disease in Ireland? Complement Ther Clin Pract. 2015; 21(1):47-51.
[41] Baird A, Umbach H, Thompson WF. A nonmusician with severe Alzheimer's dementia learns a new song. Neurocase. 2017; 23(1):36-40.
[42] Jacobsen J-H, Stelzer J, Fritz TH, Chételat G, La Joie R, Turner R. Why musical memory can be preserved in advanced Alzheimer's disease. Brain. 2015; 138(8):2438-50.
[43] Stoodley CJ, Schmahmann JD. Functional topography in the human cerebellum: a meta-analysis of neuroimaging studies. Neuroimage. 2009; 44(2):489-501.
[44] Alluri V, Toiviainen P, Jääskeläinen IP, Glerean E, Sams M, Brattico E. Large-scale brain networks emerge from dynamic processing of musical timbre, key and rhythm. Neuroimage. 2012; 59(4):3677-89.
[45] Peretz I, Zatorre RJ. Brain organization for music processing. Annu Rev Psychol. 2005; 56:89-114.
[46] Schaefer RS, Morcom AM, Roberts N, Overy K. Moving to Music: Effects of Heard and Imagined Musical Cues on Movement-Related Brain Activity. Front Hum Neurosci. 2014; 8:774.
[47] Moussard A, Bigand E, Belleville S, Peretz I. Music as a Mnemonic to Learn Gesture Sequences in Normal Aging and Alzheimer's Disease. Front Hum Neurosci. 2014; 8(294).
[48] Thaut MH. Rhythm, music, and the brain: Scientific foundations and clinical applications. Routledge; 2005.
[49] Thaut MH, McIntosh GC, Hoemberg V. Neurobiological foundations of neurologic music therapy: rhythmic entrainment and the motor system. Front Psychol. 2015; 5(1185).
[50] Gomaa YS, Sawan SA, Wittwer JE, Morris ME. Music cued exercises for motor and non-motor signs in people with dementia: Protocol for a systematic review. Int J Physiother. 2017; 4(1):55-62.
[51] Moher D, Liberati A, Tetzlaff J, Altman DG, Group P. Preferred reporting items for systematic reviews and meta-analyses: the PRISMA statement. PLoS Med. 2009; 6(7):e1000097.
[52] Reuters T. EndNote X7. Thomson Reuters: Philadelphia, PA, USA. 2013.
[53] Higgins JP, Green S. Cochrane Handbook for Systematic Reviews of Interventions Version 5.1.0. John Wiley & Sons; 2011.
[54] Downs SH, Black N. The feasibility of creating a checklist for the assessment of the methodological quality both of randomised and non-randomised studies of health care interventions. J Epidemiol Community Health. 1998; 52(6):377-84.
[55] Satoh M, Ogawa J-i, Tokita T, Nakaguchi N, Nakao K, Kida H, et al. Physical exercise with music maintains activities of daily living in patients with dementia: Mihama-Kiho project part 21. J Alzheimers Dis. 2017; (Preprint):1-11.
[56] Van de Winckel A, Fey H, De Weerdt W, Dom R. Cognitive and behavioural effects of music-based exercises in patients with dementia. Clin Rehabil.

2004; 18(3):253-60.
[57] Sung H, Chang S, Lee W, Lee M. The effects of group music with movement intervention on agitated behaviours of institutionalized elders with dementia in Taiwan. Complement Ther Med. 2006; 14(2):113-9.
[58] Cheung DS, Lai CK, Wong FK, Leung MC. The effects of the music-with-movement intervention on the cognitive functions of people with moderate dementia: a randomized controlled trial. Aging Ment Health. 2016:1-10.
[59] Johnson L, Deatrick EJ, Oriel K. The use of music to improve exercise participation in people with dementia: A pilot study. Phys Occup Ther Geriatr. 2012; 30(2):102-8.
[60] Moore J. Familiar physical activity to familiar music: The effects on apathy, agitation, eating ability, and dietary intake in institutionalized older adults with dementia. ProQuest Dissertations Publishing: University of Massachusetts Amherst; 2010.
[61] Wittwer JE, Webster KE, Hill K. Effect of rhythmic auditory cueing on gait in people with alzheimer disease. Arch Phys Med Rehabil. 2013; 94(4):718-24.
[62] Clair AA, O'Konski M. The effect of rhythmic auditory stimulation (RAS) on gait characteristics of cadence, velocity, and stride length in persons with late stage dementia. J Music Ther. 2006; 43(2):154-63.
[63] Clair AA, Mathews R, Kosloski K. Assessment of active music participation as an indication of subsequent music making engagement for persons with midstage dementia. Am J Alzheimers Dis Other Demen. 2005; 20(1):37-40.
[64] Pomeroy VM. The effect of physiotherapy input on mobility skills of elderly people with severe dementing illness. Clin Rehabil. 1993; 7(2):163-70.
[65] Hanson N, Gfeller K, Woodworth G, Swanson EA, Garand L. A comparison of the effectiveness of differing types and difficulty of music activities in programming for older adults with Alzheimer's disease and related disorders. J Music Ther. 1996; 33(2):93-123.
[66] Hooper P, Jutai JW, Strong G, Russell-Minda E. Age-related macular degeneration and low-vision rehabilitation: a systematic review. Can J Ophthalmol. 2008; 43(2):180-7.
[67] Mani R, Milosavljevic S, Sullivan SJ. The effect of occupational whole-body vibration on standing balance: A systematic review. Int J Ind Ergon. 2010; 40(6):698-709.
[68] Mesbah N, Perry M, Hill KD, Kaur M, Hale L. Postural stability in older adults with Alzheimer disease. Phys Ther. 2017; 97(3):290-309.
[69] Silverman SR, Schertz LA, Yuen HK, Lowman JD, Bickel CS. Systematic review of the methodological quality and outcome measures utilized in exercise interventions for adults with spinal cord injury. Spinal Cord. 2012; 50(10):718-27.
[70] Budde H, Wegner M, Soya H, Voelcker-Rehage C, McMorris T. Neuroscience of exercise: Neuroplasticity and its behavioral consequences. Neural Plast. 2016; 2016.
[71] Ghilardi M-F, Alberoni M, Rossi M, Franceschi M, Mariani C, Fazio F. Visual feedback has differential effects on reaching movements in Parkinson's and Alzheimer's disease. Brain Res. 2000; 876(1–2):112-23.
[72] Morris ME, Menz HB, McGinley JL, Watts JJ, Huxham FE, Murphy AT, et al. A randomized controlled trial to reduce falls in people with Parkinson's disease. Neurorehabil Neural Repair. 2015; 29(8):777-85.

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Appendix 1. Searching strategy: MEDLINE (OVID)

1. exp Dementia/ or exp Alzheimer Disease/
2. limit 1 to english language
3. (Alzheimer* or Dementia).mp. [mp=title, abstract, original title, name of substance word, subject heading word, keyword heading word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms]
4. limit 3 to english language
5. 2 or 4
6. (music* or auditory or rhythm* or acoustic).mp. [mp=title, abstract, original title, name of substance word, subject heading word, keyword heading word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms]
7. limit 6 to english language
8. (exercise* or cue* or training or move* or mobility).mp. [mp=title, abstract, original title, name of substance word, subject heading word, keyword heading word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms]
9. limit 8 to english language
10. 6 and 8
11. 5 and 10