PRINCIPLES AND PRACTICE OF CLINICAL RESEARCH
A Global Journal of Clinical Research

Effects of Music Therapy on Cognitive Function in Elderly Patients with Mild Cognitive Impairment and Early Dementia: A Systematic Review

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Abstract

Background: *Cognitive decline in the elderly significantly impacts the quality of life of patients and caregivers. Safer non-pharmacological interventions that stimulate natural healing have gained popularity recently. This systematic review evaluates the impact of music therapy (MT) in improving cognition and neuropsychiatric symptoms in the elderly with mild cognitive impairment (MCI) and early dementia.*

Methods: *Studies included randomized controlled trials (RCTs) and quasi-experimental studies focusing on MT for elderly patients (age ≥65 years) with MCI or early dementia due to Alzheimer's disease (AD) or vascular dementia (VD). Studies without control groups, non-peer-reviewed, and not in English were excluded. Searches were run in PubMed, CENTRAL, Scopus, and Web of Science using key concepts of dementia, music therapy, and cognition. The Cochrane Risk of Bias Tool was used to evaluate the risk of bias in the RCTs. Interventions included any modality of MT. Outcomes evaluated cognition using valid and reliable scales.*

Results: *Fourteen studies (1,169 participants) were included. Significant post-intervention improvements were noted in cognitive measures such as the mini-mental state exam, Montreal cognitive assessment, and Digit Span scores. Active MT reduced neuropsychiatric symptoms in AD as measured by neuropsychiatric inventory scores. However, the effects varied across cognitive domains and MT modalities. The limitations of the studies included small sample sizes, short intervention and follow-up durations, and heterogeneous study designs that limited generalizability.*

Conclusion: *Music therapy showed potential as a non-pharmacological intervention to improve cognitive function and reduce neuropsychiatric symptoms in elderly patients with MCI and early dementia. Further large-scale, well-designed studies are needed.*

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Received: July 19, 2024 **Accepted:** November 19, 2024
Published: April 25, 2025

Editor: Felipe Fregni
Reviewers: Raquel Horowitz, Jorge Marquez, Adriana Carneiro, Neils Pacheco, Elsa Semedo, Joao Kasakewitch,

Introduction

Neurodegenerative diseases and cognitive impairments represent a major health concern in aging populations globally, as they are progressive and significantly impact the quality of life (QOL) of affected individuals and their families. According to the World Health Organization (WHO), dementia affects over 55 million people worldwide, with nearly 10 million new cases each year—mild cognitive impairment (MCI), Alzheimer's Dementia (AD), and Vascular Dementia (VD) being the most prevalent types of cognitive impairment (World Health Organization, 2023). The economic burden of dementia is substantial, with global costs estimated at over $1 trillion US dollars annually (World Health Organization, 2023). Over 135 million people are estimated to be diagnosed with dementia by 2050 (Alzheimer's Disease International, n.d.). While it shortens life expectancy, its greatest effect is on QOL for those with dementia and their caregivers (Prince et al., 2015).

Current pharmacological treatments for cognitive symptoms include cholinesterase inhibitors (e.g., donepezil, rivastigmine) and N-methyl-D-aspartate (NMDA) receptor antagonists (e.g., memantine) (National Institute on Aging, n.d.). Despite their widespread use, these medications often have limited efficacy, can cause adverse effects, and may be expensive and have limited availability. Therefore, there is a growing interest in non-pharmacological interventions that could be easily implemented in daily care at home, nurse centers, or hospitals.

Some authors report potential benefits of Music Therapy (MT) for improving cognitive function, psychological symptoms, and the QOL (Fusar et al., 2018; Kang et al., 2023; Lam et al., 2020; Lin et al., 2023; Sousa et al., 2020; Umbrello et al., 2019; Wolff et al., 2023). This therapy is clinical and evidence-based and uses music to address the physical, emotional, cognitive, and social needs of individuals (American Music Therapy Association, n.d.). MT can take various forms, such as active engagement (e.g., singing, playing instruments) and passive listening, and has been used in diverse settings, including hospitals, nursing homes, and rehabilitation centers, to improve patient outcomes (Bradt & Dileo, 2014).

Despite the growing scientific evidence about this therapy among this broad population, it remains unclear the effects of MT on the elderly with MCI, AD, or VD and which specific type and duration is most effective (Fusar et al., 2018; Ito et al., 2022; Lam et al., 2020; Lin et al., 2023; Moreno et al., 2020; Wolff et al., 2023). There is a need for strong evidence and clear recommendations about the usefulness of MT. This systematic review aims to describe the evidence and report the effects of different modalities of MT in improving cognitive functions in elderly individuals with MCI, early AD, and early VD.

Materials and Methods

This review was conducted and reported following the PRISMA guidelines. Screening of the articles, full-text review, and data extraction were performed through Covidence(R) software. Systematic searches were conducted using four electronic databases: PubMed, CENTRAL, Web of Science, and Scopus. A combination of MeSH Terms, keywords, and free words using Boolean operators were used to formulate the search strategy. Filters "type of study" (clinical trials, observational studies), "language" (English,) and "publication date" (last 10 years) were used. Details of the search strategy are shown in Appendix A.
This systematic review was not previously registered in PROSPERO or another registry prior to or during the study process.

Inclusion and Exclusion Criteria

This review included studies that met the following criteria:

1. Interventional and observational studies, including randomized controlled trials (RCTs), quasi-experimental intervention studies (QES), and cohort studies;
2. Participants aged $\geq$ 65 years with a diagnosis (confirmed by any validated criteria) of MCI or early AD/VD dementia;
3. Types of exposure: The intervention was music therapy. The type of MT or duration of exposure were not limited;
4. The control group was no treatment, usual health care, or other therapies;
5. The primary outcome was cognitive function measured using valid and reliable scales.

Review articles, studies with incomplete data or unavailable full-texts, and those enrolling populations with other associated neurological and psychiatric disorders, study protocols, conference papers, and abstracts were excluded.

Selection of Studies and Data Extraction

Citations of the retrieved literature were imported into Covidence software, and duplicates were

Edmundo Inga-Zapata
Keywords: Alzheimer's disease, cognitive dysfunction, vascular dementia, music listening, singing, mental status tests
DOI: https://doi.org/10.21801/ppcrj.2024.104.9

excluded. In the first review stage, the titles and abstracts were analyzed. The selected studies then underwent a full-text review in the second stage. Titles, abstracts, and full text were independently screened by two reviewers according to the eligibility criteria. Disagreements regarding inclusion were discussed among the two reviewers, or a third reviewer was consulted. The data extraction was performed using Covidence after developing data extraction and quality assessment templates to standardize the extraction. Data were extracted by two independent extractors, with the consensus performed by a third reviewer. If necessary, the authors of the included articles were accessed via email or via the ResearchGate(R) platform to request additional data. The following data were extracted from the studies selected after the full-text review:

Data synthesis

Based on the summary provided by Covidence(R), we conducted a comprehensive narrative synthesis of findings, objectively summarizing the settings, socio-economic, demographic, and clinical characteristics of the migrants sampled, along with their social and cultural determinants of health, behaviors, values, and beliefs. Additionally, we analyzed the types of digital interventions and how their use modified vaccination coverage, personal understanding, and awareness of this topic, while also identifying the facilitators and barriers involved in immigrants' vaccination.

1. Basic study information: title, first author, year of publication, country of publication, funding, conflicts of interest.
2. Study design information: randomization method, blinding strategy, allocation concealment, dealing with missing data, type of analysis, inclusion and exclusion criteria.
3. Baseline characteristics of the participants: gender, age, type of dementia, residency.
4. Intervention: type of music therapy, duration and frequency of the therapy, association with physical exercise, type of control interventions
5. Outcomes: type of primary and secondary outcomes, measurement scale, variable measured, timing of measurement, follow-up period, report of adverse effects.
6. Results: main findings, raw scores, statistical significance, missing data, limitations.

Risk of BiaS Assessment

The quality of included studies was assessed using ROBINS-I (Risk Of Bias In Non-Randomized Studies of Interventions) (Sterne et al., 2016) for non-randomized studies and the Risk of Bias 2 (RoB 2) tool (Sterne et al., 2019) for RCTs. Seven domains were evaluated in the ROBINS-I and five domains in the RoB 2 assessments. Domains included bias due to randomization, confounders, selection of patients, deviations from intended interventions, missing data, measurement of outcome, and reporting results. Each domain was classified as low, with some concerns or high risk of bias. Two authors evaluated the studies using the tools, and a consensus was achieved using a third reviewer. An overall consensus was reported as low risk, some concerns, or high risk.

Synthesis Methods

Narrative methods were used to synthesize data. The authors summarized the main data extracted from Covidence software in Excel tables. Cognitive outcomes in the global domain, including MMSE and MoCA, were included as primary outcomes. Other cognitive outcomes within specific domains were regarded as secondary outcomes. Additionally, the data on psychological aspects and physical function were retrieved. We described the characteristics of each study based on study design, type of intervention, duration of treatment, and outcomes.

Results

The proposed search strategy resulted in the identification of 676 articles, with 4 duplicated studies identified manually and 232 duplicates identified by Covidence. After screening the titles and abstracts, 108 papers remained. After reading the full texts, we excluded 94 articles for the following reasons: wrong patient population (n=45), wrong outcomes (n=15), wrong interventions (n=12), wrong setting (n=8), protocol (n=6), wrong study design (n=4), not written in English (n=2), not full text available (n=1) and wrong indication (n=1). Consequently, 14 articles met the inclusion criteria and were incorporated into this review. The selection process is detailed in the PRISMA flow diagram presented in Figure 1.

Description of the studies

A total of 14 studies were included in the final analysis, as shown in Tables 1 and 2. The majority of study designs were RCTs (a total of 10), and four were QES. The year of publication ranged from 2013 to 2023. Two of the studies were conducted in China, 2 of them in the United States, 7 in the European continent (2 in Spain, 1 in Finland, 1 in Italy, 1 in France,

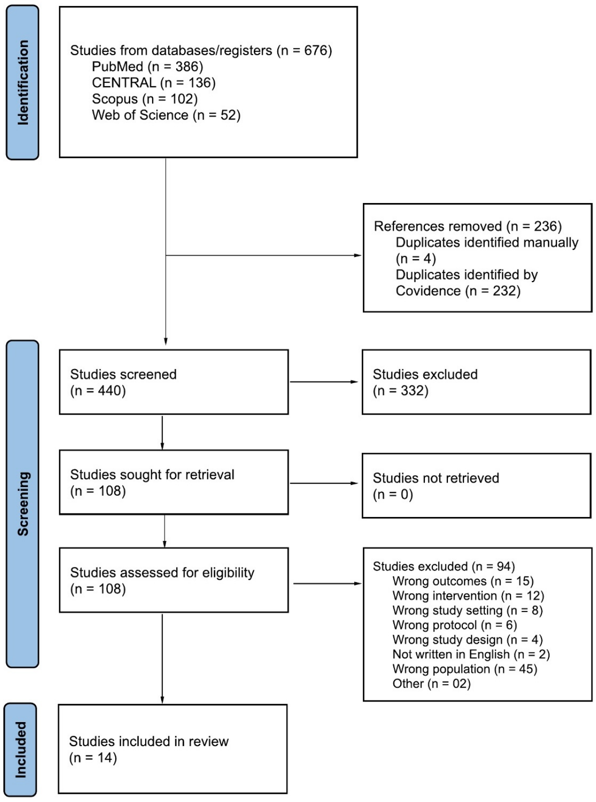

Figure 1: *PRISMA flow diagram of the study selection process.*

1 in Greece, and 1 in Portugal), 2 of them in Japan, and 1 in Brazil. As for the design, 7 of the studies were single-centered, while 7 were multicenter. From the 10 RCTs included, stratified randomization was performed in 3, simple randomization in 4, block randomization in 2 studies, and 1 RCT did not specify the randomization method.

Sample sizes ranged from 18 to 204 participants. The majority of them had small sample sizes, with 11 having less than 100 participants and five less than 50. Only 1 RCT reported the allocation concealment method using the website. Of the 14 studies, 7 were single-blinded, 2 were double-blinded, and 5 were open-labeled. Due to the intervention, blinding the patient was difficult to achieve. The outcome assessors and statisticians were the most common groups blinded. The type of analysis included intention-to-treat in 5 RCTs; 4 RCTs performed per-protocol analysis, and one did both. Ten studies were funded by sponsors, especially public entities.

Population

All participants were above 65 years of age. Socioeconomic variables such as marital status, education, and social income were not available in most included studies. The ethnicity of most patients included was also not clear; however, since the study included elderly individuals with cognitive impairment, limited assumptions can be made based on the country where the study was conducted. Recruitment was mostly from nursing homes, clinics, or hospitals, resulting in convenience sampling. Five studies recruited only patients who lived in nursing homes, four in their own home/community only, two studies recruited patients from both nursing homes and the community, and one QES had the intervention group from nursing homes and the control group from the community. Two studies did not specify residential status.

Intervention Characteristics and Control Groups

The studies used different forms of music therapy, which can be broadly categorized into active and passive modalities. Active music therapy involves patient participation through activities like singing, dancing, or playing instruments (Bisbe et al., 2020; Doi et al., 2017; Ford et al., 2019; Gómez-Gallego et al., 2021; Higuti et al., 2021; Ho et al., 2020; Lazarou et al., 2017; Pongan et al., 2017; Satoh et al., 2017; Särkämö et al., 2014; Wu-Chung et al., 2023; Xue et al., 2023). For example, studies incorporating dance movement therapy (Bisbe et al., 2020; Doi et al., 2017; Gómez-Gallego et al., 2021; Ho et al., 2020; Lazarou et al., 2017) or instrumental play (Doi et al., 2017) found improvements in both cognitive and physical health, suggesting that movement combined with music may engage multiple brain regions simultaneously. In contrast, passive music therapy, where patients listened to selected music, aimed to stimulate relaxation and emotional engagement (Barradas et al., 2021; Pecci et al., 2016). A variety of music, such as classical music, traditional songs, and familiar cultural tunes were used across studies. It is important to note that the choice of music—whether familiar or not—could significantly influence patient response, as emotionally charged or familiar music is thought to activate deeper cognitive and emotional processes. While both types of therapy were effective, the evidence suggests that active participation in music activities may produce stronger cognitive outcomes by engaging multiple sensory and motor pathways (Bisbe et al., 2020; Doi et al., 2017; Ford et al., 2019; Gómez-Gallego et al., 2021; Higuti et al., 2021; Ho et al., 2020; Lazarou et al., 2017; Pongan et al., 2017; Satoh et al., 2017; Särkämö et al., 2014; Wu-Chung et al., 2023; Xue et al., 2023). Types of music therapy interventions are presented in Table 3.

The interventions were compared with non-intervention in 3 studies (Ho et al., 2020; Lazarou et al., 2017; Xue et al., 2023). Modalities not related to music used as the control were physical therapy (Bisbe et al., 2020), exercise training (Higuti et al., 2021), and other cognitive stimulating activities, including health education (Doi et al., 2017), painting (Pongan et al., 2017), watching nature videos (Gómez-Gallego et al., 2021), cognitive stimulation (Satoh et al., 2017), and reading a book (Wu-Chung et al., 2023). Active music interventions were compared to passive music listening in 2 studies (Gómez-Gallego et al., 2021; Särkämö et al., 2014).

There were two 3-arm RCTs comparing dance therapy with exercise (Ho et al., 2020) and playing percussion instruments (Doi et al., 2017). Of the 4 QES, Pecci et al. (2016) compared listening to Mozart sonata with Beethoven's music using a cross-over design, Ford et al. (2019) did not include a control group, Barradas et al. (2021) used healthy volunteers as the control group receiving the same kind of music listening, and Gómez-Gallego et al. (2021), described previously, employed a 3-arm design. The total number of subjects in the control group was 471 cases (including 19 cases from a cross-over study). The intervention parameters including duration, frequency, and total exposure times, are detailed in Table 4.

Main Findings

MMSE Changes

Särkämö et al. (2014) investigated the effects of regular musical activities on cognitive, emotional, and social functioning in older adults with early dementia. They found that both singing and music-listening groups showed significant improvement in MMSE scores compared to the control group ($p<0.05$). Also, Doi et al. (2017) demonstrated that a music program for 40 weeks significantly improved the MMSE scale when compared to the control group ($p=0.008$), and dance had the same effect ($p=0.026$).

Higuiti et al. (2021) analyzed the MMSE and the severe Mini-Mental State Examination (sMMSE) when training with music compared with training without music in elderly with moderate to advanced dementia and did not find any significant differences between both groups compared from the baseline and between them ($p>0.05$). Lazarou et al. (2017) investigated the impact of ballroom dancing on cognitive function and found a significant improvement in MMSE from baseline to post-intervention ($p<0.01$), but the control group showed a reduction in MMSE.

Gómez-Gallego et al. (2021) investigated the effects of active music intervention (AMI) and receptive music intervention (RMI) on cognitive, behavioral, and functional outcomes in patients with AD. They found that the AMI group showed significant improvement in MMSE scores from baseline (17.79 ± 3.90) to post-intervention (19.57 ± 3.80), ($p<0.001$). The RMI group showed a slight decrease from baseline (18.28 ± 6.14) to post-intervention (17.57 ± 6.14) ($p<0.001$). The control group did not exhibit a significant change.

Montreal Cognitive Assessment Test (MoCA)

Lazarou et al. (2017) showed a significant improvement in the MoCA test from baseline to post-intervention after elderly with aMCI were treated with a ballroom dancing program ($p<0.05$). Similarly, in a RCT, Xue et al. (2023) evaluated the effects of receptive MT on cognitive functions in older adults with tMCI and depression and found that in the intervention group, there was a significant improvement from baseline (18.03 ± 2.34) to post-intervention (20.65 ± 2.41) ($p<0,001$), but not in the control group.

Digit Span Subtest of the Wechsler Adult Intelligence Scale (WAIS)

Pongan et al. (2017) found that painting and singing improve the digit span over time in patients with mild AD ($p=0.001$). Wu-Chung et al. (2023) showed that for raw digit span scores and sequencing performance, there were significant differences between music creativity participants and control participants

No	Authors	Year	Country	Study design	Sample size	Population	Intervention and Control groups
1	Barradas	2021	Portugal	Quasi-experimental	40	Elderly with AD (IG) and other causes of CI (CG) Female (%): TG - 65; CG - 75; OG - 50; All - 70. Mean age (years) ± SD: IG - 76.15 ± 6.37; CG - 71.3 ± 5.8 OG - NA; All - NI Residency: IG - nursing home; CG - own home/ community; OG - NI.	IG: Music listening in subjects with AD CG: Same, in subjects without AD
2	Bisbe	2020	Spain	Randomized controlled trial	31	Elderly with NI cause of CI Female (%): IG - 77.8%; CG - 52.9%; OG - NA; All - NI. Mean age (years) ± SD: TG - 72.88 ± 5.6; 77.29 ± 5.16; OG - NA; All - NI. Residency: NI.	IG: Choreography CG: Physical therapy
3	Doi	2017	Japan	Randomized controlled trial	201	Elderly with MCI Female (%): IG - 58.2; CG - 46.3; OG - 50.7; All - 52. Mean age (years) ± SD: IG - 76.2 ± 4.6; CG - 76 ± 4.9; OG - 75.7 ± 4.1; All - 76. Residency: own home/ community.	IG: Music (playing percussion instruments) OG: Dance CG: Health education
4	Ford	2019	United States	Quasi-experimental	35	Elderly with AD Female (%): IG - NI; CG - NI; OG - NA; All - NI. Mean age (years) ± SD: IG - NI; CG - NI; OG - NA; All - NI. Residency: nursing home.	IG: Music listening, apps engagement for memory loss CG: None
5	Gomez	2021	Spain	Quasi-experimental	90 (six nursing homes)	Elderly with AD and mild or moderate stage of the dementia Female (%): IG - 71.5%; CG -54.5%, OG - 61.9%; All - 62.6%. Mean age (years) ± SD: IG - 83.93±8.01; CG -80.02±5.78; OG -78.7±5.73; All - 80.87. Residency: nursing home	IG: Active Music Intervention (AMI) by clapping according to rhythm, dance, OG: Receptive Music Intervention (RMI) by listening CG: Watching nature videos
6	Higuti	2021	Brazil	Randomized controlled trial	18 (single center)	Elderly with AD and other causes of CI Female (%): IG - 44.4%; CG - 62.5%; OG - NA; All - NI. Mean age (years) ± SD: IG - 79.6 ± 9.3; CG - 79 ± 12.9; OG - NA; All - NI. Residency: nursing home.	IG: Exercise training with music CG: Exercise training without music
7	Ho	2020	Hong Kong	Randomized controlled trial	204	Elderly with MCI Female (%): IG - 81%; CG - 84%; OG - 81%; All - 81.9% Mean age (years) ± SD: IG - 79.4 ± 76; CG - 79.3 ± 8.1; OG - 78.3 ± 8.4; All - 79 ± 8. Residency: nursing home and own home/ community.	IG: Dance movement therapy (DMT) OG: Exercise CG: No intervention
8	Lazarou	2017	Greece	Randomized controlled trial	154	Elderly with MCI Female (%): IG- 78.3%; CG - 76.2%; OG - 80.3%; All - 78.3%. Mean age (years) ± SD: IG - 65.89 ± 10.76; 67.92 ± 9.47; OG - NA; All - NI. Residency: NI.	IG: Ballroom dancing CG: No intervention
9	Pecci	2016	Italy	Quasi-experimental	19	Elderly with MCI Female (%): IG - NI; CG - NI; OG - NA; All - NI. Mean age (years) ± SD: IG - 69 ± 3.1; CG - 68 ± 4.5; OG - NA; All - NI. Residency: NI.	IG: Mozart music session, Beethoven's music session (cross-over study) CG: NA
10	Pongan	2017	France	Randomized controlled trial	65	Elderly with AD Female (%): IG - 74.2%; CG - 57.1%; OG - NA; All - 66.1%. Mean age (years) ± SD: IG - 78.8 ± 7.43; CG - 80.2 ± 5.71; OG - NA; All - 79.5. Residency: own home/ community.	IG: Singing CG: Painting
11	Särkämö	2014	Finland	Randomized controlled trial	89	Elderly with AD and VD Female (%): IG - 59.25%; CG - 64.28%, OG - 89.65%; All - NI. Mean age (years) ± SD: IG - 78.5 ± 10.4; CG - 78.4 ± 11.6; OG - 79.4 ± 10.1; All - NI. Residency: nursing home and own home/ community.	IG: Singing CG: Listening
12	Satoh	2017	Japan	Randomized controlled trial	85	Elderly with AD and VD Female (%): IG - NI; CG - NI; OG - NA; All - NI. Mean age (years) ± SD: IG - 87 ± 5.4; CG - 87.4 ± 4.4; OG - NA; All - NI. Residency: NI.	IG: Singing; clapping to music; breath and voice training; and moving (ExM). CG: Cognitive stimulation (CS).
13	Wu-Chung	2023	United States	Randomized controlled trial	58	Elderly with MCI Female (%): IG - 12; CG - 15; OG - NA; All - NI. Mean age (years) ± SD: IG - 74.93 ± 5.56; CG - 75.03 ± 6.31; OG - NA; All - NI. Residency: NI.	IG: Workshops incorporated listening, theory, performance, and creation. CG: Reading a book
14	Xue	2023	China	Randomized controlled trial	80	Elderly with MCI Female (%): IG - 75%; CG - 80%; OG - NA; All - 77.5%. Mean age (years) ± SD: IG - 75.43 ± 4.75; 74.43 ± 4.47; OG - NA; All - NI. Residency: nursing home	IG: Receptive music therapy intervention in 3 steps: music listening. music discussion (verbal feedback) and muscle relaxation. CG: No intervention.

AD: Alzheimer Disease, AMI: Active Music Intervention, BBS: Berg balance scale, BDI- II: Beck depression inventory II, BI: Barthel index, BNT: Boston naming test, BPSD: behavioral and psychological symptoms, CG: control group; CT: clock drawing test, CI: cognitive impairment, CVF: category verbal fluency, DMT: Dance movement therapy,EMG: electromyography, EQ-5D: euroQol-5 dimension, FCRT: free and cued recall test, FIM: functional independence measure, FUCAS: functional and cognitive assessment, GDS: geriatric depression scale, HAD: hospital anxiety and depression, IG: intervention group, JLO: judgment of line orientation, LM: logical memory, LVF: letter verbal fluency, MCI: mild cognitive impairment, MMSE: mini-mental state exam, MoCA: Montreal cognitive assessment, NA: not applicable, NI: not informed, NPI: neuropsychiatric inventory, OG: other group, PAS: Pittsburgh agitation scale, PFC: paper folding and cutting test, PPS: palliative performance scale, PSS: perceived stress scale, QoL: quality of life, QUALID: quality of life in late stage dementia, RBANS: repeatable battery for the assessment of neuropsychological status, RMI: Receptive Music Intervention, SD: standard deviation, STAI: state trait anxiety inventory, TMT-A: trail making test (part A), TMT-B: trail making test (part B), TUG: time up and go, VD: Vascular Disease, VFT: verbal fluency test, WCST: Wisconsin card sorting task. WAIS: Wechsler adult intelligence scale, WMS-III: Wechsler memory scale-III.

Table 1: *Characteristics of included studies: study design and population.*

No	Authors	Year	Outcome measures	Main findings	Dropouts and Missing data
1	Barradas	2021	MMSE, GDS, EMG	Analysis of scores from MMSE revealed a significant difference in the two groups. Dementia group showed lower scores	Not reported
2	Bisbe	2020	Verbal memory (WMS-III), Visual memory (RBANS), TMT-A, TMT-B, LVF, BNT, CVF, JLO, MMSE, HAD (anxiety), HAD (depression), QoL, BBS, TUG	Choreography group resulted in significant improvement from baseline to 12 weeks in WMS-III and compared to physical therapy Both groups resulted in significant improvement from baseline to 12 weeks in RBANS	Dropout rates 5.6% in the choreography group and 22% in physical therapy group Imputation method for missing data, not specified
3	Doi	2017	MMSE, TMT-A, TMT-B	Significant improvement in memory scores in dance group patients Dance and music group showed a significant improvement in MMSE from baseline to 40 weeks	6 patients dropped out because of illnesses unrelated to intervention Expectation maximisation algorithm estimation for missing data
4	Ford	2019	QUALID, PAS, Self-reported medication us	Findings suggest that higher utilisation of PMATE over time improves residents' QOL	Residents who passed away, were discharged, or refused to participate (n=6) were excluded from the analysis Imputation method for missing data, not specified
5	Gomez	2021	MMSE, NPI, BI	AMI may improve cognition of mild to moderate AD elderly, RMI only have effect on stabilising the behaviour	Dropout rate was 0% in the control group, 0% in the MI group and 3,6% in the AMI group Missing data was not specified
6	Higuti	2021	BI, PPS, MMSE, Severe MMSE, VFT	Music did not show any significant difference on functional and cognitive aspects in elderly with moderate or advance dementia	1 dropout reported, due to death Missing data was not specified
7	Ho	2020	Depression, loneliness, positive mood, negative mood, BPSD, forward digit span, backward digit span, total retrieval span, delayed recall, verbal fluency, TMT-A, TMT-B, Instrumental ADL, cortisol	DMT significantly decreased depression, loneliness and negative mood; significantly improved the instrumental ADL compared to the control group from baseline to 3 months	Dropout rate was 10.1% in dance movement therapy, 22.4% in the exercise group and 23.5% in the control group. Full information maximum likelihood method for missing data
8	Lazarou	2017	MMSE, MoCA, GDS, FUCAS	Significant improvements in most of the investigated parameters within the IG group, whereas no improvements were found for the CG group	25 patients dropped Missing data was not specified
9	Pecci	2016	Paper folding and cutting test (PFC), clock drawing test (CT)	Mozart's music significantly improve cognitive performance PFC and CT by improving spatial and ideational-praxis abilities	Dropout rate was 10% in the control group Missing data was not specified
10	Pongan	2017	Pain, STAI, GDS, EQ-5D, FCRT, Digit Span, TMT-A, Stroop, Digit symbol, Letter fluency, Category fluency,	In the painting group, there was a significant reduction in depressive symptoms In the painting and singing groups, there was a significant reduction in anxiety and improvement in QoL (EQ-5D), Digit span and Stroop test	Dropout rates was 10.7% in painting group and 9.7% in singing group Multiple imputation method for missing data
11	Särkämö	2014	MMSE, QOL,	Regular musical leisure activities can have long-term cognitive, emotional, and social benefits in mild/moderate dementia and could therefore be utilised in dementia care and rehabilitation.	Dropout rate was 16,9%. Multiple imputation method for missing data
12	Satoh	2017	MMSE, LM-I, LM-II, Cube, Word Fluency, FIM	Significant benefits were observed in psychomotor speed or memory in the ExM or CS groups, respectively. FIM scores, reflecting ADLs, and VSRAD scores were significantly preserved in the ExM group, but significantly worsened in the CS group	Dropout rate was 25,6% in the exercise-music group and 28,6% in cognitive stimulation group Missing data was not specified
13	Wu-Chung	2023	MMSE,WCST,WAIS- IV,BDI-II,PSS	Participants in the music condition showed some improvements in cognitive functioning and socioemotional well-being.	Dropout rate was 22% (13 patients) 7 subjects due to COVID-19, the rest did not complete follow-up visits. Missing data was not specified
14	Xue	2023	MoCA: Montreal Cognitive Assessment	Receptive music therapy intervention significantly improved cognitive function and reduced depressive symptoms in older adults with MCI	Dropout rate was 5% in the control group and 5% in the intervention group Mean imputation method for missing data

AD: Alzheimer Disease, AMI: Active Music Intervention, BBS: Berg balance scale, BDI- II: Beck depression inventory II, BI: Barthel index, BNT: Boston naming test, BPSD: behavioral and psychological symptoms, CG: control group; CT: clock drawing test, CI: cognitive impairment, CVF: category verbal fluency, DMT: Dance movement therapy,EMG: electromyography, EQ-5D: euroQol-5 dimension, FCRT: free and cued recall test, FIM: functional independence measure, FUCAS: functional and cognitive assessment, GDS: geriatric depression scale, HAD: hospital anxiety and depression, IG: intervention group, JLO: judgment of line orientation, LM: logical memory, LVF: letter verbal fluency, MCI: mild cognitive impairment, MMSE: mini-mental state exam, MoCA: Montreal cognitive assessment, NA: not applicable, NI: not informed, NPI: neuropsychiatric inventory, OG: other group, PAS: Pittsburgh agitation scale, PFC: paper folding and cutting test, PPS: palliative performance scale, PSS: perceived stress scale, QoL: quality of life, QUALID: quality of life in late stage dementia, RBANS: repeatable battery for the assessment of neuropsychological status, RMI: Receptive Music Intervention, SD: standard deviation, STAI: state trait anxiety inventory, TMT-A: trail making test (part A), TMT-B: trail making test (part B), TUG: time up and go, VD: Vascular Disease, VFT: verbal fluency test, WCST: Wisconsin card sorting task. WAIS: Wechsler adult intelligence scale, WMS-III: Wechsler memory scale-III.

Table 2: *Characteristics of included studies: outcomes, main findings and dropouts.*

Authors, year	Nature of music therapy	Types of music therapy
Barradas, 2021	Passive	Listening to music
Bisbe, 2020	Active	Listening to music + dancing
Doi, 2017	Active	Listening to music + dancing + playing an instrument
Ford, 2019	Active	Listening to music + cognitive or memory training
Gómez, 2021	Active	Listening to music + dancing
Higuti, 2021	Active	Listening to music + light exercise training
Ho, 2020	Active	Listening to music + dancing
Lazarou, 2017	Active	Listening to music + dancing
Pecci, 2016	Passive	Listening to music
Pongan, 2017	Active	Listening to music + singing
Särkämö, 2014	Active	Listening to music + singing
Satoh, 2017	Active	Listening to music + light exercise training + singing + clapping
Wu-Chung, 2023	Active	Listening to music + cognitive or memory training + singing
Xue, 2023	Active	Listening to music + cognitive or memory training

Table 3: *Types of music therapy interventions across included studies (N=14).*

Authors, year	Duration of therapy (minutes per session)	Frequency of therapy (session per week)	Follow up of intervention (weeks)*	Total exposure to intervention (minutes)	Total exposure to intervention (hours)
Barradas, 2021	45	1	20	900	15
Bisbe, 2020	60	2	12	1440	24.0
Doi, 2017	60	1	40	2400	40.0
Ford, 2019	72	7	35	17,64	294
Gómez, 2021	45	2	12	1080	18
Higuti, 2021	27.5	1	12	330	5.5
Ho, 2020	60	2	84	10080	168.0
Lazarou, 2017	60	2	40	4800	80
Pecci, 2016	30	2	2	120	2
Pongan, 2017	120	1	16	1920	32.0
Särkämö, 2014	90	1	10	900	15.0
Satoh, 2017	40	1	24	960	16.0
Wu-Chung, 2023	60	3	6	1080	18.0
Xue, 2023	20	4	8	640	10.7

* One month was converted in to 4 weeks

Table 4: *Temporal parameters of music therapy interventions across included studies (N=14).*

over time (p = 0.03), but for scaled summary scores and digit span forwards/backwards, no significant differences were found (p = 0.07). These findings suggest that music creativity participants showed specific improvements in raw digit span scores and sequencing tasks over time compared to control participants, but these effects were not uniformly observed across all measures of digit span and scaled scores.

Neuropsychiatric Inventory (NPI), Barthel Index (BI), and Story Memory

Gómez-Gallego et al. (2021) investigated the effects of AMI and RMI in patients with AD. The AMI group showed a significant reduction in NPI scores from baseline (20.92 ± 9.20) to post-intervention (11.36 ± 4.01) (p<0.001). The RMI group showed no significant change, while the control group showed an increase. Higuiti et al. (2021) analyzed the BI when training with music and compared it with training without music in elderly with moderate to advanced dementia, and they did not find any significant differences between both groups compared from the baseline and between them (p>0.05). But in the same year, Gómez-Gallego et al. (2021) investigated the effects of AMI and RMI and showed that AMI had a significant improvement in BI scores from baseline (70.89 ± 13.88) to post-intervention (74.29 ± 12.96), (p<0.001). The RMI group showed a slight decrease, and the control group showed no significant change.

Doi et al. (2017) found that patients with MCI who were exposed to a 40-week dance program showed significant improvement in memory recall scores (p=0.01) compared to the control group, but the music listening group was not significantly different from the control (p=0.123). Satoh et al. (2017) investigated the effects of physical exercise with music (ExM) compared to cognitive stimulation (CS) in patients with mild to moderate dementia. They found a significant improvement in Logical Memory I (LM-I) from baseline to post-intervention in the CS group (p=0.039).

Trail-Making Test (TMT), Clock-Drawing Test (CDT), and Verbal Fluency Test (VFT)

Doi et al. (2017) found that patients with MCI who were exposed to a 40-week dance and music listening program did not show significant TMTA (p=0.052 and p=0.094) or TMT B (p=0.339 and p=0.390) compared to the control group. Satoh et al. (2017) investigated the effects of physical exercise with music (ExM) compared to cognitive stimulation on cognitive function and activities of daily living in patients with mild to moderate dementia. They found a significant improvement in TMT-A from baseline to post-intervention in the ExM group (p=0.014). Pecci et al. (2016) showed that, after a session of Mozart music listening, the patients showed a significantly increased performance on CDT (p=0.03).

Higuiti et al. (2021) analyzed VFT when training with music and compared it with training without music and did not find any significant differences between both groups compared to the baseline and between them (p>0.05). Bisbe et al. (2020), when assessed verbal fluency after choreographed exercise and multimodal physical therapy in elderly with amnestic mild cognitive impairment, found that in the physical therapy group, there was a significant improvement from baseline (11.86 ± 3.26) to 12 weeks (13.50 ± 2.85); (p=0.013).

Missing Data and Drop-Outs

Across the studies, to ensure robust results, missing data was managed using various statistical techniques such as multiple imputations and intention-to-treat (ITT) analyses (Xue et al., 2023) and expectation maximization (Doi et al., 2017) or per-protocol analysis (Bisbe et al., 2020). Other cases discharged participants who passed away or excluded them if they refused to participate (Ford et al., 2019). Most studies reported minimal impact from missing data, highlighting their efforts to mitigate effects and maintain the integrity of their findings (Gómez-Gallego et al., 2021).

Dropout rates varied across the studies, with some reporting significant percentages. Gómez-Gallego et al. (2021) and Higuti et al. (2021) reported low or no dropout rates in some groups. Reasons for dropouts included participant deaths, refusal to continue, or other unspecified reasons. Notably, Doi et al. (2017) reported higher dropout rates in the control (5.97%), dance (17.91%), and music (19.4%) groups. Efforts to retain participants and minimize dropouts were evident, but high dropout rates in some studies could impact the generalizability of the results. Additionally, the COVID-19 pandemic affected some follow-up visits, as reported by Wu-Chung et al. (2023).

Feasibility of the Interventions

The feasibility of implementing MT was generally well-supported across studies. High adherence rates were noted, such as in Doi et al. (2017), with adherence rates of 86% for dance and 85.9% for music. Overall, studies indicated that MT is feasible in diverse settings, including nursing homes and clinical environments (Ford et al., 2019). Some studies noted variability in adherence to specific protocols, such as tablet use (Ford et al., 2019), but these did not significantly detract from the overall feasibility. The studies suggested that MT could be implemented effectively with proper support and resources (Särkämö et al., 2014; Wu-Chung et al., 2023).

Assessment of risk of bias in individual studies

Figure 2 summarizes the RCT quality assessment as per the RoB2 and its respective domains. Of the 10 studies assessed through RoB2, 3 (30%) are high risk, 5 (50%) possess some concerns, and the rest 2 (20%) have low risk. The domain with less risk is the D3 followed by D1, and the domain with higher risk is D4 followed by D5.

Assessment of QES was done using the ROBINS-I tool (Figure 3). Pecci et al. (2012) did not account for confounders, and selection was based on cognitive status after the start of the study. There was limited information about adherence to interventions and missing data, putting it at a moderate risk of bias. Gomez-Gallego et al. (2021) randomly assigned the nursing homes to intervention, which reduced the risk of confounding. The participant selection and interventions were well defined, with blinded assessment, which makes the study at a low risk of bias. On the other hand, Ford et al. (2019), has a moderate risk of bias due to lack of control for confounding, possible selection bias, and unclear interventions. Similarly, the Barradas et al. (2021) study is also at moderate risk of bias due to a lack of control for confounding and selection bias. However, the interventions were clearly described, and they do not report any deviation from the intended interventions. The outcome measures were standardized in all these studies, and there are no signs of selective reporting.

Discussion

The studies included in this review were heterogeneous in terms of types of studies and types of music therapy intervention. This could be explained because there is evidence that MT in several modalities can improve all cognitive function and emotional outcomes, reduce behavioral symptoms and enhance QOL in elderly patients with Mild Cognitive Impairment (MCI) and dementia (Dorris et al., 2021; Fusar et al., 2018; García et al., 2022; Ito et al., 2022; Jordan et al., 2022; Lam et al., 2020; Lin et al., 2023; Moreno et al., 2020; Rodakowski et al., 2015).

From a neurological perspective, music therapy enhances cognitive functions by engaging key neural pathways involved in memory, attention, and emotional regulation (Ting et al., 2024). Studies have demonstrated that music therapy promotes neuroplasticity, the brain's ability to reorganize itself by forming new neural connections. This process is especially important in dementia, where neural degeneration occurs. Active music therapy, such as playing an instrument or singing, has been shown to stimulate multiple regions of the brain, including the hippocampus (crucial for memory), the prefrontal cortex (responsible for executive function), and the auditory cortex. These activities also enhance synaptic density, which is vital for maintaining cognitive functions. Moreover, the rhythmic and emotional aspects of music may activate the brain's limbic system, which regulates emotions and supports cognitive function. As a result, music therapy can create stronger brain connectivity and potentially slow cognitive decline in patients with mild cognitive impairment (MCI) or early-stage dementia (Ting et al., 2024). Psychologically, MT can reduce stress and improve overall mental health and cognitive performance (Wu-Chang et al., 2023). Behaviorally, engaging in music therapy can increase social interaction, motivation, and participation in daily activities, which are crucial for cognitive health (Reschke et al., 2023).

Music Intervention on Multiple-Domiain of Cognitive Functions

Studies using multi-domain tests as primary outcomes (MMSE, MoCA) have shown that MT improves cognitive impairments in MCI and early dementia. The MT in these studies was either related to dance movements (Bisbe et al., 2020; Doi et al., 2017; Ho et al., 2020; Lazarou et al., 2017), and clapping hands (Gómez-Gallego et al., 2021). One study found significant cognitive improvement in MCI (Xue et al., 2023), but another (Gómez-Gallego et al., 2021) found no significant effect when compared to active music intervention. As shown in Figure 4, these studies are part of a broader global research effort on music-based interventions for the elderly with MCI, AD, and VD, with varying levels of research activity across different countries.

Music Intervention on Specific Domains of Cognitive Functions

Outcome measurements on executive functions, by previous investigators, have shown mixed results. Bisbe et al. (2020) showed a significant effect of choreographed exercise on VFT, while another study (Higuti et al., 2021) did not find a significant difference in VFT between exercise with music group and

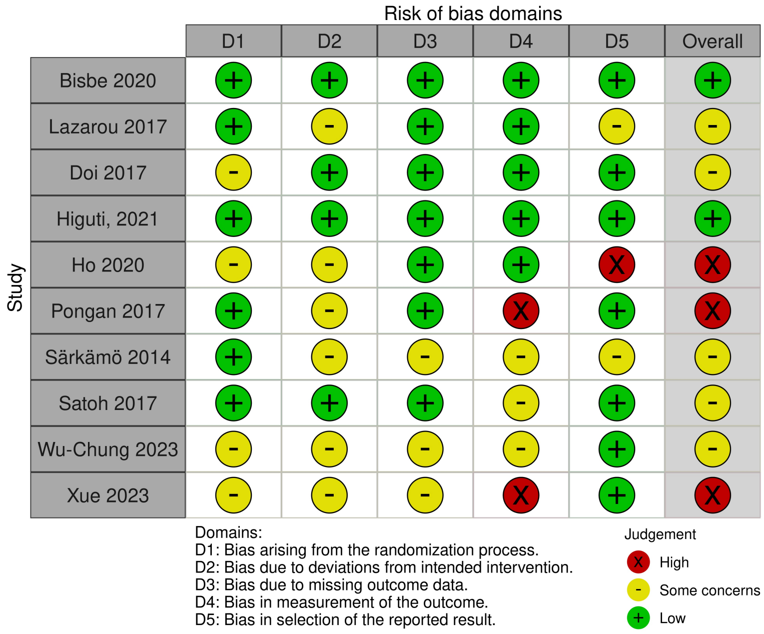

Figure 2: *Risk of bias assessment for randomized controlled trials using the RoB 2.0 tool.*

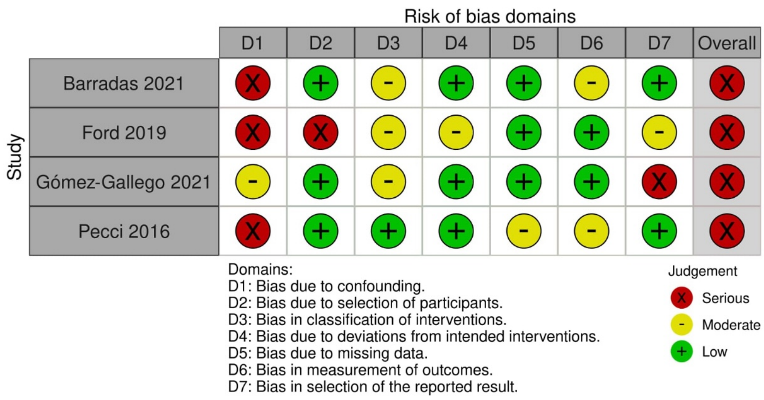

Figure 3: *Risk of bias assessment for non-randomized studies using the ROBINS-I tool.*

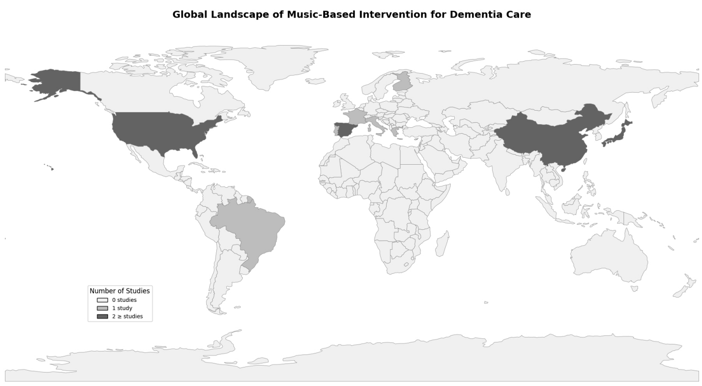

Figure 4: *Global distribution of studies on music-based interventions for elderly with MCI, Alzheimer's disease, and vascular dementia included in this review.*

exercise group. Less commonly used measurements that also involve visual-motor coordination, such as the cube copying, CDT, PFC, and TMT-B, yielded varied results. One study with non-significant effects used TMT-B, incorporating dancing with music (Doi et al., 2017). In contrast, a study demonstrated a positive effect, particularly on cube copying (Satoh et al., 2017), the latter incorporated rhythmic activities along with cognitive tasks (e.g., clapping hands to music, creating rhythms). Interestingly, one study using Mozart music listening also showed a significant effect on PFC (Pecci et al., 2016). The inconsistencies in the results on executive functions may be explained by the differences in ethics of the population, different outcome measures used or different types of music interventions. Whether music interventions have a greater impact on executive functions related to language, as measured by VFT, and less impact on executive functions related to visual-motor coordination, remains unclear. Further studies should investigate these different aspects of cognitive function.

Working memory was another domain of cognitive function examined in previous studies. The most common tests used were the digit span test, DSST, and the Stroop test. The included studies showed that music interventions had some impact on working memory; the intervention in these studies were singing compared with painting (Pongan et al., 2017) and incorporating music as one component in the learning process of a workshop (Wu-Chung et al., 2023). Music interventions may help in working memory as demonstrated by improved digit span scores. Singing and composing music may contribute to focused attention due to repetitive rhythm and emotional components, and the interaction of music and mind can engage the brain to improve concentration.

Story memory involves the encoding, storing, and retrieving of facts or events over the long term. One out of two studies included in this paper (Doi et al., 2017) showed that combining music interventions with dancing improved cognitive function. As previous meta-analyses (Jia et al., 2019) have shown positive effects of physical activities on cognitive functions in AD, the improvement in story memory may be attributed to exercise rather than music intervention alone. In contrast, Satoh et al. (2017) did not find an improvement in logical memory in the combined music therapy and exercise group compared to cognitive stimulation. This could be due to the greater impact of cognitive stimulation compared to physical exercise, or it may be that the level of exercise was insufficient to improve cognitive function.

Music Intervention on Physical Functions and Psychological Aspects

One study (Gómez-Gallego et al., 2021) assessed psychological aspects using the Neuropsychiatric Inventory (NPI). Three studies (Gómez-Gallego et al., 2021; Higuti et al., 2021; Satoh et al., 2017) addressed physical functions related to activities of daily living (ADL) using either BI or functional independence measure (FIM), showing mixed results. Satoh et al. (2017) found that the FIM score did not change in the group with exercise combined with music, whereas it worsened in the group with cognitive stimulation. Higuti et al. (2021) also did not find any changes in BI. The only study that showed improvements in ADL and psychiatric outcomes was from Gómez-Gallego et al. (2021); however, the results should be interpreted with caution due to the quasi-experimental design of the study, which is subject to potential bias.

Comparison with Previous Systematic Review Studies

A systematic scoping review and meta-analysis (Tao et al., 2023) investigated the effectiveness of dance movement interventions on the cognitive functions of older adults with MCI, AD, and dementia. The review included 13 RCTs with a total of 1,708 participants, and 8 RCTs were included in the meta-analysis. The results showed positive outcomes regarding global cognition, memory, and depression, but not executive functions. Our study included the same 4 RCTs (Bisbe et al., 2020; Doi et al., 2017; Ho et al., 2020; Lazarou et al., 2017) with dance and MT from the previous systematic review, showing similar results regarding global cognition. However, our study has shown favorable outcomes in executive functions using VFT by music interventions incorporated with movement (Bisbe et al., 2020) in contrast to the previous meta-analysis. This may be due to different outcomes measured for executive functions, as in our study, the most commonly used measure was VFT, whereas the previous study analyzed the effect on TMT-B in the meta-analysis. The improvement of executive functions was also confirmed by Ito et al. (2022), another systematic review and meta-analysis that included studies distinct from ours.

Strengths and Limitations of the Study

The populations of the included studies were recruited from various settings—nursing homes, communities, and clinics—and the studies were conducted in multiple countries around the world, including America, Europe, and Asia. This diversity may better reflect real-world data. Also, almost all studies reported high participation and adherence safety and showed that MT could be highly feasible.

There are several limitations, such as small sample sizes and homogeneous populations (Bisbe et al., 2020; Pecci et al., 2016; Pongan et al., 2017; Särkämö et al., 2014) and short-term interventions. The single-site nature of many studies further constrained the applicability of the results to broader populations (Särkämö et al., 2014). Specific to some studies, the assessment instruments may not have been sensitive enough to detect all changes, and self-reported data could be unreliable (Ho et al., 2020). Thus, objective and standardized measures should be utilized to enhance the accuracy of the findings. Some studies also reported challenges such as variable levels of physical activity (Ho et al., 2020) and the inability to strictly separate the effects of physical exercise from music (Satoh et al., 2017). We only selected studies with cognition as the primary outcome, which may have limited the number of studies included. Low-quality studies were also added and could have introduced potential bias in the evaluation of Music Therapy on Cognitive Function. Finally, based on the heterogeneity of the results and type of studies, larger and better-designed studies are needed to confirm these results and, understand the long-term effects of MT and compare the effects of music interventions alone versus combined with physical exercise. Another critical limitation of the studies is the lack of detailed information on the adherence to music therapy protocols. In some cases, participant engagement with music therapy may vary based on factors such as cognitive ability, mood, or physical health, which can introduce significant variability in outcomes. Furthermore, few studies have considered the role of caregiver involvement in music therapy, which could be a confounder affecting patient outcomes. Additionally, the studies included in this review were conducted in diverse cultural settings, and the role of culturally specific music in therapy has not been fully explored. This could introduce a cultural bias, as familiar or traditional music may influence cognitive and emotional responses differently across populations. These factors should be considered when interpreting the generalizability of the findings.

Implications for practice and future research

The results of our study showed that music intervention, particularly when including dance movements or combined with cognitive tasks, has a positive impact on cognitive functions in global and some specific domains, especially working memory, as demonstrated by digit span tests. These findings suggest that incorporating MT into group therapy sessions within community settings could be beneficial for individuals with MCI and early dementia, considering its feasibility and its potential to improve cognitive function.

Music therapy not only offers a non-pharmacological approach but could also be integrated into routine care in nursing homes, community settings, and rehabilitation centers. This therapy is relatively low-cost, requires minimal equipment, and can be tailored to individual patient needs, making it accessible to a wide range of healthcare settings. Given its potential benefits on cognitive function and psychological well-being, integrating music therapy into daily patient care routines could improve patient outcomes and reduce caregiver burden. Future studies should focus on developing standardized music therapy protocols that can be easily adopted in various healthcare settings, ensuring consistency in implementation across different patient populations.

Differences in population characteristics, outcome measures, types of music interventions, integration of music with other therapies, especially with movements and cognitive tasks, and varying levels of exposure to musical interventions contribute to inconsistencies in cognitive outcomes in the specific domain. These knowledge gaps should be addressed in future studies using high-quality designs, larger sample sizes to provide more robust and reliable data (Bisbe et al., 2020; Ford et al., 2019; Gómez-Gallego et al., 2021; Lazarou et al., 2017; Pecci et al., 2016; Pongan et al., 2017; Särkämö et al., 2014; Satoh et al., 2017; Xue et al., 2023) and extended periods to assess the observed benefits over time (Bisbe et al., 2020; Doi et al., 2017; Gomez et al., 2021; Lazarou et al., 2017; Pongan et al.,2017; Särkämö et al., 2014; Satoh et al., 2017; Xue et al., 2023). Also, due to the known benefits of physical exercise on cognitive functions, future trials comparing exercise alone with combined exercise and music are needed to determine whether music interventions provide additional cognitive benefits.

Future research should explore the long-term effects of different types of music therapy on various cognitive domains, such as working memory, attention, and executive function, over extended follow-up periods. Additionally, exploring the role of personalized music therapy, where patients select music based on personal preferences or cultural background, could provide more individualized care. Large-scale, multicenter randomized controlled trials with stratified randomization should aim to reduce confounding factors, such as caregiver involvement and patient mood, to provide more robust data. Moreover, studies should investigate the cost-effectiveness of implementing music therapy in both institutional and home-care settings.

Conclusion

Overall, music therapy is a non-pharmacological intervention that benefits cognitive function in elderly patients with MCI and early dementia in isolation and in combination with physical exercise or dance. Our results suggest that music therapy, especially in its active form, could potentially be integrated into elderly care. However, further large-scale, well-designed studies are necessary to confirm these findings and establish clear guidelines for clinical practice.

Acknowledgement

We would like to express our gratitude to Prof. Felipe Fregni, Alma Tamara Sanchez Jimenez, and Fathima Minisha, whose guidance, encouragement, and constant supervision were crucial to elaborate this Review. We also want to thank all the senior, second, and first teacher assistants and all the PPCR team for their valuable inputs in the process, their patience and encouragement were crucial in the development of this work.

Supplementary Materials

Appendix A: Search strategies

Author Contribution

All authors contributed equally to the manuscript.

Funding

This research received no external funding.

Conflicts of Interest

The authors declare no conflict of interest.

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