

*Review*

Dance programs for people with traumatic brain injury: A scoping review

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Abstract: Modified dance for people with traumatic brain injury (TBI) is an emerging adjunct neurorehabilitation technique. The aim of this review is to describe the characteristics of dance programs developed for people with TBI, and to examine how stakeholders perceive these programs. Eight databases (MEDLINE, Scopus, Embase, CINAHL, Web of Science, SPORTDiscus, PsycINFO, and ProQuest Dissertations and Theses) were searched for studies on dance and TBI. Seven eligible articles were identified, involving a total of 22 dance participants with TBI and a further three people with TBI in a control group. The most common dance techniques used were dance movement therapy, improvisation, meditative movement, and mirroring. Modifications to programs included one-on-one delivery, individual tailoring with strategies to assist with cognitive or mobility barriers, and support from clinicians or assistants. Overall, the dance programs were feasible to deliver and acceptable to participants. Three studies revealed mixed evidence of efficacy in terms of motor fitness outcomes (e.g., balance and mobility), and there was insufficient evidence for efficacy in terms of cognition, neuroplasticity, and psychosocial outcomes. The review makes recommendations to enhance the safety and sustainability of dance for the neurorehabilitation population and to improve the standardized reporting of program design and execution to advance the field.

Keywords: Dance movement therapy; TBI; adaptive dance; neurorehabilitation

Introduction

Approximately 350,000 Australians have ongoing disability following traumatic brain injury (TBI) (Gardner & Zafonte, 2016). Of these, many require daily or near-daily psychosocial support (emotional, employment or school, and interpersonal relationship support) or support with activities of daily living (such as assistance with self-care, money management, medication use, and transport) (Tate et al., 2020). Following TBI, participation in leisure and recreation activities dramatically decreases (Beadle et al., 2020). This reduced participation can be attributed to a variety of biopsychosocial factors, including fatigue, memory impairment, anxiety, pain, and compromised balance and coordination (Wise et al., 2010). Additionally, individuals with TBI have reported a reduced motivation to engage in exercise (Burgess et al., 2024; Hamilton et al., 2016). Furthermore, the inability of some healthcare providers to effectively address the specific needs of these individuals also contributes to reduced engagement in physical activity (Burgess et al., 2024). This lack

of leisure activity reduces the opportunity for social contact, further impacting psychosocial and emotional outcomes (Beadle et al., 2020). Thus, a focus on recreation activities during rehabilitation has been recommended (Fleming et al., 2011).

Adapted dance may be a beneficial recreation activity in rehabilitation for people with neurological conditions. Potential benefits relate to social connection, a multisensory-enriched and motivating environment, and the scope to increase a sense of creativity and agency. Furthermore, the execution of dance involves the integration of both mind and body, with cognitive processing being deeply rooted in bodily movements. It has been suggested that engaging in mind-body activities with others may represent a novel approach to neurological rehabilitation (Martínez-Pernía, 2020). Use of adapted dance in other neurological disorders (e.g., Parkinson's disease, dementia, Huntington's disease and multiple sclerosis) has gained momentum and has been found to improve gait parameters, balance, cognition, psychological outcomes, and quality of life (Mabire et al., 2019; Patterson et al., 2018; Ruiz-Muelle & López-Rodríguez, 2019). However, dance has only recently begun emerging as a rehabilitative technique for people with TBI (Jeffay et al., 2023). Specifically, in the INCOG 2.0 guidelines for executive function, Jeffay et al. (2023) referred to dance as a "potential emerging treatment" that combines physical and mental exercise. More evidence is needed to determine the impact of dance on cognitive functioning and discern its benefits beyond physical exercise alone.

To enhance individuals' safety and maximize their engagement, dance programs for people with TBI need to be specifically devised and adapted to their needs. Yet, there is limited guidance on how to design or tailor such programs. There are currently no guidelines for TBI, nor position statements on exercise prescription from the American College of Sports Medicine or Exercise and Sports Science Australia. To date, no review has examined research on the use of dance in rehabilitation for people with TBI to inform program prescription, development of strategies and teacher training and any adaptation of dance programs specific to the needs of this population.

In light of this research deficit, reviewing research from two similar fields could be beneficial: 1) the literature on dance in people with stroke (instead of dance following TBI), and 2) the literature on other mind-body practices such as yoga in people with TBI. Given the similarities in functional impairments arising from stroke, reviews on people with stroke may be broadly applicable to people with TBI. However, it is important to note that the socio-demographic characteristics of people with TBI (typically younger and more males) and neuropathological mechanisms differ from those of stroke (Meschia, 2014). Damage following TBI is often more diffuse or widespread than stroke (e.g., shearing and tearing of axon pathways), with lesions most common in front-temporal cortices. Similarly, although yoga may be comparable to dance, the physical and cognitive requirements of dance differ significantly from yoga. Nevertheless, some findings may be relevant to the current review.

One review has been conducted on dance following stroke (Kipnis et al., 2023). The Kipnis et al. (2023) scoping review of dance for people with stroke examined the composition of the dance programs. Not all studies described their dance intervention, but out of those that did, almost half of the studies (5/11) reported using adapted dance informed by stroke rehabilitation guidelines and included movements recommended by therapists. However, little detail was provided about specific movement and teaching techniques. Four studies assessed feasibility. Retention in dance programs ranged from 56 to 91 percent, whereas adherence ranged from 93 to 99 percent and only two minor safety incidents were reported (fatigue and foot swelling). Overall, Kipnis et al. (2023) concluded that dance was feasible in chronic stroke populations and participants found it enjoyable, particularly the social aspects. Due to the heterogeneity of studies and outcome measures, no conclusions were drawn regarding the efficacy of dance, but there were trends observed towards positive

changes in balance and falls risk. Findings for disease impact and interpersonal aspects were inconsistent, and the impact on cognition had not been assessed objectively. Qualitative analysis suggested psychosocial benefits such as improvements in mood and motivation.

The review by Kipnis et al. (2023) reported that stakeholders perceived that the dance teachers' adaptability or willingness to modify the program according to the needs of people with stroke was integral to intervention effectiveness. For example, Gregor et al. (2021) found that the approach to teaching the dance programs to people with stroke was critical to the acceptability of the program. This related to aspects such as teacher communication (e.g., language used), adaptability of the program, and how well programs were tailored to the person's ability level. Similarly, barriers to participation were highlighted, such as fear of falling and fatigue. Use of strategies that created a sense of safety was deemed pivotal to the program's success.

A large mixed-methods retrospective study (n = 1563) on the feasibility and acceptability of yoga for people with TBI (Donnelly et al., 2021) also identified challenges related to dizziness and fatigue. Consistent with the review by Kipnis et al. (2023), perceived safety of the program and the teacher's approach and qualities were found to be important. Accommodations and the instructions the teacher used were perceived to increase a sense of safety (Donnelly et al., 2021). Useful adaptations included: keeping their head above their heart to minimize forward flexion, minimizing head movements, the use of chairs and the wall for stability, and blocking sections (kneeling and standing) to facilitate transitioning. Useful teaching techniques included: the teacher using step-by-step repeated instruction, referring to landmarks instead of left and right, gradually building up to more challenging activities, teachers using a non-judgmental tone, and utilizing two instructors to help provide support such as modification suggestions and to demonstrate the poses.

In summary, while dance has been considered a "potential emerging treatment" for people with TBI, there is limited guidance for designing adapted dance programs. Cross-disciplinary literature suggests that the acceptability of such programs for people with brain injury depends on addressing key factors such as safety, barriers to participation, and teacher adaptability. To develop and implement effective programs for individuals with TBI, it is critical to understand the techniques, movements, dance styles, accommodations, and stakeholder perceptions, enabling program designers and teachers to anticipate challenges and make appropriate adaptations. Additionally, assessing the effectiveness of these programs is essential for future program design and research.

In light of these considerations, the current scoping review sought to describe the characteristics of dance programs for people with TBI, with a particular interest in understanding stakeholder perceptions and evaluating the effectiveness of trialed interventions. Therefore, the research questions guiding this review are: 1) What are the characteristics of dance programs developed for or conducted with adults with TBI? 2) How do people with TBI, support staff and clinicians perceive dance programs for people with TBI? 3) How feasible (e.g., retention, adherence, occurrence of safety incidents, and reported challenges or barriers) and effective (did they achieve their program goals e.g., evidenced through pre-post measures) is dance for people with TBI?

Materials and Methods

Methodology

The protocol was published in the Open Science Framework on August 29th, 2023. The protocol was guided by the Arksey and O'Malley (2005) and Levac et al. (2010) frameworks. The review is reported according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses extension for Scoping Reviews (PRISMA-ScR) (Tricco et al., 2018).

Study Search

The database search was conducted between August 30 and October 5, 2023 and updated on April 6 and 7, 2025. The search strategy was devised through consultation with a health services librarian. Titles, abstracts and MeSH headings (or subject headings) were searched. See Supplementary Methods S1 for an example of the search for MEDLINE (EBSCOhost). The databases searched were, MEDLINE, Scopus, Embase, CINAHL, Web of Science, SPORTDiscus, PsycINFO, and ProQuest Dissertations and Theses.

Study Selection

The following eligibility criteria were used. Dance studies that described the use of dance in an adult (18+) TBI sample and employed any type of methodology were included (e.g., case studies and pilot studies). Studies involving individuals with mixed typologies of acquired brain injuries (e.g., TBI and Stroke) were eligible for inclusion if at least 50 % of the sample consisted of participants with TBI, or if the results for the TBI subgroup could be isolated (e.g., in Single Case Experimental Design [SCED] studies). Dance studies were included if they reported on the design and implementation of a program or intervention, regardless of whether outcomes were provided. Studies addressing the acceptability of interventions were considered if they incorporated the perspectives of any relevant stakeholders. The search was limited to peer-reviewed articles published in English, as well as publicly available unpublished Doctorate Theses. There was no restriction on publication date. Studies including dance plus other exercise (such as stretching or walking) were included. However, the additional exercises were noted, with efforts made to distinguish the benefits of dance independently where possible.

The intervention needed to be described as dance to be included. This excluded other movement to rhythm such as rhythmic auditory stimulation and neurologic music therapy. Furthermore, it excluded other mindful movement therapy such as Tai Chi and Yoga. Combined interventions such as pharmacology plus dance, or repetitive transcranial magnetic stimulation plus dance were excluded.

Identified articles were imported into Covidence. A title and abstract search was completed by the lead author (DP). For this, an abstract screening tool was developed as recommended by Polanin et al. (2019) (see Supplementary Methods S2) with a yes/no eligibility decision required. Potentially eligible full-text articles were reviewed by the lead author (DP) and an independent reviewer (RG) using Covidence according to the inclusion and exclusion criteria. Discrepancies between reviewers regarding study inclusion were resolved through group discussion (DP, RG, and MN).

Data Collection Process

Qualitative and quantitative data were extracted into pre-arranged categories by DP and confirmed by RG using a pre-existing framework as suggested in Pollock et al. (2023). The following categories for feasibility, acceptability, and efficacy were developed based on a recent review by Ownsworth et al. (2021). Feasibility: reported study accrual or program uptake (e.g., how many who were deemed eligible decided to participate), program adherence compared to dropout rates, challenges, barriers and support required and reported adverse events. Acceptability: reported opinions and reactions (including perceived disadvantages) to the program such as satisfaction ratings, feedback on the usefulness or benefits, and intention to continue or recommend the program to others. Efficacy: objective functional improvements, self-reported changes in functioning or wellbeing, and caregiver or clinician ratings were assessed using pre-post measures or change relative to the person's baseline or a control or alternative condition. Suitable examples of what could be extracted regarding the teaching approach were based on themes highlighted in other brain injury

movement research previously discussed (e.g., accommodations made and teaching approaches) (Donnelly et al., 2021; Gregor et al., 2021).

Furthermore, any information on the teacher onboarding process was extracted. The final information to be extracted was determined in meetings and agreed upon by all reviewers. See Supplementary Methods S3 for the customized spreadsheet. The framework was then used to organize data into themes and categories, as follows: (1) program design and implementation, (2) instructional approaches, and (3) feasibility, acceptability, and efficacy.

Results

See Figure 1 for the PRISMA diagram, and Table 1 for an overview of the studies. The initial search yielded 619 articles, with an additional five articles identified through other sources. After duplicate removal, 353 records remained. A further 332 were excluded by title and abstract screening, leaving 21 to be reviewed as full text. There was 77% agreement between DP and RG concerning the inclusion of the 21 studies. Disagreement was resolved through discussion with a third reviewer (MN). The search process yielded seven eligible articles (reports), describing eight dance programs for people with TBI. The article by Berrol and Katz (1985) described the delivery of two different dance movement therapy programs. Of the seven articles, two studies used a pre-post design (Dault & Dugas, 2002; Särkämö et al., 2021), with one of these employing a crossover design where participants were randomized into one of two groups (dance or standard care). In this study, participants either received dance in the first phase (AB group) or the second phase (BA group). Two studies were case studies with repeated-measures outcomes (Kullberg-Turtiainen et al., 2019; Lachance et al., 2021), while two articles described three case studies that provided descriptive information on the delivery of dance programs without outcome measures (Berrol, 1990; participants 'D' and 'LG' Berrol & Katz, 1985). Finally, one study compared a dance movement program to physiotherapy (Talbot, 2006), focusing primarily on the differences between approaches. As such, only the program design will be discussed here. The following sections present the results organized into four domains: participant characteristics, program design, instructional approaches, and feasibility, acceptability, and efficacy.

Participant Characteristics

A total of 22 individuals with TBI have completed a documented dance program. Dance participants with TBI were predominantly male (14 males and 8 females). Where individual ages were reported (six articles), the mean age was 32.05 years, with an age range of 18 to 54 years. For studies that reported a pre-calculated mean, the average ages were similar ($M = 36.3$ years [AB group] and 35 years [BA group]) (Särkämö et al., 2021). The time since injury (either exact or mean) was variable, ranging from 6 months to 9.2 years. All dance program participants had moderate to severe or severe TBI.

In many studies, participants were receiving ongoing usual care with dance specified as acting as an adjunct therapy (Berrol, 1990; Berrol & Katz, 1985; Lachance et al., 2021; Särkämö et al., 2021). However, of note, in Dault and Dugas (2002), ongoing rehabilitation was inconsistent across participants in the dance group, and in Kullberg-Turtiainen et al. (2019), the dance therapy was made part of the patients' ongoing physiotherapy.

It is important to note that other individuals with TBI also participated in the studies, but their data were not included in the above averages and ranges. Specifically, in Berrol and Katz (1985) additional individuals from the rehabilitation centre participated in DMT, but only data from the one participant were reported. Additionally, in Dault and Dugas (2002),

a further five individuals with TBI were assigned to a control condition (Traditional Muscular Training); of these, only three completed the program (Dault & Dugas, 2002).

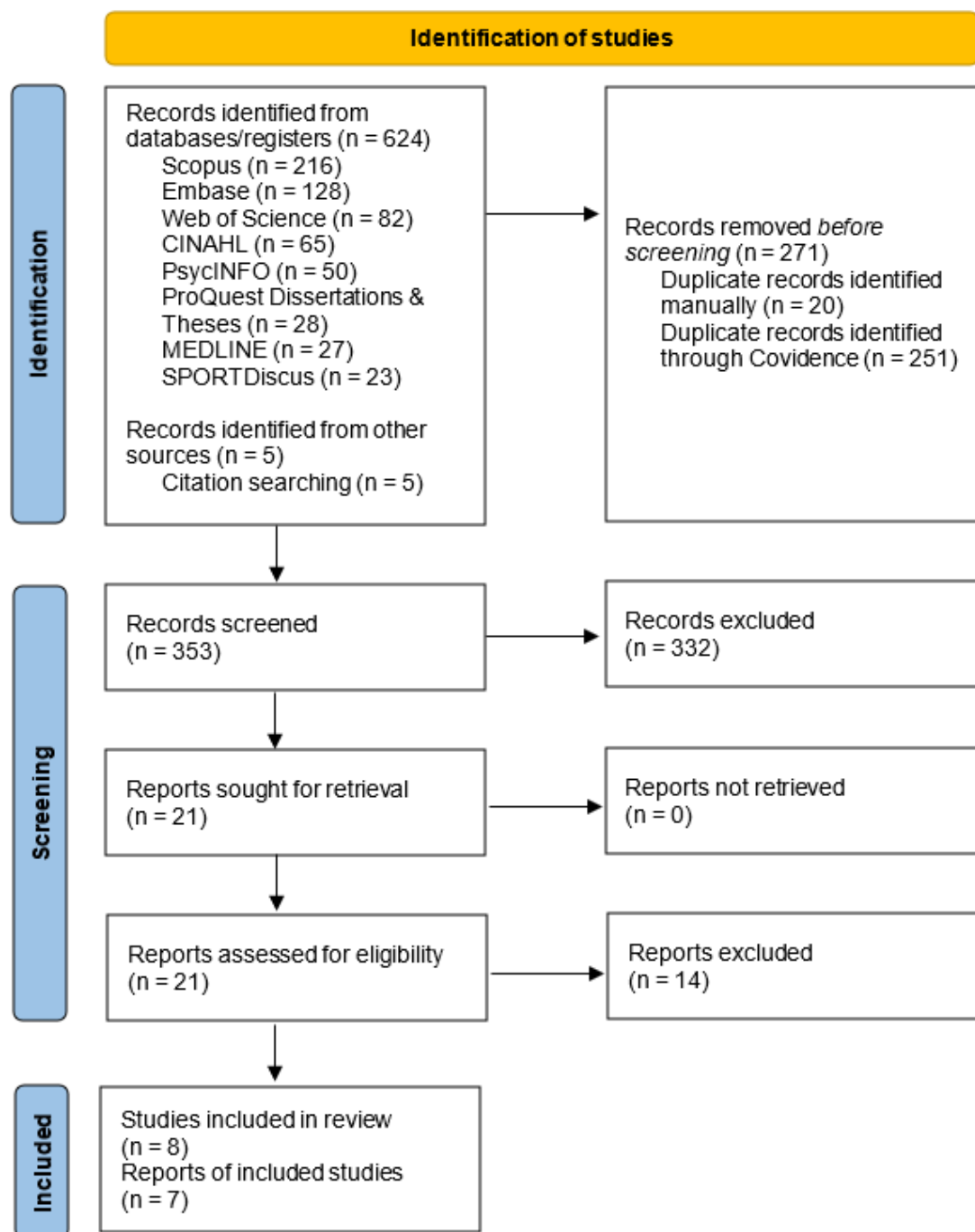


Figure 1. PRISMA flow diagram of the study selection process.

Table 1. Overview of TBI Dance Rehabilitation Studies and Participant Demographics.

Author	Study type	Measures	Aim of study or program	(N)	Age (years)	Injury severity	Time since injury
(Berrol, 1990)	Descriptive case study	-	Improve balance and physical condition	N = 1 (male; individual and group DMT)	35	Severe ^c	4 years
(Berrol & Katz, 1985)	Two case studies (individual and group therapeutic dance)	Descriptive only	Review of DMT in rehabilitation and two dance intervention case studies	N = 1 (male; group dance)	38	Severe	2 years
				N = 1, (male; DMT)	26	Severe	4 years
(Dault & Dugas, 2002)	Non-randomized, experimental study	Modified jumping jack Clinical Test for Sensory Interaction in Balance (centre of pressure displacements)	Effectiveness of Step and Slide for postural imbalance and co-ordination deficits in TBI	N = 8 (6 males, 2 females; 5 dance, 3 TMT control)	Dance group ages = 35, 27, 25, 18, 54 years TMT ages = 27, 20, 30 years	6 x severe 1 x mild 1 x uncategorized	Dance (6 months, 10 months, 7 years, 8.7 years, 8.8 years) TMT (7 months, 1.1 years, 2.1 years)
(Kullberg-Turtiainen et al., 2019)	Case study	Functional Independence Measure Electroencephalography Observations Clinical report Video analysis of mobility performance	Feasibility and efficacy of intensive goal directed dance rehabilitation	N = 1, male	25.5 ^a	Severe	6.5 years

Author	Study type	Measures	Aim of study or program	(N)	Age (years)	Injury severity	Time since injury
(Lachance et al., 2021)	Single Case Experimental Design ‘Viola’	Four Square Step Test Multiple Directional Reach Test Mini-BESTest	Impact of DMT on mobility	N = 1, female (1 of 7 participants with TBI)	39	Not specified	Not specified
(Särkämö et al., 2021)	Crossover design with 6-month follow up	Motor measures: Trunk Impairment Scale Berg Balance Scale Action Research Arm Test 6-metre walking speed (GAITRite) Neuropsychological measures: Montreal Cognitive Assessment Frontal Assessment Battery Digit Span Similarities (WAIS-IV) Block Design (WAIS-IV) Sustained Attention to Response Test Self-report questionnaires:	Feasibility, applicability, protocol adherence and treatment effects of Dual-Assisted Dance Rehabilitation	N = 11 (7 males, 4 females; AB = 6, BA = 5)	35.75 ^b	Severe or extremely severe TBI ^d	AB group (mean 9.2 years) BA group (mean 5.8 years)

Author	Study type	Measures	Aim of study or program	(N)	Age (years)	Injury severity	Time since injury
		Behavior Rating Inventory of Executive Function - Adult version, Beck Depression Inventory-2, Quality of Life after Brain Injury					
(Talbot, 2006)	Case study 'Joana'	Comparison of DMT and traditional therapy	Comparison of dance and conventional physical therapy for individuals with brain injury	N = 1, (female; 1 of 5 participants with TBI receiving DMT)	30	Severe ^d	1 year

Note. DMT = dance movement therapy; TBI = traumatic brain injury; WAIS-IV = Wechsler Adult Intelligence Scale, Fourth Edition. Unless noted otherwise, age is in exact years. ^a Age estimated from time since injury. ^b Due to the reporting format in the original paper, this number represents mean age, rather than the exact age. Unless noted otherwise, injury severity classification was not stated. ^c Based on the Rancho Scale of Cognitive Functioning Level VII, ^d Diagnosis of severe or extremely severe TBI was based on either loss of consciousness (LOC) > 7 days, or post-traumatic amnesia (PTA) ≥ 4 weeks.

Program Design

The duration of sessions ranged from 45 to 90 minutes and were typically conducted one to two times each week. The length of the program ranged from 12 weeks (Dault & Dugas, 2002) to 12 months (Berrol & Katz, 1985). Only one study reported intensity (Lachance et al., 2021), which ranged from moderate to high - adjusted based on therapists' observations. There was relatively even distribution of programs carried out as group sessions $n = 4$ ('R' Berrol & Katz, 1985; Dault & Dugas, 2002; Lachance et al., 2021; Talbot, 2006) compared to those conducted as individual therapy $n = 3$ ('D' Berrol & Katz, 1985; Kullberg-Turtiainen et al., 2019; Särkämö et al., 2021) and in one study the participant performed both individual and group therapy (Berrol, 1990).

Studies were conducted in a transitional living centre (case study of the participant named 'R' Berrol & Katz, 1985), outpatient clinics (case study of the participant named 'D' Berrol & Katz, 1985; Lachance et al., 2021), an intensive day program (Berrol, 1990), specialized rehabilitation centres (Särkämö et al., 2021), and community venues (Talbot, 2006). Two studies did not specify the setting (Dault & Dugas, 2002; Kullberg-Turtiainen et al., 2019). None of the studies provided detailed descriptions of the physical setting, such as the size of the space, flooring, lighting, ventilation, or available equipment. However, some references were made to specific elements of the environment. For instance, Berrol and Katz (1985) noted the presence of a mirror in the room, and Talbot (2006) mentioned a window.

The process of teacher onboarding was not specified, except for Dault and Dugas (2002), where teachers watched participants for two weeks to understand their functional abilities. In all other studies, no information was supplied regarding how the dance teachers planned any necessary adaptations, teaching techniques (number of repetitions, degree of complexity, and cueing techniques), or protocols for safety concerns.

Five of the dance programs used dance movement therapy (DMT) (the therapeutic use of movement to improve wellbeing), one involved step and slide (which incorporated aerobic dance and stepping movements) (Dault & Dugas, 2002), and two were assisted dance where the dance teacher guided the class and a physical therapist performed manual assistance. In one of the assisted dance programs, the participant learned and created choreography to be performed (Kullberg-Turtiainen et al., 2019), and the other used a combination of dance components (e.g., moving rhythmically, body part isolation, learning a sequence of movements, and stretching) (Särkämö et al., 2021). The structure of the classes generally followed a standard pattern of three parts: 1) Introduction and warm up which involved encouraging socialization and increasing proprioception and attention; 2) The main body of the class (e.g., improvisation, movement synchronization, learning choreography, use of adapted rehabilitation techniques [therabands], and mirroring); and 3) A mindful movement cool-down.

Instructional Approaches

Information on how the dance classes were taught or instructed was limited. Few studies contained explicit descriptions of how the dance class was taught regarding any specific theory used for teaching. In Särkämö et al. (2021), the dance teacher was in front of the participant and cued the dance movements both verbally and visually, and the physical therapist provided support. Similarly, in the case study by Kullberg-Turtiainen et al. (2019), it was noted that the dance teacher provided guidance while the physiotherapist provided manual assistance. Finally, Berrol and Katz (1985) described the use of the floor and mirror for feedback on alignment. No study described how feedback on errors was given.

Information or examples of how the classes progressed over the course of the program were rarely described. However, in Berrol (1990), the participant progressed through the

classes with modifications added to repetitious movements over time (e.g., walking to a beat with focus ahead, walking to a beat changing gaze, walking with external counting in place of a beat, walking with internal counting, then the participant making the decisions of where to move). In a similar vein, it was noted in Dault and Dugas (2002) that complexity was increased through the use of additional arm movements and increased speed.

Two studies noted specific dance movement goals. In the case study by Kullberg-Turtiainen et al. (2019), a goal-directed program was used. Specifically, the overall goal of the intervention was for the participant to participate in a dance competition performing to 800 spectators at the end of the 20-week intervention. Dault and Dugas (2002) had an end goal that at completion of the training (12 weeks), participants would be able to complete four aerobic dance movements, eight step movements and eight slide movements without assistance.

TBI injury can result in various cognitive challenges, including difficulties with memory, attention, and executive functioning. As a result, individuals living with TBI may experience distractibility, challenges in planning and goal-setting, as well as difficulty monitoring their performance (Barman et al., 2016). Due to these cognitive deficits, instructors used adjustments to assist with learning and memory. Berrol and Katz (1985) used cards listing a movement quality (e.g., strong). Berrol (1990) reviewed the material in the previous session in the warm-up and wrote this on the chalkboard. Berrol and Katz (1985) also used a review in the cool-down to assist memory. This review consisted of a verbal and movement recap with input from the instructor and group members. In the case study by Kullberg-Turtiainen et al. (2019), for the first two months, the instructor taught sequences/movements of only 10 to 30 seconds in length. Lessons began with reciting what had been remembered, after which the teacher added new material. The final sequence was completed at two months, and the routine was then repeated for the remainder of the 20-week period. Särkämö et al. (2021) only taught sequences of two to three movements in a stepwise manner to eventually make up 10 movements. Both Talbot (2006) and Dault and Dugas (2002) used repeatable movement phrases. Berrol and Katz (1985) asked questions to assist processing, such as “how did it feel to resist?” and “what was it like to co-operate as a group?” They also used imagery to help heighten movements.

The approaches to managing mobility deficits in the dance class varied. As discussed, both Särkämö et al. (2021) and Kullberg-Turtiainen et al. (2019) incorporated assistance from therapists separate from the dance teacher into the program design. In contrast, in Berrol and Katz (1985), the dance teacher devised bespoke techniques to assist the participant. For example, the instructor developed a technique to help their participant slide from the wheelchair to the floor, and also a technique for the dance teacher to assist the participant when standing. Several other programs were individualized, with difficulty or choreography adjusted based on the dance therapist’s observation (Dault & Dugas, 2002; Kullberg-Turtiainen et al., 2019; Lachance et al., 2021; Särkämö et al., 2021).

Some studies excluded participants who did not demonstrate a safe degree of mobility to participate (Dault & Dugas, 2002; Särkämö et al., 2021). Conversely, Lachance et al. (2021) used improvised movements with a theme instead of attempting to attain a specific correct movement. For instance, they improvised movements based on the tempo, or the space a movement takes up. Moreover, Berrol and Katz (1985) focused mainly on using DMT to experience the strength that the participant had. Similarly, Kullberg-Turtiainen et al. (2019) utilized the participants’ strengths in the dance program (although this was not further described from a motor perspective). In contrast, Dault and Dugas (2002) used reduced speed in movements to manage mobility issues.

Music was used to assist movement in different ways. Music was used to help maintain a steady movement pattern by Berrol (1990), whereas Talbot (2006) used a variety of music

to enhance the quality of the movement being performed. For example, they used slow melodic music for warm-up, music with a strong rhythm for centre work to assist with rhythmic movement, and no music for mindful warm-down. Others used music as a motivating factor. For example, in the studies by Särkämö et al. (2021) and Kullberg-Turtiainen et al. (2019), participants chose their own favorite or important music to move to.

Feasibility, Acceptability, and Efficacy

Results overview are Table 1 (Appendix A). Furthermore, a summary is provided below.

Feasibility: Särkämö et al. (2021) reported that they screened 3000 people, of whom 11 met eligibility. Eligibility criteria included the requirement of motor deficits, but sufficient motor function to enable participation. They also must have been between 12 months and 10 years since their severe or extremely severe injury. Two studies reported adherence to the program with attendance rates at classes above 94 % (Lachance et al., 2021; Särkämö et al., 2021). One group dance study reported attrition rates. In Dault and Dugas (2002), all five participants in the dance group completed the training, whereas two of the five in the control group dropped out. In one study that used one-on-one dance training (Särkämö et al., 2021), one person out of eleven discontinued due to experiencing a seizure after nine sessions. However, it was not stated whether this occurred during the dance class or at rest. Overall, reported incidents or safety concerns were low and mainly related to impulsivity (Berrol & Katz, 1985) and a medical episode (Särkämö et al., 2021).

However, there were some potential barriers or challenges noted for dance programs with TBI participants, which included risk-taking, disinhibition, an increase in sexually inappropriate behavior (Berrol & Katz, 1985), and difficulty learning the material (Berrol & Katz, 1985). A challenge in movement initiation in improvisation was highlighted in Berrol and Katz (1985) and in Berrol (1990). Further, expanding the movement repertoire acted as a reminder of pre-injury ability (Berrol & Katz, 1985). Finally, because of mobility restrictions, many classes required assistance from therapists or were individual treatment only. This may be a potential resourcing barrier which may limit the sustainability of dance programs.

Acceptability: Qualitative data, including participant quotes, indicated that they generally found the dance programs acceptable. Quotes highlighted positive experiences related to how it felt to move, improvements with movement, and enjoying the agency of trying different movements. However, there was one reported instance of feeling embarrassed when leading mirroring activities (Berrol & Katz, 1985). The perceptions of dance movement therapists, physiotherapists and personal assistants were similarly positive and focused on sensorimotor aspects such as improved ability of movement or co-ordination, and increased movement repertoire. There was a theme in one case study where the shared perspectives of allied health staff, the neuropsychologist, and neurologists suggested cognitive benefits such as improved perseverance, memory, self-control, alertness and concentration, and self-awareness (Kullberg-Turtiainen et al., 2019). Only one study by Särkämö et al. (2021) used surveys to assess satisfaction and reported that all participants perceived benefits for their mobility and cognition.

Efficacy: Three studies reported pre-post outcomes for motor fitness based on objective tests. The results mostly concurred with stakeholders' perceptions of the benefits. Specifically, in the SCED study, 'Viola' achieved statistical improvement in the 4 square test, Mini Best Test, and the Multi Directional Reach Test (Lachance et al., 2021). Furthermore, dance participants with TBI (n = 5) improved postural sway and temporal delay whereas the traditional muscular training group did not (n = 3) (Dault & Dugas, 2002). Based on these outcomes, these studies achieved their aims regarding improving mobility (Lachance et al.,

2021) and postural balance and co-ordination through dance (Dault & Dugas, 2002). However, in the latter study, one of the assessments (lying down star jumps) was novel to the study and has not been validated. Further, inconsistent outcomes across participants (Dault & Dugas, 2002) and variability in performance across testing days (Lachance et al., 2021) should be noted. In the Särkämö et al. (2021) study, which used a crossover design ($n = 11$), when change scores from baseline to post dance intervention were compared to the change scores of the group in the control phase, both dance intervention groups showed a positive treatment effect for participants' Trunk Impairment Scale score ($d = .76$ and $d = .47$). When their scores were pooled, the change from the dance intervention was significant ($p = .010$) indicating that dance improved their dynamic sitting balance and trunk co-ordination. Whereas no statistical change was observed in other motor fitness tasks such as functional balance, mobility, and upper extremity dexterity and co-ordination (i.e., Berg Balance Scale, speed on the 6-meter walking task, and the Action Research Arm Test). Overall, the evidence for motor benefits is mixed.

The study by Särkämö et al. (2021) also investigated the impact of dance on cognition using a combination of objective and subjective measures. By assessing change scores, medium to large treatment effect sizes were evident for improvements in auditory attention, verbal reasoning, and visuo-construction skills (i.e., Digit Span, Similarities and Block Design of the Wechsler Adult Intelligence Scale-IV [WAIS-IV]) and in behavior regulation, and metacognition (clinical scales of the Behavior Rating Inventory of Executive Function - A [BRIEF-A], and the Global Executive Composite score [BRIEF-A GEC]). A significant change in the pooled score was found in verbal reasoning ($p = .005$). However, no significant changes were found for measures of executive function, sustained attention, and global cognitive status (i.e., Frontal Assessment Battery [FAB], Montreal Cognitive Assessment [MOCA], and Sustained Attention to Response Test [SART]). In fact, sustained attention performance was poorer at post-intervention in one group. Furthermore, in some scores, in the comparative control phase, performance decreased (BRIEF-A GEC and BRIEF-A BRI), or improved (MOCA) (Särkämö et al., 2021). Overall, the evidence for cognitive benefits was mixed and caution is needed with interpretation due to likely practice effects on measures and variability in the data.

Psychosocial, functional status, and neuroplasticity outcomes were rarely assessed. Mood and quality of life (QOL) were assessed in the crossover design study by Särkämö et al. (2021). QOL scores were variable with a non-significant pooled change ($p = .977$), whereas a large effect size was reported for mood for the dance phase in both groups ($d = 1.19$ and $d = 1.17$) with a significant pooled score ($p = .002$). One case study investigated neuroplasticity using EEG and its relation to change in their Functional Independence Measure (FIM) score (Kullberg-Turtiainen et al., 2019). Dance was associated with altered brain connectivity in the default mode network, and this corresponded to an increase in FIM score. In sum, psychosocial, functional status and neuroplastic outcomes associated with dance programs for TBI are under-researched but indicate the potential for further research.

Discussion

The limited body of research in this area suggests that the field is still in its early stages of development. The small number of studies warrants caution in the interpretation of the findings. Nevertheless, the findings in light of the review's research questions will now be discussed, alongside their importance.

To address the first research question, several characteristics of the dance programs were described. The programs used a small range of techniques, with dance movement therapy being the predominant approach. Within many programs, improvisation was a common component. The instructional approaches and adaptations made in response to

participants' cognitive and motor challenges were described. While mobility adaptations were generally well considered (e.g., therapists or volunteers present), studies infrequently provided explicit details on adaptations to instructional approaches (e.g., exercise progression and cueing). Nevertheless, the instructional approaches that were described offer valuable insights for future dance health program designers, suggesting strategies that have been employed and underscoring the need for further development of instructional adaptations as a foundation for future programs.

To address our second research question regarding perceptions of individuals with TBI, support staff, and clinicians toward dance programs for people with TBI, the perspectives of dance health stakeholders were collated. Overall, dance was perceived as acceptable and beneficial by the majority of stakeholders (although note the limited data). There were some exceptions that warrant further discussion.

Free choice in movement is one of the aspects that separates dance from other therapies and there is some support for its use. For example, movement choice has been found to be beneficial to brain plasticity (Dotan Ben-Soussan et al., 2013). However, the current review notes that some participants experienced difficulties with initiating free choice movement. Specifically, the patient 'R' frequently volunteered to initiate movement, but the chosen movements were consistently limited to hand circling, or movements were predominantly gestural in nature (Berrol & Katz, 1985). In contrast, the patient 'LG' refused participation, stating that they did not know what to do (Berrol, 1990). This challenge has also been highlighted in dance research with people with stroke (Beaudry et al., 2019). It is likely that this is due to the high-level cognitive processes required for this task. For example, the task 'move your hand in as many different ways you can think of' requires divergent thinking (e.g., creating a novel way of moving a limb instead of the usual manner) and response inhibition (to inhibit the usual or ongoing response). Furthermore, a contact improvisation task where one reacts to another's movements requires generating solutions to problems and then making a choice. Therefore, further research is needed to explore ways to manage/facilitate the improvisation aspect given the cognitive challenges apparent in people with brain injury.

Our review also highlighted diverse approaches to managing the cognitive challenges accompanying TBI, but it is unknown whether these approaches were acceptable to stakeholders. Dance studies used memory aids, memory recaps, the use of movement repetition, and some attempted to reduce demands on memory through minimizing the choreography. However, no formal interviews were conducted to explore whether the techniques used were perceived as useful and supportive. Other dance research for people with brain injury concluded that the management of these challenges was crucial to program success (Gregor et al., 2021). Therefore, focus groups and/or interviews to explore acceptability of dance programs are recommended to further our understanding of whether current adaptations are adequately creating a safe and supportive environment.

To address our third research question regarding the feasibility and effectiveness of dance programs for people with TBI, the available studies were examined. Regarding feasibility, too few studies reported on retention and adherence, limiting the ability to draw conclusions; however, those that did report this data suggested they sustained adequate participation levels. Similarly, while reported safety incidents were generally low, the potential for impulsivity and disinhibition was noted. Increased reporting of this data in future studies is essential. This information is crucial for dance researchers when designing research methodology (e.g., sample size and study design), and to ensure that any barriers to participation are minimized and potential risks are mitigated.

A potential resource barrier that may limit translation to practice was found. Managing mobility challenges safely required either one-on-one delivery, or student volunteers and

therapists to be present (or both). To facilitate translation of dance programs into practice, and the longevity of programs, solutions to this resource barrier will be required. Currently, in Australia, the National Disability Insurance Scheme provides funding under capacity-building supports for individuals living with disability. Under such support, an individual living with TBI can access the support of therapists such as Clinical Exercise Physiologists to assist in the modification and clinical monitoring of patients during classes, reducing the potential barrier. Therefore, one solution is to utilize broader allied health services such as Exercise Physiologists in community programs.

Regarding efficacy, once again, there was also too little data, and assessment techniques were too diverse to draw any firm conclusions. The aims of the studies were primarily focused on feasibility, safety, or exploratory inquiry, with only a small portion aiming to address efficacy, further reflecting the early stage of development in this field.

This aside, our review found initial support for a potential positive impact on motor outcomes from dance that warrants further investigation. The kinematic nature of dance training (motor forces/energy moving through the body in sequential patterns without external force) mirrors requirements for successful completion of activities of daily living. Dance induces positive adaptive stresses in both efferent (motor control and balance) and afferent (sensory and proprioceptive) signaling, eliciting improvements in underlying motor patterns (Särkämö et al., 2021). However, in the current review, motor outcome measures were diverse. This was also found in the dance review with people with stroke (Kipnis et al., 2023). Similarly, a recent rapid systematic review on health outcomes from exercise prescription in moderate-to-severe TBI was limited due to a lack of standardized core outcome measures (Johnson et al., 2023). Standardization of motor outcome measures in dance health research is recommended. Further research is also needed to examine whether objective measures of motor outcomes concur with stakeholder reports.

Gap Analysis

The current review found that the TBI dance literature to date is not assessing the full spectrum of possible psychosocial benefits. Elements that have been observed in dance literature in people with other neurological disorders, such as sense of belonging and flow (Shirazipour et al., 2024), increased social interaction (Berrol et al., 1997), and social connection (Kipnis et al., 2023), have not been investigated to date in TBI research. Mood was formally assessed in one study using the BDI-2 (Särkämö et al., 2021), and this measure investigates the degree to which one feels negative feelings such as failure, irritability, fatigue, and worthlessness. Therefore, only reduction in negative mood states has been assessed— as opposed to an increase in positive states of wellbeing. According to the WHO definition, health is not merely the absence of disease but involves the ability to thrive (World Health Organization, 2024). In sum, there is currently a gap in TBI research regarding the psychosocial impacts of dance that future dance research should address.

There are three gaps regarding program design. First, researchers did not develop dance programs in consultation with people with TBI. According to the NIH consensus panel (NIH consensus statement, 1998), patients should have the opportunity to plan and design rehabilitation programs. This space could be advanced through focus groups incorporated into the design process so that the views of people with lived experience of TBI are not under-represented in programs and literature. Second, fatigue (which affects up to three-quarters of people with TBI) (Ponsford et al., 1995) has been highlighted as a potential barrier in other dance literature (Beaudry et al., 2020; Gregor et al., 2021) but was neither accounted for in program design nor monitored. This is counter to recommendations that extra care be taken to avoid fatigue in physical activity with people with TBI (van Markus-Doornbosch et al., 2017). Therefore, future dance rehabilitation studies could improve alignment to

recommendations in their design and implementation. Third, program descriptions were insufficient to replicate or to theorize what elements may have impacted the findings. Studies largely omitted information regarding the tailoring used and necessary modifications. Future studies could report this in a standardized way. For example, Cotterill et al. (2018) described the use of the TiDIER checklist outside of clinical trials, and this has been useful in dance programs with people with stroke (Beaudry et al., 2019). Similarly, exercise prescription derived from the FITT (Frequency, Intensity, Time, and Type) principle, allows clinicians the ability to set adapted individualized programs to optimize clinical outcomes. More detailed descriptions would enhance the clinical application of dance programs in practice.

Finally, the approach to evaluating the efficacy of the programs needs to consider the specific requirements of the population. There was heterogeneity of patient outcomes either from week to week, across measures, or across participants. This is consistent with the cohort and not unique to this literature (Covington & Duff, 2021). Use of the SCED methodology may be useful to control for participant-level variability. SCED methods involve the detailed observation and repeated measurement of a single case over time. Data are collected during a baseline period, followed by the intervention phase and subsequent follow-up. This is then replicated across different participants to strengthen the findings. The focus on individual-level analysis makes SCED particularly valuable in clinical settings, where understanding the individual response of each participant is beneficial.

Additionally, SCED is especially useful when larger group studies are not feasible (Krasny-Pacini & Evans, 2018). The repeated measures within the design help to reduce the impact of variability, providing more robust insights. The generally good adherence and low attrition rates reported in the studies suggest that this methodology is feasible. Moreover, SCED is now categorized as class one evidence (Tate et al., 2013) and therefore findings are sufficiently rigorous to be used for decision-making regarding dance program prescription and intervention effectiveness.

Limitations

The purpose of the review was predominantly to gather insight into the nature and characteristics of dance programs developed for people with TBI; hence, no risk of bias analysis was conducted. The body of literature was also small, and therefore, the review included dance programs without objective analysis and reporting.

The paucity of studies examining the efficacy of dance programs for individuals with TBI constitutes both a limitation of the present review and a constraint on the broader application of its findings. The gap highlights the lack of robust evidence regarding the effectiveness of dance as an intervention for individuals with TBI. Consequently, due to these limitations, the conclusions drawn from dance health interventions in other neurological conditions, such as Parkinsons disease or stroke, cannot be generalized to individuals with TBI at this time.

Perspectives

This is the first study to review the nature and characteristics of dance used for rehabilitation in people with TBI, and furthermore, whether they achieved their aims. This review found that the research base is small. To date, studies have focused on assessing the benefits for motor function and have overlooked the evidence for neuroplastic change and impacts on psychosocial function. Our review also highlighted important gaps in dance rehabilitation program design and implementation – specifically regarding how dance programs are devised and evaluated. Standardized reporting of program design and execution would advance the field.

Supplementary Materials: 3 Supplementary files and 1 Appendix Table.

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Appendices

S1 Database search

Searches were adapted slightly due to the specifications of each database. For example, where MeSH headings cannot be used, subject headings will be used. Similarly, the different proximity search operators will be substituted where necessary (N3, NEAR/3, adj3).

S1 AB (brain OR head) N3 (trauma* OR damag* OR injur* OR wound OR contusion OR oedema OR edema OR swell*) OR TI (brain OR head) N3 (trauma* OR damag* OR injur* OR wound OR contusion OR oedema OR edema OR swell*)

S2 AB "Traumatic brain injury" OR TBI OR concussion OR TI "Traumatic brain injury" OR TBI OR concussion

S3 [Mesh Headings] Brain injuries OR Brain damage, Chronic OR Brain injuries, Traumatic OR Brain injuries, Diffuse

S4 S1 OR S2 OR S3

S5 AB Danc* OR Ballet OR Tango OR Bolero OR folk OR waltz OR salsa OR ballroom OR "contact improv*" OR "authentic movement" OR "primitive expression" OR Bailamos OR TI Danc* OR Ballet OR Tango OR Bolero OR folk OR waltz OR salsa OR ballroom OR "contact improv*" OR "authentic movement" OR "primitive expression" OR Bailamos

S6 [MeSH Heading] Dancing OR "Dance Therapy"

S7 S5 OR S6

S8 S4 AND S7

Note: Jazz, contemporary and DMT were not included in the search strategy because they returned a high number of irrelevant results.

S2 Abstract Screening Tool

Citation, Title, and Abstract Screening

1. Does the title or abstract use English?

a. Yes: continue screening

b. No: stop screening

2. Does the title or abstract NOT indicate that a systematic review or meta-analysis was conducted?

a. Yes: continue screening

b. No: stop screening

3. Does the title or abstract indicate that this is NOT a correction or erratum?

a. Yes: continue screening

b. No: stop screening

4. Is the document a peer-reviewed article or a thesis ?

a. Yes: continue screening

b. No: stop screening

Abstract Screening

5. Does the abstract indicate that an adult sample was studied?

a. Yes or Unsure/Unclear: continue screening

b. No: stop screening

-For example: the study only samples preschool students or younger

Note: If it is a mixed-age sample, stop screening.

6. Does the abstract indicate that dance was studied?

a. Yes or Unsure/Unclear: continue screening

Example keywords: Dance, Ballet, Tango, Bolero, folk, waltz, salsa, ballroom, contact improvisation, authentic movement, social dance, aerobic dance, partner dance, just dance

Key point 1: Studies including dance plus other exercise (such as stretching or walking) will be included.

Key point 2: Dance programs combined with other therapeutic trials (e.g., pharmacological or repetitive transcranial magnetic stimulation) are to be excluded.

b. No: stop screening

Key point 1: The intervention needs to describe dance to be included.

Other constructs such as movement in the absence of music, or movement that is only for the purpose of making music are not eligible. Movement that is not choreographed to music (tai chi or yoga) or described as dance (e.g., improvisational dance) is not eligible.

Key words to exclude: rhythmic auditory stimulation, RAS, neurologic music therapy, NMT, physiotherapy, occupational therapy, yoga, tai chi, and Qigong.

7. Does the abstract indicate that the dance program was developed for or conducted with people with TBI? The dance program must include at least 50 % people with a TBI, or the results must be able to be extracted.

a. Yes or Unsure/Unclear: continue screening

b. No: stop screening

Decision: Should this article be included?

a. Yes, all 7 screening questions answered Yes or Unclear

b. No, at least one answers definitely “No”

S3 Data Extraction Spreadsheet

Study info	To be extracted	Example
General study information		
	Title, Author, Year published, Country	
	Type of evidence source	Dissertation, peer reviewed journal
Characteristics of included studies		
Methods		
	Aim of the study	
	Assessment used	
	Analysis used	
	Study type	Intervention, qualitative, review, case study
	Other treatment condition	e.g., standard medical care continued, or traditional strength training.
	Setting, Number of participants assessed	Include patients with TBI, and other cohorts involved such as carers and staff members who give feedback.
	Number of other participants attending the program, Method of recruitment of participants	If other cohorts are included in the dance program
Participant demographics		
	Age, Gender, Ethnicity, Injury type/cause, Severity, Functional	

Study info	To be extracted	Example
	status (e.g., FIM), Time since injury/diagnosis, Medication, Other medical conditions	
Dance program design		
	Inclusion criteria	
	Exclusion criteria	
	Aim/intent of the program/study	
	Therapeutic goal	
	Frequency	
	Intensity	
	Time	
	Type - dance style or genre	Modified dance, DMT, Ballet,
	Method of delivery	Virtual, exergaming, in-person
	Class characteristics	Individual, group, partnered, non-partnered
	Dance teacher characteristics	Dance training, qualifications, experience with special populations
	Description of dance teacher onboarding	
Program notes	Warm up	
	General practice	
	Warm down	
	Break information	
	Cost to participants	
	Location	Health facility, dance studio, university research room
Feasibility		
	Accrual/uptake	
	Adherence	
	Dropout rates	
	Reported challenges or barriers	
	Reported support required	
	Safety and adverse events	Falls, seizures
	Incidents	
Acceptability		
	Reported opinions	e.g., feedback on usefulness/benefits
	Qualitative themes or reported quotes	
	Satisfaction ratings	
	Feedback on usefulness/benefits	
	Intention to continue	
Efficacy		
	Caregiver or clinician rating	e.g., 6 min walk test
	Objective pre-post outcome measure	e.g., the SART
	Participant subjective ratings	e.g., DASS

Appendix A

Appendix A Table. Extraction into Categories - Feasibility, Acceptability, and Efficacy

Author	Feasibility	Acceptability	Efficacy
(Berrol, 1990)	Reported challenges or barriers: <i>Dance movement therapist</i> – LG had difficulty initiating movement.	Opinions: <i>Dance movement therapist</i> – LG increased movement repertoire. <i>Special educator</i> – LG seemed more confident, more able to persevere with cognitive tasks, and not as easily frustrated. <i>Psychologist</i> – his movement seemed a catalyst for psychological and cognitive improvement. <i>Staff</i> – LG dramatically changed his demeanor. <i>Patient LG</i> – feels freer now. <i>Patient LG</i> – I discovered I had a body.	-
(Berrol & Katz, 1985)	Reported challenges or barriers: <i>Dance movement therapist</i> - R would volunteer to initiate movement, but choice of movement varied little. However, if given cue of try a different body part, could shift to the lower leg. <i>Dance movement therapist</i> - R's actions were largely gestural and did not incorporate postural movement. <i>Dance movement therapist</i> - learning new material for subsequent retrieval was a problem. R - felt embarrassed performing leadership mirroring activities in pairs.	Reported opinions: <i>Dance movement therapist</i> - Participant was able to use more upright posture, to reach into space more expansively, and move with an increased dynamic range. Quote: R – “We are getting closer and closer. That feels nice.”	-
(Berrol & Katz, 1985) Case study of Individual treatment (D)	Reported challenges or barriers: <i>Dance movement therapist:</i> Risk taking in achieving mastery of a new activity and unrealistic or unsafe attempts at activities was a major issue.	Reported opinions: <i>Dance movement therapist</i> - sitting balance improved. <i>Dance movement therapist</i> - range of motion in paralyzed limbs increased.	-

Author	Feasibility	Acceptability	Efficacy
	<i>Dance movement therapist</i>: Expanding his movement repertoire increased his awareness of his severe movement limitations. <i>Dance movement therapist</i>: Memories of premorbid lifestyle were triggered. Incidents: <i>Dance movement therapist</i>: Participant attempted to walk when not in a safe position causing conflict between therapist and patient. <i>Dance movement therapist</i>: Sexually inappropriate behavior to staff and clients was exacerbated.	<i>Dance movement therapist</i> - D enjoyed using the full space and not being confined by dimensions of rehabilitation equipment. Quotes <i>D</i> –“felt good to move.” <i>D</i>- he enjoyed the sessions because the dance movement therapist “let him try things.”	
(Dault & Dugas, 2002)	Retention: All five participants completed the dance training. Two people in the control group (traditional muscular training) did not complete the program.	Reported opinions: Three participants reported they felt more efficient while executing daily activity.	Objective pre-post outcome measure: Dance group pre to post: Temporal delay of wrists ($t = 3.03$; $p < .001$). Whereas non-significant change in the control group. Dance group pre to post: Temporal delay of the knees ($t = 3.67$; $p < .001$). Whereas non-significant change in the control group. Decreased postural sway for the dance group ($t = 2.14$; $p < .005$), but not the control group.
(Kullberg-Turtiainen et al., 2019)	-	Reported opinions: <i>Physiotherapist and dance teacher</i> - balance, posture, mobility, and endurance improved (e.g., movements were more symmetrical and greater range of motion). <i>Physiotherapist and dance teacher</i> - procedural and episodic memory were better and he could develop mnemonics. <i>Personal assistant</i> – he was feeling more secure, independent, and self-controlled.	Objective pre-post outcome measure: Short term FIM: short term FIM increased 29 % compared to previous measurement. Long term FIM: long term FIM increase 24 %. Maximum standing from 15 to 30 min. DMN subnets was positively correlated with FIM score, $r = .057$; $p < .05$).

Author	Feasibility	Acceptability	Efficacy
		<i>Personal assistant</i> - executive functions got faster, alertness level and concentration were much better, and he could regulate the activity rest cycle by himself. <i>Personal assistant</i> - working memory and motor functions improved. <i>Personal assistant</i> – now working with two hands in co-ordination task. <i>Personal assistant</i> - increased frequency of using walker and longer duration. Clinical examination: <i>Neuropsychologist</i> - self-awareness, self-reflection, alertness level, attention, and coping, and episodic and working memory improved. <i>Neurologist</i> - acted self intentionally, functions were low but faster, stimulus dependency was diminished and he controlled his left upper limb better and worked bimanually more.	
(Lachance et al., 2021)	Adherence: Viola attended 23 of the 24 sessions.	-	Objective pre-post outcome measure: Very large effect size for improvement in the 4 sq test (ES -1; $z = -2.31$, $p = .021$). Very large effect size for improvement in MDRT-behind (ES = 1, $z = 2.45$, $p = .014$) Very large effect size for improvement in Mini BESTest (ES =1; $z = 2.45$, $p = .014$)
(Särkämö et al., 2021) DARE to move	Accrual: 3000 screened for eligibility, 11 met eligibility Adherence: participated in an average of 94.6% Attrition: 1 person discontinued due to seizure. Adverse event:	Participants satisfaction ratings: Significantly higher than average benefit to mobility, and benefit to cognition. Other domains rates as above average benefit but did not reach significance.	Objective pre-post motor outcome measure: Improvement on the TIS: Group AB compared to control ($d = 0.76$)¹. Group BA compared to control ($d = 0.47$)¹. Significant pooled score change from pre to post dance intervention on TIS score $p = .010$ ². Objective pre-post cognition measures:

Author	Feasibility	Acceptability	Efficacy
	Possibility of the epileptic seizure onset in one participant being due to the multimodal aspects of dance.		Improvement on the Digit Span, Similarities, and Block Design subtests of the WAIS-IV ($d = 0.32\text{--}0.89$) ¹ . Significant pooled score change from pre to post dance intervention on WAIS-IV (Similarities) ($p = .005$) ² . Subjective pre-post psychosocial measure: Improvement in mood (BDI-2). Group AB compared to control ($d = 1.19$) ¹ . Group BA compared to control ($d = 1.74$) ¹ . Significant pooled score change from pre to post dance intervention on BDI-2 ($p = .002$) ² . Other outcome measures did not show significant change (BBS, ARAT, speed on the 6-meter walking task, MOCA, FAB, SART, BRIEF, and QOL).
(Talbot, 2006)	-	Reported opinions: <i>Mother</i> - did not think these things (daughter moving across the room, smiling, and fully participating) could happen based on neuropsychological evaluation. <i>Dance therapist</i> - Joanna was minimally engaged or would disengage from exercise in the PT session if the exercise did not have spatial intent.	



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