Complementary Therapies in Clinical Practice 49 (2022) 101662

Contents lists available at ScienceDirect

Complementary Therapies in Clinical Practice

journal homepage: www.elsevier.com/locate/ctcp

Feasibility, acceptability and effects of dance therapy in stroke patients: A systematic review

Isabel Ares-Benitez [a,b], Maxime Billot [c], Philippe Rigoard [c,d,e], Fatima Cano-Bravo [f], Romain David [c], Carlos Luque-Moreno [g,*]

[a] Faculty of Nursing and Physiotherapy, University of Cádiz, 11009, Cadiz, Spain
[b] IntegraSalud (Functional Rehabilitation Center), 11500, Puerto de Santa Maria, Spain
[c] PRISMATICS Lab (Predictive Research in Spine/Neuromodulation Management and Thoracic Innovation/Cardiac Surgery), Poitiers University Hospital, 86021, Poitiers, France
[d] Department of Neurospine & Neuromodulation, Poitiers University Hospital, 86021, Poitiers, France
[e] Pprime Institute UPR 3346, CNRS, ISAE-ENSMA, University of Poitiers, 86360, Chasseneuil-du-Poitou, France
[f] Virgen del Rocio Universitary Hospital, 41013, Seville, Spain
[g] Departamento de Fisioterapia, Facultad de Enfermería, Fisioterapia y Podología, Universidad de Sevilla, 41009, Sevilla, Spain

ARTICLE INFO

Keywords:
Postural balance
Dance therapy
Complementary therapies
Stroke rehabilitation
Gait Disorders, Neurologic

ABSTRACT

Introduction: Stroke is the leading cause of non-traumatic disability in adults, with balance and gait disturbances representing the main limitations of body functions. Dance therapy (DT) has shown positive effects in older adults and in patients with neurological pathologies. This systematic review aims to examine the feasibility, acceptability and effects of DT in stroke rehabilitation, specifically on functional gains of gait and balance.
Methods: A systematic search was carried out for articles published in the MEDLINE, PEDro, Web of Science, Scopus and CINHAL in February 2021 and updated in April 2021. **Results**: Eight studies were included (2 clinical cases, 5 case series and 1 randomized controlled trial), 7 of them in patients with chronic stroke and only 1 in subacute stroke phase. The most widely used dance modality was tango and ballet, with sessions ranging from 30 to 110 min. DT seems to show positive effects on post-stroke body functions and activities such as gait and balance. Reported dropout rates are inconsistent, no adverse effects were reported, and participant satisfaction was high.
Conclusion: Given the heterogeneity and uneven quality of the included studies, strong conclusions cannot be put forward on the effectiveness of DT in post-stroke body function and activities. Nevertheless, DT seems to be safe and acceptable therapy for patients, and no adverse effects have been reported. More studies with a high level of evidence and feasibility are needed to determine the patient profile, the characteristics of the intervention, the participation rate and the role of the rehabilitation professional most likely to generate optimal benefit.

1. Introduction

Stroke is currently the leading cause of non-traumatic disability in adults, being more frequent in people over 65, although it can also affect young people and children [1]. Rehabilitation intervention in post-stroke patients is a process that aims to prevent complications and reduce neurological deficit, the objective being to achieve maximum functional capacity, and consequently facilitate personal autonomy and social reintegration [2,3]. To date, 30% of stroke survivors experience functional disability associated with paralysis, balance problems, speech disorders and cognitive deficits [4]. While some benefits can be obtained through rehabilitation [4], balance and gait disturbances in post-stroke patients usually do not disappear completely and represent a significant functional limitation, being associated with a higher risk of falls [5,6].

Conventional rehabilitation, through repetitive exercises, manual therapy, task-oriented exercises and other techniques, has shown

Abbreviations: DT, Dance therapy; RCT, Randomized control trial; CMSQ, Checklist for measuring study quality; STPW, Spatio-temporal parameters of walking (STPWs); BBS, Berg Balance Scale; TUG, Time-up and go test; ICF, International Classification of Functioning, Disability and Health.

* Corresponding author. Departamento de Fisioterapia, Facultad de Enfermería, Fisioterapia y Podología, Universidad de Sevilla, c / Avicena s/n, 41009, Sevilla, Spain.
E-mail address: carloslm@us.es (C. Luque-Moreno).

https://doi.org/10.1016/j.ctcp.2022.101662
Received 25 March 2022; Received in revised form 6 August 2022; Accepted 18 August 2022
Available online 28 August 2022

benefits in the functional recovery of stroke survivor patients [7]. However, the proposed activities may sometimes be unmotivating [8] and the frequency and intensity of conventional rehabilitation are usually insufficient to achieve maximum possible recovery [7]. Furthermore, motor learning is sustained by positive interaction with the external environment [9] and high-variable training seems to favor balance confidence in post-stroke patients with severe impairments [10]. For this reason, in recent years complementary therapies have been developed to optimize post-stroke rehabilitation [11,12], one of them, being Dance Therapy (DT), because of its close relationship with balance.

Dance is an activity that involves the performance of movements of the whole body, through space and synchronized with music [13]. Some of the most widely used dance modalities are the Argentine tango, ballet and ballroom dancing in older adults, and in the neurological population [14–17]. In a recent systematic review and meta-analysis, Fong Yan et al. [18] highlighted that DT can be considered as an effective alternative exercise modality to improve physical health and outcomes associated with sedentary and inactive behavior in several pathological populations. DT also offers aerobic benefit similar to physical activity programs, as well as to a sense of social well-being [18]. In addition, dance in older adults has improved gait stability, reaction time and balance compared to control an age-matched control group [19,20].

DT has previously been used for rehabilitation in neurological pathologies such as Parkinson's disease and has shown benefits at cardiovascular, cognitive and social levels along with improvements in balance and gait [14,16,17,21]. Recently, a systematic review investigating the effects of dance on neurological conditions other than Parkinson's disease (stroke (only 3 studies included), multiple sclerosis, spinal cord injury and Huntington's disease) have reported improvements in general health, walking and balance similar to those obtained in Parkinson's disease patients [14]. To date, there is no evidence of DT effects specifically dedicated to the post-stroke patients. Despite the fact that post-stroke patients present some clinical manifestations common to other neurological pathologies, their specificity (marked asymmetry, common gait patterns, balance alterations, etc.) can determine specific aspects of the best DT for these patients. In addition, it is necessary to discuss particular aspects, such as the stage of chronicity of the patients (post-stroke time), which is not as decisive in other neurological pathologies, and it may be critical to analyze the feasibility and effects of treatment based on spontaneous recovery at each stage.

The aim of this study was to provide a systematic review of the literature on DT interventions specifically applied to post-stroke patients, with the objectives: (i) to describe the types of DT interventions performed (type of dance, individual/group, intensity, frequency), taking into account the chronicity of the patients; (ii) to investigate the feasibility (in terms of participant dropout, occurrence of adverse events, adherence) and acceptability (in terms of perceived effectiveness and satisfaction) of DT interventions; (iii) to evaluate the effectiveness of DT interventions on motor impairments (balance) and functional activity limitations (gait), in accordance with the International Classification of Functioning , Disability and Health (ICF) model [7,22]; and (iv) to determine the role of the rehabilitation professional in DT for post-stroke patients.

2. Material and methods

2.1. Study design

A systematic review of the literature was carried out according to the *Preferred Reporting for Systematic Reviews and Meta-Analyses (PRISMA)* [23] and the systematic review registration number CRD42020193668 (PROSPERO).

2.2. Search strategy

A systematic electronic search of articles published in the *PEDro*, *Web of Science*, Scopus, *MEDLINE* and *CINHAL* databases was carried out in February 2021 and updated in April 2021. Two evaluators (IAB and CLM) independently conducted the research in the databases and the selection of eligible papers. A third evaluator (MB) was consulted in case of disagreement.

The terms used in the search strategy were "*Stroke*" and "*Dance Therapy*" (as *MeSH terms*) and "*cerebrovascular accident*" and "*Dance*" (as a colloquial language term). Table 1 describes the search process and the results found.

Due to the scarcity of articles that met our inclusion and exclusion criteria, a search was conducted through the grey literature (reference lists of included articles and relevant systematic reviews were hand searched in google scholar, as well as doctoral theses in the DART-Europe, Dialnet-thesis repositories)".

2.3. Inclusion and exclusion criteria

In the present review, different study designs (randomized control trials (RCTs), case studies, case series and case-control) were accepted, due to the small number of RCTs to answer the research question. The PICO question [24,25] was asked: For a post-stroke patient, is DT feasible for improving limitations of body function and/or activities (balance and gait)?

(P) Patients with post-stroke hemiparesis.
(I) DT understood as any intervention or treatment that uses the performance of movements coordinated with music using any dance modality or style.
(C) Comparison with other types of intervention or non-intervention, or no comparation.
(O) Effects on limitations of body functions/activities (balance and gait).

The search filter was used: "articles published in English or Spanish".

Studies that measured the feasibility and acceptability of DT in this type of population were also included.

As exclusion criteria: qualitative, descriptive or non-objective evaluation of study variables.

2.4. Evaluation and methodological quality

The evaluation of the methodological quality of the studies included in the systematic review was carried out through the *Checklist for Measuring Study Quality* (CMSQ) [26] (Table 4), an instrument with proven validity and reliability in different types of studies, obtaining the respective correlation values for criterion validity and intra- and inter-examiner reliability (r = 0.90, 0.88 y 0,.5) [26] and currently recommended in systematic reviews that include different types of experimental design.

Table 1
Search strategy for the different databases.

Database	Search Strategy	Results
PEDro	Stroke AND dance	3
Web of Science	TI=((stroke OR "cerebrovascular accident") AND (dance OR "dance therapy"))	24
Scopus	TITLE((stroke OR "cerebrovascular accident") AND (dance OR "dance therapy"))	10
CINAHL complete	TI((stroke OR "cerebrovascular accident") AND (dance OR "dance therapy"))	7
MEDLINE	TI((stroke OR "cerebrovascular accident") AND (dance OR "dance therapy"))	18
Total	62	

The level of evidence and grade of recommendation was evaluated through the proposed classification of the *Centre for Evidence –Based Medicine de Oxford* (OCEBM) [26] (Table 3), which is one of the most widely used systems of evidence hierarchy in the health field, due to its high degree of specialization according to the type of clinical scenario [27].

3. Results

Based on our inclusion and exclusion criteria, 8 studies were included. Fig. 1 shows an outline of the article selection process, detailing the reasons for exclusion.

3.1. Synthesis of results

The 8 studies selected for the systematic review were analyzed by extracting the most relevant information (Table 2) for their evaluation: author and year, grade of recommendation, level of evidence and study design, characteristics of the sample (number of participants, age and post-ictus time), characteristics of the intervention (duration and modality), variables of interest and their respective measurement tools and the results obtained. Table 3 shows the synthesis of results on the feasibility of the DT intervention.

The included studies were very heterogeneous with a low level of methodological evaluation (between 11 and 21) (Table 4), with 5 case series [27–31], 2 clinical cases [32,33] and 1 randomized controlled trial [34]. Only the latter presented a good grade of recommendation and level of evidence (A, 1b).

All studies had a poor level of evidence and grade of recommendation, showing favorable results, but not conclusive due to insufficient sample size and lack of randomized control groups. The characteristics of the studies show a poor level of internal and external validity as measured by the CMSQ. However, all obtained similar positive results on the variables of interest.

The most relevant characteristics of the studies included in this systematic review are presented in Table 2.

3.2. Participant characteristics

With regard to participant characteristics, the total number of patients was 111, of whom 56 were men and 55 women. Patient age ranged from 47 to 73 years. All were post-stroke patients in different phases of evolution (the inclusion criteria for determining subacute or chronic phase was "having suffered a stroke 1–6 months ago or >6 months ago"). Patients in the subacute phase reported a post-stroke time ranging from 1 to 6 months (2.44 months on average), and those in the chronic phase from 1 to 13 years. Patients with severe cognitive deficits, recent surgeries, serious health status or who did not tolerate a certain amount of daily physical activity were excluded. Most studies exclude patients who are not able to walk independently (with or without technical aids),

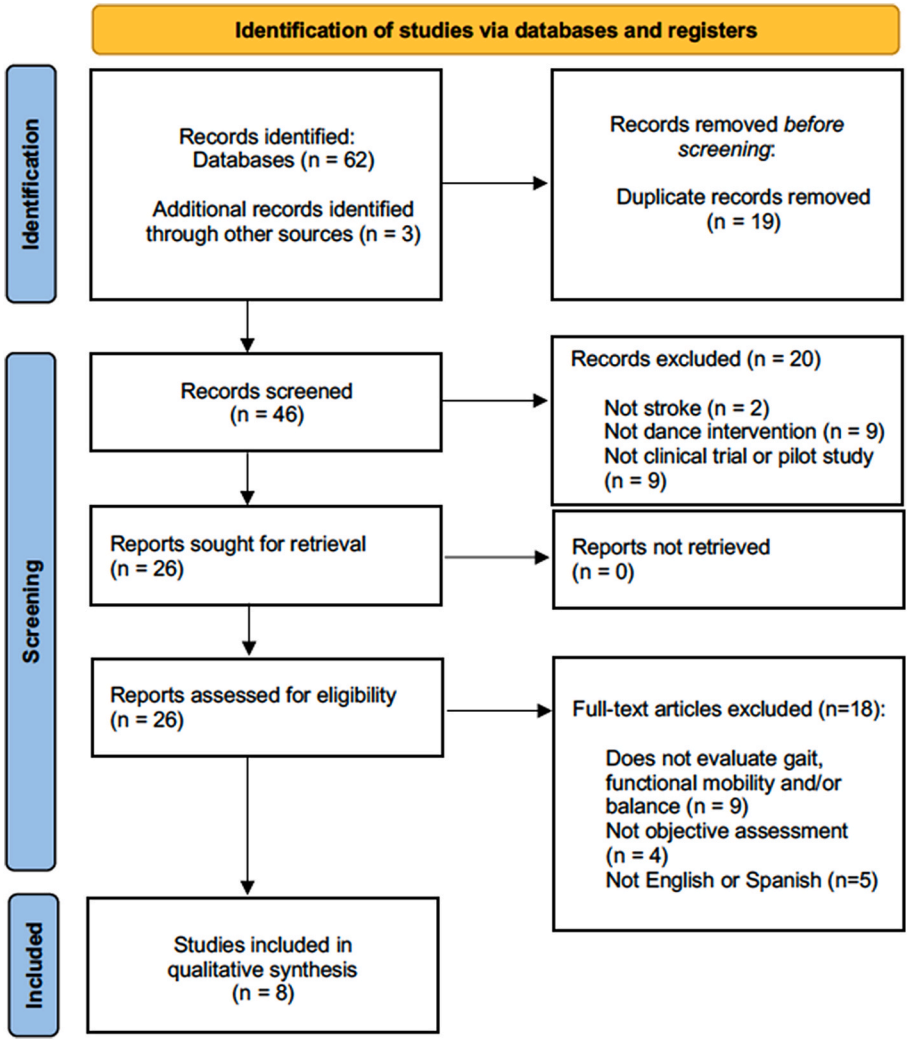

Fig. 1. PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) flowchart.

Table 2
Synthesis of results.

Author and year. (LE, GR)	De-sign	SampleAge (years) *x (sd)*	Post-Stroke time	Intervention	Variables of interest and measurement tools	Results
Dureska 2007[1] (C,4)	CC	n = 1; 48	5 years Chronic	90 min, 3 d/w, 8s. (24 sessions) Ballet. Individual	Balance (BBS, DGI, ABC) STPW (GAITRite®) Functional mobility (TUG)	↑ Balance (pre/post 4 points BBS) and STPW and TUG (pre/4s)
Hackney et al. 2012[2] (C,4)	CC	n = 1; 73	13 years Chronic	90 min, 20 d, 11w. (20 sessions) Tango. Couples	Balance (BBS, FRT, ABC) STPW (GAITRite®) Functional mobility (TUG)	↑ Balance (8 points BBS pre/post and 0.19 m in FRT pre/follow-up)
Demers et al. 2015[3] (C,4)	CS	n = 9; 63.7(11.7)	2.44 m (1,66) Subacute	45 min, 2 d/w, 4w. (8 sessions) *Jazz dance* and merengue. Group	Balance (BBS)	↑ Balance (15,66 points more on average in BBS)
Subramaniam et al., 2015[4] (C,4)	CS	n = 11;	9.72 years (3.32)	85–100 min, 6w. (20 sessions)	Balance (BBS) Voluntary balance control (LOS)	↑ Balance (Significant differences in BBS)
		60,75(5.12)	Chronic	(1°: 5 d/w/2w; 2°: 3 d/w/2w; 3°: 2 d/w/2w.) Just Dance 3 (*Kinect*). Individual	Reactive balance control (MCT) RF (TUG)	Significant differences in CoP response time, movement velocity and maximum excursion.↓ RF (Significant differences in TUG)
Dursun E. et al. 2016[5] (C,4)	RCT	T = 26	T: 38.96 m (35.29)	30 min, 5 d/w,3w. (15 sessions) Tango. Couples	Balance (BBS)	Significant differences in BBS and TUG between T and control group
		47.15(15.5)	Control: 41.87 m (31.68).	T: BTX-A + 45min CPT+ 30min Tango	Functional mobility (TUG)	
		Control = 19 49.21(12,7)	Chronic	Control: BTX-A + 45 min CPT+ 30min CPT		
Patterson et al. 2018[6] (C,4)	CS	n = 20; 62.4 (10.5)	6.4 years (6.0) Chronic	60 min, 2 d/w,10w. (20 sessions) Ballet, contemporary, jazz, folk and Ballroom dancing. Group	STPW (Zeno Walkway, ProtoKinetics) Balance (Mini BESTest)	↑ WS (pre/post 3.7 cm/s), no significant differences STPW ($p > 0.05$). ↑ Balance ($p < 0.05$)
Subramaniam et al. 2019[7] (C,4)	CS	n = 13; 60.75(5.12)	9.72 years (3.32) Chronic	85–110 min, 6w. (20 sessions) (1°: 5 d/w/2w; 2°: 3 d/w/2w; 3°: 2 d/w/2w.) Just Dance 3 (*Kinect*). Individual	Balance: (FRT) RF (ABC, TUG)	↑ paretic UL movement and ↓RF (ABC and TUG)
Micheli Rochetti et al. 2021[8] (C,4)	CS	n = 11; 54.3(15)	+ 1 year Chronic	50 min, 2d/w, 6w. (12 sessions) Bolero basic steps and stretching exercises. Individual	Balance (BBS, FRT) Functional mobility (TUG)	↑ Balance (Significant differences in BBS and FRT)↑ Functional mobility (Significant differences in TUG)

ABC (Activities specific Balance Confidence Scale); **BBS** (Berg's balance scale); **BTX-A** (Botulinum Toxin A); **CC** (clinical case); **CoP** (centre of pressure); **CPT** (conventional physical therapy); **CS** (case series); **d** (day); **DGI** (dynamic gait index); **FRT**(Functional Reach Test); **GR** (Grade of recommendation); **LE** (level of evidence); **LOS** (Limits of Stability test); **m**(months); **MCT** (Motor Control Test); **min** (minutes); **RCT** (randomized control trial); **RF** (risk of falls); **STPW** (spatio-temporal parameters of walking); **sd** (standard deviation); **T** (tango group); **TUG** (Time-up and go test); **UL** (upper limb); **w** (week); **WS** (walking speed).

except for Demers et al. [27], in which some patients were wheelchair-bound and could do part of the intervention sitting down. In the two studies of Subramaniam et al. [29,30], it was absolutely essential to maintain independent standing without technical aids for at least 5 min, as it was impossible to perform the intervention in any other way.

Only 1 out of the 8 studies reviewed carried out the intervention in patients with subacute stroke phase [27].

Only 2 studies [27,28] determined previous dance experience through questionnaires; 60% of the patients in the Patterson et al. [28] study had previous experience. One study mentioned [31] "previous contact with dancing" as non-inclusion criteria. Demers et al. [27] defined having received formal dance training before the stroke as "having received dance classes for more than one year as an adult". Participants reported that DT was challenging but fun (3 patients out of 7 who dropped out did so because they did not like the intervention).

3.3. Dance intervention characteristics

Total duration of the DT program of ranged from 3 to 11 weeks, with an average of 6.75 weeks. The dance sessions were provided with a frequency of 2–5 sessions a week, with an average of 2.6 sessions a week. Furthermore, duration of the dance sessions ranged from 30 to 110 min (including the corresponding breaks), with an average of 69.4 min.

All dance modalities followed basic principles such as rhythm, coordinating movements, weight changes and balances. A rehabilitation professional with knowledge and experience in the discipline of dance could adapt any step to the needs of his patients, providing one more tool to add to the wide range of techniques used in neurological rehabilitation.

Group therapy has shown beneficial effects at the psychosocial and community integration levels [35]. 4 studies use the individual modality [29–32], 2 in couples [33,34] and 2 do the intervention in groups [27,28].

As regards the DT programs mentioned in the studies included in this review, 2 were provided by interdisciplinary health care staff [27,34], 1 by a physiotherapist student with 10 years of practice in dance and 3 by dance instructors with previous experience working with elderly people or those with functional limitations [28,32,33]. Finally, 2 studies did not indicate who performed the intervention [29,30].

3.4. Dance therapy feasibility and acceptability

These results are detailed in Table 3. Five studies [27–29,31,34] reported on participants who dropped out, with a mean rate of 18%. Common reasons were another disease, did not like the intervention or difficulty of attendance. Four studies [28,30,32,34] reported attendance, and only 2 [28,32] reported absences, and the reasons for missed classes commonly included scheduling conflicts, bad weather, personal issues, or illness.

None of the studies report adverse events. On some occasions, reference was made to fatigue ("I worked hard, I'm tired" and also "I feel

Table 3
Synthesis of results (Feasibility).

Author and year. (LE, GR)	Adverse events	Adherence (dropout and reasons)	Participant perception and satisfaction	Compliance (attendance)
Dureska 2007	Not reported	N = 0/1	Not reported	Lapses in duration of study. Vacation or sick leave.
Hackney et al., 2012	Not reported	N = 0/1	Exit questionnaire: He wanted the program to continue because of perceived benefits for his mobility, balance, and QOL.	Not reported
Demers et al., 2015	None	N = 7/9 (4 discharged from rehabilitation before completion of eight dance sessions and 3 they did not like the intervention)	Challenging, enjoyable activity and it was great to complement to their usual therapies. 7 dropped out and did not enjoy the intervention.	Not reported
Subramaniam et al., 2015	None	N = 0/11	IMI Scale. Significant main effect of training on motivation [F (2, 20) = 36.677, (p < 0.01)].	Most of the participants were adherent to the rehabilitation paradigm in this study (98% for vigorous first two weeks, consisting of 5 sessions/week and 100% for two weeks of 3 sessions/week and last two weeks of 2 sessions/ week).
Dursun et al., 2016	None	N = 0/26	"All the participants were very proud for their achievements".	It was observed that none of our participants had to discontinue tango class or additional conventional rehabilitation sessions because of extreme fatigue.
Patterson et al., 2018	Not reported	N = 2/20 (before starting the intervention. 1 would not be able to attend the dance classes regularly and 1 was no longer interested)	Exit questionnaire: "I loved it. It helped me be confident in walking without my cane. I enjoyed being in a group with others with stroke."	The median number of classes attended out of a maximum of 20 was 19 (Q1 = 18, Q3 = 20). Throughout the entire study period a total of 10 classes were missed across eight participants. The average attendance rate was 92.5% of dance classes across all participants.
Subramaniam et al., 2019	None	N = 2/13 (1 difficult to commute to the laboratory and 1 technical problem during data collection)	Not reported	Not reported
Micheli Rochetti et al., 2021	Not reported	N = 6/12 (3 other diseases, 2 did not accept to stop conventional physiotherapy and 1 missing sessions)	Not reported	Not reported

IMI: Intrinsic Motivation Inventory; **QOL:** quality of life.

as tired as after a good session of physio" [27]; "not very intense" [31]) but in no case was it a problem for the participants, who could rest if they needed it or had scheduled breaks. Participants reported that DT was challenging but fun (3 patients out of 7 who dropped out did so because they did not like the intervention) [27]. Falls were not reported and, in general terms, the patients felt more confident to move and less in fear of falls.

Participant perception and satisfaction was assessed by Exit questionnaire [28,33], Intrinsic Motivation Inventory (IMI) Scale [30] or by subjective questions [27,34]. The main results were positive, except for 3 participants did not like dance intervention [27]. The participants felt more confident, and they enjoyed meeting other people with similar conditions (Table 3). Some wished to continue or lengthen DT [27,28, 33].

3.5. Outcomes according to the ICF

The results reported in the different selected studies refer to the body functions/activities levels of the ICF [22], specifically those corresponding to gait and balance.

3 of the selected articles [28,32,33] objectively studied spatio-temporal parameters of walking (STPWs) in chronic post-stroke patients, without significant differences in these parameters after the DT intervention. 2 of them investigated gait with the GAITRite® system [32,33] and another through pressure measurement system (Zeno Walkway™, ProtoKinetics) [28]. The latter study [28] evaluated gait at the self-pace walking speed, and reported an improvement of 0.027 m/s from pre to post-intervention. However, STPWs were not improved significantly after the dance intervention. Hackney et al. [33] also evaluated gait speed during the 6-min walking test in three conditions, normal gait speed, reverse gait and fast gait, and they obtained changes of +0.20 m/s, +0.10 m/s and 0.00 m/s, respectively. Dureska's study [32] evaluated STPWs with and without technical aids (such as a cane). The improvement in walking speed was similar with or without a cane (0.104 m/s and 0.116 m/s, respectively). They also highlighted that greater improvement was observed after 4 weeks (halfway through the intervention), and they attributed the lack of results during the final 4

Table 4
Methodological evaluation of selected studies according to the Checklist for Measuring Study Quality (CMSQ). Source: Downs SH, Black N. The feasibility of creating a checklist for the assessment of the methodological quality both of randomised and non-randomised studies of health care interventions. J Epidemiol Community Health. 1998; 52(6):377-84[32].

Cheklist/ítems	Dureska 2007[35]	Hackney et al., 2012[36]	Demers et al. 2015[37]	Subramaniam et al., 2015	Dursum et al. 2016[38]	Patterson et al. 2018[39]	Subramaniam et al., 2019	Rochetti et al., 2021
Quality of the study:	**6**	**6**	**6**	**7**	**7**	**7**	**7**	**6**
1. Hypothesis/objective	1	1	1	1	1	1	1	1
2. Results	1	1	1	1	1	1	1	1
3. Inclusion/exclusion criteria	1	1	1	1	1	1	1	1
4. Intervention	1	1	1	1	1	1	1	1
5. Confounding factors	0	0	0	0	0	0	0	0
6. Conclusions	1	1	1	1	1	1	1	1
7. Random variability	0	0	0	0	0	0	0	0
8. Adverse effects	0	0	1	0	0	1	0	0
9. Losses in follow-up	0	0	0	1	1	1	1	0
10. Values of probability	1	1	0	1	1	0	1	1
External validity:	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**
11. Patient Participation Request	0	0	0	0	0	0	0	0
12. Patients' representative of the population	0	0	0	0	0	0	0	0
13. Staff, place and facilities representative	1	1	1	1	1	1	1	1
Internal validity	4	4	4	8	8	4	8	5
14. Blinded subjects	0	0	0	0	0	0	0	0
15. Blinded examiners	0	0	0	0	0	0	0	0
16. Filtration of clear information	0	0	0	0	0	0	0	0
17. Tracking length adjustments	0	0	0	1	0	0	1	0
18. Test statisticians appropìate	0	0	0	1	1	1	1	1
19. Compliance with the intervention	1	1	1	1	1	1	1	1
20. Outcomes measures precise	1	1	1	1	1	1	1	1
21. Recruitment subject of study	1	1	1	1	1	1	1	1
22. Subject recruitment period	1	1	1	1	1	1	1	1
23. Radonmization groups	0	0	0	1	1	0	1	0
24. Assignment randomized intervention (subjects and examiner)	0	0	0	0	1	0	0	0
25. Correction confounding factors	0	0	0	0	0	0	0	0
26. Losses of subjects in follow-up	0	0	0	1	1	1	1	0
Statistical power	**2**	**0**	**2**	**5**	**5**	**5**	**5**	**2**
27. Sufficient power to detect clinical effects in sizes sample	2	0	2	5	5	5	5	2
Total score	**13**	**11**	**13**	**21**	**21**	**17**	**21**	**17**
Percentage (%)	**40,62%**	**34,37%**	**40,62%**	**65,62%**	**65,62%**	**53,12%**	**65,62%**	**53,12%**

weeks to numerous absences.

All the studies included in this review evaluated balance directly or indirectly, and the most widely used scale to objectify such changes was Berg's balance scale (BBS) [27,30–34], Time-up and go test (TUG) [29–34], the Functional Reach Test (FRT) [29,31,33] and the Mini-BESTest [28], with general significant results in favor of the DT intervention.

Demers et al. [27] obtained a significantly improved balance outcome (BBS) with an average of 15.7 points of difference from the initial assessment. Hackney et al. [33] obtained an 8 points improvement of the BBS score, while Dureska [32] reported a 4 points benefits. In the same line, Dursun [34] found significant improvement in the balance outcome in the tango group compared to the control group in subacute post-stroke patients [27] (<6 months). The study by Patterson et al. [28] showed significant improvement in balance evaluated with the MiniBESTest [36] ($p = 0.0005$).

Subramaniam et al. [29] showed that the TUG changes after DT intervention were significantly correlated with changes in the flexion angle of the shoulder joint in the functional stand-reaching test ($R^2 = 0.52, p < 0.05$), highlighting the importance of the upper limb in balance reactions in post-stroke patients. In addition, Subramaniam et al. [30] and Micheli Rochetti et al. [31]. showed significant TUG improvement from pre to post DT intervention. Hackney et al. [33] reported TUG performance improvement of 1s from pre to post- DT intervention and 1.7s from pre to 1-month follow-up. In the case-control study [34] an average TUG change was obtained in the DT and the control group of 4.98 ± 7.1s and 2.65 ± 5.3s, respectively ($p = 0.421$). Furthermore, the clinical case with ballet [32] intervention showed an improvement of 5s on the TUG.

4. Discussion

DT was performed as complementary rehabilitation approach in post-stroke patients in subacute or chronic phase. From the 8 included studies in this systematic review, DT showed feasibility and acceptability for post-stroke patients who are able to stand or using a wheelchair, through individual, couple or group sessions. The most common DT program was offered 2–3 times a week (1 h/session) for 6–7 weeks [37], and interventions close to 1 h could be more highly recommended to achieve motor engagement [39]. While DT showed promising but not significant improvement for gait speed, significant benefits were reported on balance after DT intervention.

4.1. Participant characteristics

Demers et al. [27] used DT in subacute post-stroke patients and

showed a greater capacity of recovery than chronic post-stroke patients. The authors suggested that this finding was due to the greater spontaneous neuroplasticity that has been previously observed in subacute rather than chronic post-stroke patients [40,41]. Interestingly, the proposed approach of these authors was to include patients with severe functional limitations, such as being wheelchair-bound, to benefit from early intervention through DT, in line with other qualitative studies [39]. It is essential to determine the benefits in subacute and chronic phases, and to identify whether the improvement in patients in the subacute phase is due to spontaneous recovery [42] or to the intervention itself. In this review, due to the heterogeneity of the experimental design we were unable to compare changes in balance without any distinction between stroke phases. Nevertheless, all studies reported significant improvement in balance, which could indicate, in line with the literature [42], that response to DT is independent of post-stroke phases, as long as an individualized treatment plan is designed with realistic objectives.

Previous experience in DT activity could significantly influence the level of therapeutic adherence, as well as the motor skill memory of movements [17]. However, patients, regardless of their previous experience of dance, enjoyed practicing DT, showing the feasibility of DT in a population with subacute and chronic stroke. While DT could be intimidating for people who have not previously participated in dance classes [16], Demers et al. [27] reported that DT was challenging and fun for the patients. Previous dance experience could nevertheless be taken into account by adjusting the level of the DT programs proposed to post-stroke patients, in addition to their functional capacities. All in all, DT could be considered as a good complement to conventional rehabilitation to ensure motivation and adherence to the rehabilitation program. Three of the studies [27,28,30] also report no adverse effects, which supports DT feasibility.

4.2. Dance intervention characteristics

All dance modalities follow basic principles such as rhythm, coordinated movements, weight changes and balances. More specifically, the Tango or adapted Tango, which is practiced by two people [15], provides great safety and allows the patients to perform the DT rehabilitation program without technical aids. This condition also helps patients to safely explore their functional limit capacities. In another way, when DT is administrated in a group, it should be small in order to control the needs of each individual and to provide more individualized attention. To increase safety, the collaboration of volunteers could be of help [43,44], and an adapted dance intervention (including ludic-inclusive components in addition to the functional aspect) [45] could be carried out with patients seated on chairs, favoring the participation of those in a subacute stage [39]. The greatest strength of group DT in subacute post-stroke rehabilitation is that it has a perceived positive impact on mental functions, personal factors, motivation, and interpersonal and social interactions. This type of intervention represents an innovation for patients and could help to intensify their mobility [10], functional recovery, perceived effort [39] and endurance, with only minimal effects on fatigue [38]. A rehabilitation professional (usually physical or occupational therapists) [45] with knowledge and experience in the discipline of dance [31] or collaborating with dance artists [46], could therefore adapt the steps to patient needs, guiding and assisting the upper hemiparetic side. He/She could also use different types of dance, individual or by pair, to meet individual patient preference [47] and ultimately optimize attention/concentration and therapy adherence. In this sense, some descriptive studies on the use of DT in post-stroke patients highlight the importance of the characteristics of the dance instructor carrying out an adjusted intervention [37] and planning the intervention in virtual environments [29,30,48]. Positive results at the level of the autonomic nervous system through aerobic training in virtual environments suggest that a more aerobic intervention [48] would entail distinct advantages [49]. DT could be considered as one more valuable tool in the wide range of techniques used in stroke rehabilitation.

4.3. Dance therapy feasibility and acceptability

Dropout rates (18%), when reported, are in line with neurological conditions other than Parkinson's disease [14], and significantly lower than in Parkinson's disease [50,51]. The low drop-out rates reported in the studies by Subramaniam et al. [29,30] could suggest that the use of virtual reality, which provides extra motivation, could be the key, as reported by participants. Losses due to patients not liking the intervention could be related to preferences for other activities as a complement to conventional rehabilitation. However, the adverse effects were null, so DT has been shown to be shown as a safe intervention, as long as it meets the standards described in the studies. Future studies are necessary to determine the profile of patients who most likely to benefit from this intervention.

The perception of improvement and satisfaction was, in general terms, very positive in all five studies in which they were reported, and shows high acceptability of the DT intervention by the patients.

4.4. Outcomes according to the ICF

The loss of mobility and gait in stroke survivors still represents a major challenge in rehabilitation [65], and it is associated with alteration of independence, social engagement and quality of life [66–68]. A qualitative study reported beneficial effects in physical, emotional and social aspects of the post-stroke patient [69] and, although none of the studies have directly evaluated participation as an outcome, these results might be influenced by the level of the ICF, and future studies need to be more thoroughly documented [70]. A walking speed of 1 m/s or less is associated with limitations in daily life activities and community life, and a speed less than 0.6 m/s is associated with a higher probability of hospitalization [71]. Although it has been recommended in order to eliminate error and inter-patient variability to observe an improvement of 0.3 m/s [72] after rehabilitation program, a change in 0.1–0.2 m/s can also be considered as clinically relevant [73]. The three studies that assessed gait reported limited benefits from no change to an increase of 0.20 m/s. Furthermore, Hackney et al. [33] assessed backward walking speed and reported an improvement of 0.10 m/s. While limited, these results suggest that Tango exercises, and more broadly, DT rehabilitation programs, could help to improve gait in different directions and should be evaluated in ecological situations in future studies.

It has been clearly established the literature that stroke-induced balance disorders are associated with various somatosensory impairments, motor dysfunction, and perceptual and visual disturbances [52–55]. The 8 studies included in this systematic review showed improvement in balance after DT intervention performed individually or in groups [28,32]. It is worth noting that the greatest clinically relevant (>6) [56] balance improvement (>15 points in BBS) [27] was observed in a subacute post-stroke patients. Even with no evidence, we can suggest that an early stage of stroke DT intervention might result in an optimal rehabilitation program associated with neuroplasticity [40].

DT is a global therapy involving the whole body. To date, it is unclear which mechanisms could be mainly involved in balance rehabilitation with DT. However, it has been reported that post-stroke patients were more receptive to visual information compared to healthy counterparts [55,57]. While some evidence of rehabilitation efficacy could emerge with therapy directly related to visual information such as virtual reality [57–61], future studies are needed to investigate sensory reweighting after DT intervention in post-stroke patients, and its influence on body awareness [62].

Subramaniam et al. [29] showed that improvement of upper limb flexion angle of the shoulder and reaction time after 10 DT training sessions was correlated with changes in TUG test in 13 post-stroke patients. It was also previously reported that improved reaction time and

functional capacity of the upper limbs is helpful for stability recovery and fall avoidance [63].

Although most of the studies have focused their evaluation on balance and gait, assessment of upper limb performance of DT rehabilitation of stroke can be considered as clinically relevant to maintain equilibrium in dynamic conditions, as in reaching and grasping tasks.

From a case report, Hackney et al. [33] reported that 20 sessions of Tango led to improved TUG. It has been shown that dynamic balance measures [63] (such as the TUG) are greater predictors of the risk of falls than walking speed or static balance test. The authors also found increased TUG performance with dual cognitive task (count backward) and suggested that the multitask nature of the tango involving music, current and future step patterns, partnering with other dancers, could be related to the dual task benefit. All in all, these findings suggested that DT can improve cognitive interference treatment in motor tasks in stroke survivors, notably while walking [33,64].

4.5. Limitations and perspectives

While our review has objectives related to feasibility that are part of a scoping review (clarify key concepts and definitions; examine how research is carried out in a field; identify key characteristics and factors; identify and analyze knowledge gaps), it also has objectives related to DT effects (such as determining, as much as possible, the incipient evidence on the effectiveness of this discipline in post-stroke patients) that would be framed in a systematic review. In the present study, we can neither meet the requirements to produce statements to guide decision-making, nor report the risk of bias of the different studies).

Despite the fact that the terminology related to stroke is quite broad, only the terms “stroke” AND “cerebrovascular accident” were taken into account in the search strategy, since other Entry Terms recommended by MeSH such as Brain Vascular Accident, Apoplexy did not give new results. We avoided using the term hemiplegia because it could be due to brain damage unrelated to stroke. Adding the term hemiplegia did not influence our results or number of included studies.

This study has limitations due to the scarcity of studies with a high level of evidence (only one RCT). Furthermore, the heterogeneity of types of dance, the number and the duration of sessions, and the different follow-up periods did not allow meta-analysis. While our systematic review showed promising DT rehabilitation on the ICF levels of body functions/activities (balance and gait), future studies are needed to determine the dose-response of the DT, while also taking into account other levels of the ICF such as participation. In addition, DT combined with virtual reality could help to standardize DT. The analysis carried out in the present study can contribute to the implementation of future RCTs.

5. Conclusions

Although DT is complementary to conventional rehabilitation in pathologies such as Parkinson’s disease, there are very few studies that report this type of intervention in post-stroke patients, despite its high prevalence and frequent alterations in walking and balance. We cannot strongly conclude about its feasibility since the dropout data are inconsistent, and future studies will be necessary to reach a consensus. However, in the studies included, it was shown to be a safe intervention, without adverse effects and with high satisfaction and good perceptions by the participants.

Given the heterogeneity and uneven quality of the included studies, strong evidence has not been provided on the effectiveness of DT in post-stroke body functions/activities. Future studies would also include activities/participation and personal and environmental factors. DT seems to be safe, particularly when performed with a rehabilitation professional trained in neurological pathology and dance. Group dance seems to achieve better benefits in terms of social integration, while through individual intervention the needs and objectives of each patient can be better established. The most widely used dance modality was tango and ballet, with sessions ranging from 30 to 110 min. The tango modality seems to achieve better results due to the performance of steps in a couple. Therapeutic dance can be considered as a complementary tool for rehabilitation in stroke survivors, in both subacute and chronic phases. Nevertheless, future high-quality studies are needed to determine the dose-response characterization and to standardize the clinical approach.

Declaration of interest

Authors have nothing to disclose.

Acknowledgement

We thank Jeffrey Arsham for his proofreading of the manuscript and his suggestions regarding medical writing.

Appendix A. Supplementary data

Supplementary data related to this article can be found at https://doi.org/10.1016/j.ctcp.2022.101662.

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