

# Feasibility of dance therapy using telerehabilitation on trunk control and balance training in patients with stroke

## A pilot study

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### Abstract

**Background:** This randomized controlled trial aimed to investigate the effects of dance therapy using telerehabilitation on trunk control and balance training in patients with stroke and compare them with the effects of conventional treatment.

**Methods:** We enrolled 17 patients with subacute or chronic stroke who were randomly assigned to either an experimental or a control group. In addition to conventional physical therapy, the experimental group (n = 9) participated in 40-minute, non-face-to-face, dance-therapy sessions and the control group (n = 8) received conventional physical therapy. The primary outcome measures were the Trunk Impairment Scale (TIS) scores to assess trunk control and balance function between the 2 groups as a measure of change from baseline to after the intervention.

**Results:** We found that the TIS scores of the patients in the experimental group significantly improved ( $P = .017$ ). The TIS results indicated non-inferiority within a predefined margin for dance therapy using telerehabilitation (difference = -0.86, 95% confidence interval [CI] = -2.21 to 0.50).

**Conclusion:** Dance therapy using telerehabilitation significantly improved the TIS scores in the experimental group and was not inferior to conventional rehabilitation treatment when compared in a non-inferiority test. The remote dance program may therefore have similar effects to those of conventional treatment regarding trunk-control improvement in patients with stroke.

**Abbreviations:** ADLs = activities of daily living, BBS = berg balance scale, CI = confidence interval, COVID-19 = coronavirus disease, EQ-5D = EuroQoL 5 Dimension, FAC = functional ambulation categories, K-MBI = Korean modified Barthel index, PD = Parkinson disease, QoL = quality of life, TIS = trunk impairment scale, TUG = timed up and go.

**Keywords:** dancing, postural balance, stroke, telerehabilitation

## 1. Introduction

Stroke is a leading cause of disability worldwide, with approximately 105,000 people in South Korea experiencing new or recurrent stroke annually.<sup>[1]</sup> Stroke can result in a broad range of disabilities, including impairments in mobility, strength, vision, swallowing, language and communication, fatigue, and emotionalism. Among these negative sequelae, balance impairment is a significant and long-term issue in patients with stroke. Most activities of daily living (ADLs) – including sitting, standing, and

gait – are related to balance function, and higher levels of balance impairment are related to decreased physical impairments and increased disability. Balance impairments are also negatively associated with cognitive and emotional variables, such as depression, cognitive functioning, and anxiety. Owing to the relationship between balance and these important variables, it stands to reason that impaired balance is closely associated with quality of life (QoL) after stroke.<sup>[2]</sup> Additionally, impaired trunk control is common among stroke survivors.<sup>[3]</sup> These impairments are directly associated with an increased risk of falls,

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impaired mobility, and participation restrictions, which could also lead to severe disability and dependency in patient ADLs.<sup>[4]</sup>

Dance therapy was shown to improve gait and balance in individuals with neurological conditions, such as stroke and Parkinson disease (PD).<sup>[5,6]</sup> A systematic study demonstrated that dance therapy effectively enhanced gait and balance function in patients with neurological conditions, excluding PD, and patients reported higher satisfaction than with conventional treatment.<sup>[7]</sup> Additionally, dancing provided aerobic benefits similar to those of walking programs and was associated with both emotional and social wellbeing.<sup>[8,9]</sup> Despite the limited number of studies, similar effects were observed in patients with stroke regarding dance therapy; therefore, we considered the potential of dance programs as novel interventions to improve gait and balance in individuals with chronic stroke.

Prior to the coronavirus disease (COVID-19) pandemic, conventional rehabilitation strategies for patients with stroke involved face-to-face exercise interventions between the physical therapist and patient; however, as COVID-19 is transmitted via person-to-person contact, the importance of telerehabilitation – which provides non-face-to-face rehabilitation services using electronic communication technology – has been highlighted. Therefore, we considered that dance therapy using telerehabilitation may be an effective and feasible treatment. This pilot study aims to investigate the effect of dance therapy using telerehabilitation on trunk control and balance training in patients with stroke and to verify non-inferiority compared to conventional treatment.

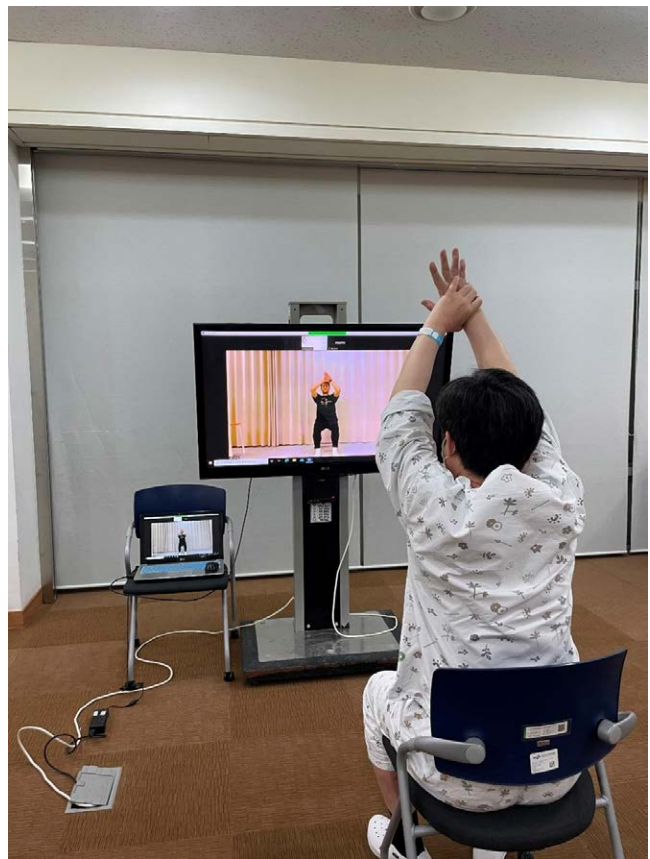
## 2. Method

### 2.1. Participants

This was a randomized controlled trial. A total of 17 patients with subacute or chronic stroke (from 1 month to 24 months of onset) were randomly assigned to either an experimental or control group; all participants were inpatients recruited from the Department of Rehabilitation Medicine of Pusan National University Yangsan Hospital. Patients were randomly allocated to the experimental group or conventional intervention group in a 1:1 ratio using a computer-generated randomization sequence. The assigned group was determined by the consecutive opening of sealed opaque envelopes that contained the name of the group; these envelopes were placed in a plastic container. Randomization was performed centrally, and group allocation was sequentially communicated to the sites via text message. The inclusion criteria were hemiplegia occurring >1 month after the first occurrence of stroke, ability to maintain a sitting posture alone and walk 10 m independently or with the aid of a minimum assistive device, and the ability to tolerate 40 minutes of activity. The exclusion criteria were severe cognitive, visual, or hearing functional impairments; lower extremity musculoskeletal abnormalities or injuries, neurological diseases other than stroke, and preexisting conditions that affect balance function. The study was approved by the Pusan National University Yangsan Hospital Institutional Review Board for human participants (No. 30-2019-012), and informed consent was obtained from all participants.

### 2.2. Intervention

In addition to conventional physical therapy, the experimental group (n = 7) participated in 40-minute, non-face-to-face, dance-therapy sessions – twice a week for 3 weeks – with a dance instructor experienced in working with people with physical disabilities. To create an environment that resembled home-based telerehabilitation as closely as possible, the dance program was conducted in an independent space through real-time desktop videoconferencing using Zoom (Zoom Video Communications Inc, San Jose, CA); 2-way audio-visual communication enabled interaction between the parties, allowing the dance instructor to guide the participants. Desktops and TV monitors with video



**Figure 1.** Dance program through real-time desktop videoconferencing using Zoom.

cameras were installed in front of the space; this enabled the dance instructor to observe the participants and provide real-time feedback and modification as required, as well as facilitate peer support from other participants (Fig. 1). For safety purposes, any obstacles were removed, and a caregiver participated in the dance program along with the patient; the researcher monitored the occurrence of any safety accidents, such as falls, from outside the classroom. The control group (n = 7) received conventional physical therapy for the duration the experimental group received therapy (the dance program in addition to existing conventional physical therapy).

### 2.3. Dance protocol

Kara et al<sup>[5]</sup> reported that dance programs are safe and feasible for patients with chronic stroke. The protocol of this study was based on the Dance for PD<sup>[6]</sup> has been newly applied to stroke patients. This study was performed by a professional therapist (choreographer) who completed Dance for PD reconstructing movements that can help balance or gait function in consideration of the characteristics of hemiplegic patients.<sup>[6]</sup> Each participant in the experimental group (n = 7) attended a 40-minute virtual dance class bi-weekly for 3 weeks. The typical structure of a dance class is described in detail, with examples, in Table 1. Generally, classes began with a warm-up while sitting, which transitioned into chair and/or standing choreography; this was followed by dance-skill practice at the center of the room.

### 2.4. Outcome measures

All data were collected by trained physiotherapists and doctors. Demographic and stroke characteristic data included age, sex, height, weight, time since stroke, type of stroke, and side

**Table 1**  
**Structure and content of a typical dance class.**

Elements	Example activities
(1) Introduction and warm-up	<ul style="list-style-type: none"> <li>• Focus on active range of motion and stretching of arms and legs while sitting.</li> <li>• Use of levels; e.g., reaching arms above the head and down toward the floor.</li> </ul>
(2) Chair and/or standing choreography	<ul style="list-style-type: none"> <li>• Focus on strength and balance.</li> <li>• Use of back of chair for support if needed.</li> <li>• Dance movements for strength encouraged arm movement against gravity; closed kinetic chain, distribution of body weight resisted exercise of the legs.</li> <li>• Dance movements for balance encouraged by adjusting the size of the base of support and arm reaching outside the base of support.</li> </ul>
(3) Dance skills	<ul style="list-style-type: none"> <li>• Working in pairs with either dance volunteers or other participants based on functional balance and independence.</li> <li>• Focus on moving throughout the space, coordinating movements of the head and arms with a continuously changing base of support (i.e., walking/dancing across the floor).</li> </ul>
(4) Closing	<ul style="list-style-type: none"> <li>• Partnered dance styles included: the Cha-cha, Waltz, and Box step.</li> <li>• Ending class with bows</li> </ul>

of hemiparesis. The primary outcome measures were the Trunk Impairment Scale (TIS) scores to assess trunk control and balance function between the 2 groups as a measure of change from baseline to after the intervention. The effects of dance therapy using telerehabilitation were compared with those of conventional therapy through the TIS. Secondary outcomes included significant changes in the Berg Balance Scale (BBS), Timed Up and Go (TUG) test, Functional Ambulation Categories (FAC), and Korean Modified Barthel Index (K-MBI) scores after therapy. Health-related QoL was measured using the EuroQoL 5 Dimension (EQ-5D) tool.

**2.4.1. Trunk impairment scale.** The assessment for trunk impairment such as paresis was carried out using the TIS. The TIS has 17 provisions: static equilibrium ( $n = 3$ ), dynamic equilibrium ( $n = 10$ ), and core's coordinated abilities ( $n = 4$ ). The TIS score ranges from 0 to 23, with higher scores indicating good core control. Inter-tester reliability and intratester reliability were 0.87 to 0.96 and 0.85 to 0.99, respectively, indicating high reliability and internal validity.<sup>[10]</sup>

**2.4.2. Berg balance scale.** The valid and reliable BBS – a physical performance measure commonly used both in rehabilitation research and clinical practice – was included as a measure of balance.<sup>[11,12]</sup> It includes 14 items designed to assess both static and dynamic balance. Scoring ranges from 0 to 56, with higher scores indicating better balance; a score of 46 or lower indicates balance impairment and fall risk and may be used to predict post-stroke fall risk.<sup>[13]</sup>

**2.4.3. Timed up and go test.** The TUG test was used to determine the functional movement and locomotion necessary for sitting, standing, and walking. Participants were seated in a chair with an armrest and were instructed to stand upon the verbal instruction “Start,” pass the turnaround at the 3-m mark, and sit back on the chair. The measurements were repeated in triplicate using a stopwatch, and the average value was recorded.<sup>[14]</sup>

**2.4.4. Functional ambulation categories.** Ambulatory activity was measured using the FAC, a reliable, valid, and responsive assessment tool that distinguishes between 6 levels of walking ability. A score of 0 denotes that the participant cannot walk, while scores of 1, 2, and 3 represent a dependent walker who requires support from another person in the form of continuous manual contact (1), intermittent manual contact (2), and supervision (3). Scores of 4 and 5 denote an independent walker who can only walk on a level surface (4), or any surface, including stairs (5).<sup>[15]</sup>

**2.4.5. Korean modified barthel index.** The K-MBI evaluates independence concerning ADLs in patients recovering from

stroke. This test comprises 10 subtests regarding ADLs. Depending on the amount of assistance needed, the subtest is graded using a 5-point scale; the lowest total score is 0, and the highest total score is 100. Higher scores indicate more independence in ADLs.<sup>[16]</sup>

**2.4.6. Quality of life.** Health-related QoL was measured using the EQ-5D,<sup>[17]</sup> which comprises 5 items regarding mobility, self-care, usual activity, pain/discomfort, and anxiety/depression, to assess the current health of the participants. Each item has 3 possible responses; the response that best described the current health status was chosen by the respondent to evaluate health-related QoL. The EQ-5D quality weight correction score (EQ-5D index) was calculated based on calculation methods and standards suggested by the Korea Disease Control and Prevention Agency.<sup>[18]</sup>

## 2.5. Statistical analyses

Statistical analysis was performed using SPSS software (version 20.0; IBM Corp., Armonk, NY). Categorical variables were assessed using the chi-squared test, and continuous variables were analyzed using the Mann–Whitney *U* test. To determine non-inferiority, we hypothesized that dance therapy using telerehabilitation through a real-time, 2-way video communication system would not be inferior to conventional rehabilitation treatment by the non-inferiority margin. The predefined, 1-sided non-inferiority margin was calculated as a reflection of a minimal clinically important difference (TIS: 3.5).<sup>[19]</sup> For the non-inferiority analysis, the 1-sided 95% confidence interval (CI) was reported according to the 1-sided non-inferiority margin. The Wilcoxon signed-rank test was used for intra-group comparisons of the secondary outcomes before and after treatment, while repeated-measures analysis of variance was performed for inter-group comparison. The statistical significance for all analyses was set at  $P < .05$ .

## 3. Results

### 3.1. Participants

Of the 17 patients enrolled in the present study, 9 were allocated to the experimental group and 8 were allocated to the conventional group (Fig. 2). Two patients were transferred to another hospital and dropped out of the experimental group, and 1 patient discontinued conventional treatment because of general deconditioning; therefore, this patient was excluded from the dataset. Table 2 shows the patient characteristics, including age, sex, height, weight, time after stroke, stroke subtype, and side of hemiparesis. There were no statistically significant differences in patient characteristics between the 2

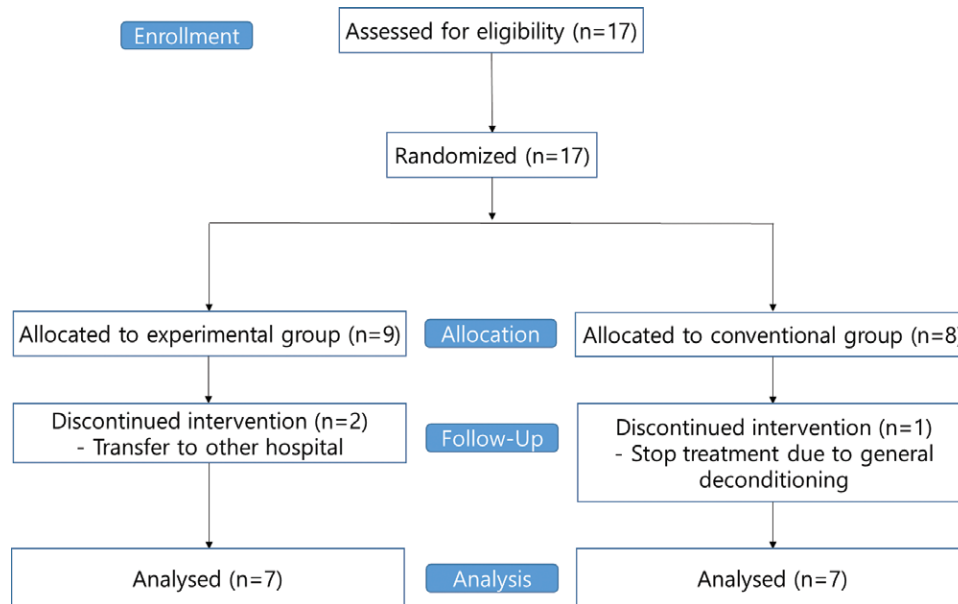


Figure 2. Study flowchart.

**Table 2**  
Patient demographics.

Variable	Experimental group	Control group	P value
Patients (n (%))	7 (50%)	7 (50%)	
Age (years)	54.71 ± 17.08	61.14 ± 14.45	.462
Sex			1.000
Male (n (%))	5 (71.4%)	5 (71.4%)	
Female (n (%))	2 (28.6%)	2 (28.6%)	
Height (cm)	167.00 ± 7.07	158.50 ± 15.39	.209
Weight (kg)	64.29 ± 12.82	59.43 ± 15.26	.531
Time after stroke (days)	159 ± 113.02	113 ± 267.00	.290
Stroke subtype			.577
Ischemic	4 (57.1%)	5 (71.4%)	
Hemorrhagic	3 (42.9%)	2 (28.6%)	
Side of hemiplegia			.127
Right	7 (100%)	5 (71.4%)	
Left	0 (0%)	2 (28.6%)	

The values are mean ± SD or number (%).

\* $P < .05$

groups ( $P > .05$ ). No adverse events were observed in either group during the study.

### 3.2. Outcome measures

**3.2.1. Primary outcome.** The patients in the experimental group demonstrated a significant improvement in TIS scores ( $P = .017$ ). The upper 1-sided 95% CI was 0.5 – which was within the limit of 3.5 points and thus demonstrated the non-inferiority of the experimental group – and the absolute difference was -2.21 points (Fig. 3). The TIS results indicated non-inferiority within a pre-defined margin for dance therapy using telerehabilitation (difference = -0.86, 95% CI = -2.21 to 0.50).

**3.2.2. Secondary outcome.** Patients in the experimental group demonstrated a significant improvement in the K-MBI ( $P = .004$ ) and TUG ( $P = .033$ ) scores at the follow-up assessment. It was also observed that patients in the control group demonstrated a significant improvement in the BBS ( $P = .019$ ) and K-MBI ( $P = .036$ ) scores. Additionally, the EQ-5D index significantly improved after treatment in both the experimental ( $P = .04$ ) and

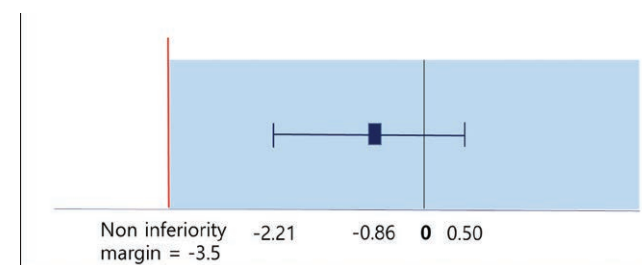


Figure 3. Non-inferiority plot of the Trunk Impairment Scale score. Difference between the experimental and control groups regarding the change in the Trunk Impairment Scale score. The error bias indicates the 95% confidence intervals; the shaded area indicates the non-inferiority zone.

control ( $P = .03$ ) groups. There were no significant differences in secondary outcomes between the 2 groups (Table 3).

## 4. Discussion

The purpose of this pilot study is to investigate the effect of dance therapy using telerehabilitation on trunk control and balance training in patients with stroke and to verify non-inferiority compared to conventional treatment. Herein, dance therapy using telerehabilitation significantly improved the TIS scores in the experimental group and was not inferior to conventional rehabilitation treatment when compared in a non-inferiority test. The remote dance program may therefore have similar effects to those of conventional treatment regarding improvement in trunk control in patients with stroke. Among the secondary outcomes, the K-MBI ( $P = .004$ ) and TUG ( $P = .033$ ) scores significantly improved, suggesting that dance therapy using telerehabilitation may effectively improve movement in daily life and balance function. These findings are consistent with those of previous studies.<sup>[7,20,21]</sup>

Compared with conventional therapy, dance therapy contains interesting elements – such as music and rhythm – which may produce additional effects.<sup>[22,23]</sup> In this study, the experimental group exhibited significantly improved QoL, higher compliance during the study period, and greater interest and intention for re-participation in the future ( $P = .04$ ). Additionally, side effects such as safety accidents, falls, and musculoskeletal

**Table 3****Comparison of results before and after treatment in the experimental and control groups.**

		Experimental group (n = 7)	Control group (n = 7)	Inter-group P value
TIS	Pre-	14.29 ± 5.19	15.29 ± 3.35	.19
	Post-	15.86 ± 5.93	18.00 ± 2.52	
	Intra-group P value	.017*	.001*	
K-MBI	Pre-	68.29 ± 18.38	61.00 ± 16.67	.28
	Post-	75.43 ± 16.22	73.86 ± 16.59	
	Intra-group P value	.004*	.036*	
BBS	Pre-	38.57 ± 12.91	40.29 ± 8.86	.16
	Post-	41.89 ± 12.88	46.71 ± 6.32	
	Intra-group P value	.099	.019*	
TUG	Pre-	43.14 ± 31.92	30.43 ± 16.63	.94
	Post-	35.14 ± 24.73	22.86 ± 10.29	
	Intra-group P value	.033*	.145	
FAC	Pre-	3.14 ± 1.06	3.29 ± 1.25	.09
	Post-	4.00 ± 1.41	3.57 ± 1.62	
	Intra-group P value	.078	.522	
EQ-5D index score	Pre-	0.70 ± 0.12	0.65 ± 0.12	.64
	Post-	0.77 ± 0.12	0.75 ± 0.07	
	Intra-group P value	.04*	.03*	

The values are mean ± SD or number (%).

BBS = Berg Balance Scale, EQ-5D = EuroQoL 5 Dimension, FAC = Functional Ambulation Categories, K-MBI = Korean Modified Barthel Index, TIS = Trunk Impairment Scale, TUG = Timed Up and Go.

\*P &lt; .05

damage were not reported, suggesting that dance therapy using telerehabilitation is a safe treatment for hemiplegic patients at risk of falls. COVID-19 has led to restrictions regarding face-to-face treatment and medical resources, which has limited conventional treatment for patients with stroke. Severe aggravation of conditions and death due to COVID-19 may be particularly fatal for patients with chronic diseases; thus, the importance of rehabilitation treatment through a safe, non-face-to-face approach (telerehabilitation) has greatly increased. Many studies have analyzed the effectiveness of telerehabilitation, with most reporting that telerehabilitation is comparable to in-clinic rehabilitation. In prior analyses, several studies reported that both telerehabilitation and conventional rehabilitation resulted in statistically significant improvement in ADLs; moreover, no significant differences in improvement were noted between the groups.<sup>[24–26]</sup> The effect of telerehabilitation, compared with that of conventional rehabilitation, was found to be equivalent.<sup>[25–27]</sup> Regarding health-related QoL, a previous study reported that although both groups had improved health-related QoL, no differences were evident between them.<sup>[24]</sup>

Consistent with the findings of previous studies, our data suggested that dance therapy using real-time, 2-way communication-based telerehabilitation did not have inferior effects when compared with conventional rehabilitation treatment. Moreover, dance therapy using telerehabilitation is sufficiently safe to be easily conducted at home and is associated with high compliance and satisfaction, often leading to autonomous participation. Telerehabilitation can be performed at home or in local communities, in other environments with internet access, without special tools, and under the assistance of a guardian. Compared with conventional treatment, which may be considered repetitive and boring, dance therapy was found to be an effective method of treatment with interesting elements that increased the likelihood of patient compliance and continued participation. This supports that dance therapy using telerehabilitation is a useful alternative to conventional treatment during the current COVID-19 pandemic when face-to-face is difficult.

Although recovery of gait function is an important outcome of stroke rehabilitation, it was not considered a primary outcome in this study. As programs to enhance gait function may pose a high risk of falls, such programs were not included during telerehabilitation; gait function was therefore not assessed as a primary outcome to ensure the safety of the participants. Still, recovery of balance and trunk control are important factors that can affect gait improvement in the future.<sup>[28]</sup> In our study, the telerehabilitation program focused on balance and trunk control; clinically significant improvements were observed regarding these functions. Additionally, among the secondary outcomes, the TUG score significantly improved, suggesting that gait function also improved to a certain extent.

Several other limitations must be considered when interpreting the findings of this study. First, the sample size was small. Second, the study was conducted for a relatively short period of time, and the long-term effects of the program could not be assessed. Third, a setting similar to a home-environment was established in the hospital; however, there may have been differences when conducting a home-based program. Fourth, other conventional treatments were not excluded from the study; thus, it is difficult to determine the single effects of dance therapy using telerehabilitation. However, dance therapy itself is not yet a proven treatment for stroke; this is a pilot study conducted because it was impossible to verify superiority and inferiority by performing dance therapy alone for patients with stroke who need treatment. As a result of this pilot study, we confirmed the non-inferiority of dance therapy. Based on this, we plan to conduct a comparative analysis of dance therapy and conventional therapy in a future study.

Despite these limitations, rehabilitation using dance therapy is a relatively effective and economical treatment that can improve patient participation. In the future, additional large-scale randomized controlled trials and community-based studies are required.

In conclusion, dance therapy using real-time, 2-way telerehabilitation was an effective treatment program that improved trunk control and balance function in patients with hemiplegia

due to stroke. The program could therefore be considered a safe and effective model for remote rehabilitation during the current COVID-19 pandemic.

### Author contributions

**Conceptualization:** Ji Hong Min, So Jung Lee, Yong-Il Shin.

**Data curation:** Eun Chae Lee, So Jung Lee.

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**Investigation:** Muhyun Kim.

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**Supervision:** Sung-Hwa Ko.

**Writing – original draft:** So Jung Lee.

**Writing – review & editing:** Ji Hong Min, So Jung Lee.

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