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Abstract

Balance and mobility are a common concern among older adults. This pilot randomized controlled study examines the effect of dance-based therapy to increase balance and mobility in 27 participants with mean age 85 years (±7.5) from a single aging-in-place facility in the Midwest. Multidirectional reach, velocity, step length differential, and a Functional Ambulation Profile were measured before and after 18 sessions of low-impact dance-based therapy. Although a Wilcoxon rank sum test showed no significance, effect size analyses suggest that dance-based therapy was mildly or moderately effective in several components of balance and mobility. Additional research is needed with a full-scale trial.

Keywords

fall, balance, mobility, dance therapy

Falls are the leading cause of injury death for adults aged 65 and above. They are also the most common cause of nonfatal injuries and hospital admissions for trauma among this age group (Centers for Disease Control

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and Prevention, 2010). Exercise is recommended for older adults to slow functional decline, and increase balance and mobility to reduce the risk of falling (Michael et al., 2011). There is accumulating evidence that physical exercise using dance may have a therapeutic benefit of improving balance and mobility, thus possibly reducing the fall risk in older adults (Hamburg & Clair, 2003; Keogh, Kilding, Pidgeon, Ashley, & Gillis, 2009).

Dance as a Therapeutic Activity

The purpose of this pilot study was to explore the effect of dance-based therapy on balance and mobility in older adults. Many older adults were engaged in dance as a social activity in the 1940s and 1950s. However, the use of dance as a therapy has been growing. Integrating motor and cognitive components are key features of programs using music and dance as therapy (Trombetti et al., 2010).

Rhythmic cuing and the relationship to movement outcomes have been a growing area of interest for neuroscientists over the last decade. Researchers at the Center for Biomedical Research and Music report that musical rhythm cues are responsible for priming the motor neurons in the brain, which provide motivation for the muscles to complete a motor task inherent in dance-based therapy (Thaut, 2011). They also found that therapeutic dance reactivates muscle memory for movements that were possibly once second nature in older adults.

Thaut, McIntosh, Prassas, and Rice (1992) investigated the effect of auditory rhythm on temporal parameters of the stride cycle and normal gait at three different walking cadences. Results from a study with 16 participants without limitations showed several significant ($p < .05$) changes with rhythmic cuing. Data suggest that auditory rhythm improved stride rhythmicity and effected muscle activity. Thus, researchers have identified a need for studies using the principles of rhythmic cuing in the form of music integrated into interventions to enhance gait and upper limb movements (Malcolm, Massie, & Thaut, 2009; Thaut et al., 2007).

One of these interventions, the Lebed Method™ (TLM), chosen as the intervention for this study, is a dance therapy program that is based on movements that are used in allopathic, medically based therapies, such as physical and occupational therapy programs (Lebed, 2002). TLM has been used (since 2000) internationally with populations who have physical limitations (Lebed, 2008). Led by a specially trained and certified instructor, TLM is used in more than 500 medical and community facilities in 14 counties (Lebed, 2008). TLM focuses on the physical aspects of clinical improvement of chronic

disorder patients and in the recovery of acute illness/postsurgical participants as well as the emotional and the psychosocial improvement of its participants (Molinaro, Kleinfeld, & Lebed, 1986). The physical component of TLM was the focus of this research.

TLM movements are specifically designed for persons with limited upper and lower body movement. All of the movements can be done standing, sitting, or by a combination of both. The sessions include small groups of participants, typically 10 to 15 per group. Each session begins with a 10 min set of movements to stimulate lymphatic circulation. The circulation of the lymph, dependent on intrathoracic pressure changes with respiration and muscular contraction, is promoted by TLM movements through controlled respiration, directed skeletal muscle contractions, and gravitational assistance (Sandel et al., 2005). All movements are slow and rhythmic to facilitate deep breathing and gently increase the heart rate. A typical session includes choreographed dance sequences that combine gentle, low-impact aerobic, jazz, and ballet movements repeated several times as a dance routine using a range of tempos, choreographed to music of the participant's era (Lebed, 2002). A cool-down and group-sharing activity concludes each 45-min session. Table 1 outlines the dance routine movements with intended outcomes for this study.

Researchers have established that TLM movements increased shoulder range of motion in a group of breast cancer survivors ($p = .008$; Sandel et al., 2005). In a 6-week pilot longitudinal study with older persons, researchers reported a global improvement of 50% from baseline in combined balance and gait measures (Krampe, Rantz, Dowell, Schamp, Skubic, & Abbott 2010). Although TLM is used internationally, research on the therapeutic effect for older adults has been limited to one pilot study (Krampe et al., 2010). Therefore, further research is warranted to explore the effects of dance therapy on balance and mobility.

Theoretical Framework

The Disablement Process, developed by Verbrugge and Jette (1994), guided the study. The Disablement Process is based on the Disablement Model, developed by Nagi (1991), which describes a pathway along a continuum from active pathology, impairments, functional limitations, and disability in older adults. Verbrugge and Jette defined functional limitations as restrictions in performing fundamental physical actions used in daily life by one's age and sex group, such as ambulating, reaching, stooping, and climbing stairs. These fundamental actions require the maintenance of balance and mobility (Verbrugge & Jette, 1994). The Disablement Process states that

Table 1. The Lebed Method™ Dance Routine Movements With Intended Outcomes

Routine	Movements	Intended Outcome
Lymphatic Warm-Up; 1940s Big Band Music	Blow bubbles or pinwheels: deep breathing, head, chin, chest, rolls, ear to shoulder, arm circles, easy marches	Open up chest and lungs; give muscles oxygen to perform well
Dance No. 1/Under the Boardwalk	Spine Roll Up, sway, step touch, jazz shoulders	Develop balance and strengthen lower extremities
Dance No. 2/Hello Dolly	Seated: march, touch toe, Shoe Shine, hand to shoulder, shimmy	Shift weight from side to side; develop balance
Dance No. 3/Fever	Climb the Ladder, Put Out the Fire, Figure Eights	Develop balance and strengthen lower legs, increase range of motion
Break	Everyone drinks water, relaxes, rests, and visits	Group sharing; benefit of social aspect of dancing
Dance No. 4/Kansas City	Shut the Door, One Arm Swim, Circle the World	Accommodate shifting movements; develop balance and flexibility
Dance No. 5/ Sentimental Journey	Reach for the Stars, Bow and Arrow, Circle the World	Accommodate shifting movements; develop balance and flexibility
Cool down	Closing comments	Group sharing, benefit of social aspect of dancing

functional limitations can be modified with therapeutic regimens. Impairments and functional limitations occur as a part of disuse atrophy caused by less physical activity. The effect of these changes can be seen in altered balance and mobility (Laughton et al., 2003). Dance therapy based on movements designed to improve balance and mobility has the potential to slow functional decline and functional limitations. Therefore, improved balance and mobility can impact the desire to keep moving and, ultimately, slow down the pathway to disability.

Purpose

The purpose of this study was to explore the effect of dance-based therapy on participants in the treatment group compared with a control group. The hypotheses tested were as follows:

Hypothesis 1: The treatment group will demonstrate improved balance, measured by the Multidirectional Reach Test (MDRT).

Hypothesis 2: The treatment group will demonstrate increased mobility, measured by increased velocity; increased Functional Ambulation Profile (FAP); and decreased step length differential (SLD), measured on the GAITRite assessment.

Method

Design

An exploratory pretest/posttest randomized controlled design was used. This small, pilot randomized controlled trial (RCT) was conducted to obtain outcome data on intervention effects of dance therapy as an interim step in a larger, fully powered trial (Conn, Algase, Rawl, Zerwic, & Wyman, 2010; Feeley et al., 2009).

Sample

Participants were recruited from a single Midwest aging-in-place (AIP) facility. The single facility was chosen because it represents the continuum of aging, from active community living to frail nursing home–eligible older adults. Rather than moving residents as their needs change, this specific model of AIP includes individual apartments, direct personal care as needed, ongoing nursing assessment, coordination of care, health promotion activities, and social activities (Rantz, 2003). The more active residents drive their own cars and are involved in the community, whereas the frail residents primarily stay in the facility. Common illnesses include arthritis, heart disease, and diabetes; a few have early stage Alzheimer's. The residents were able to ambulate, with or without assistance and or an assistive device. Consequently, 23 of the total population of residents used a walker, 11 used a wheelchair, 1 wore leg braces, and 4 used canes as needed. About 90% of the residents had at least one chronic illness; 60% had multiple chronic illnesses. Study participants who met the inclusion criteria were a representative sample of the facility.

Inclusion Criteria

Two criteria for participation were included based on the pilot results (Krampe et al., 2010). A Mini-Mental State Exam (MMSE) score of 23 or above was the cognitive level deemed necessary to follow the leader's

instructions (Folstein, Folstein, & McHugh, 1975). The second inclusion criterion was the ability to stand up with or without assistance for short periods of time. The facility nurse assessed the entire population of residents ($N = 60$), and from this group, 33 residents (55%) met the inclusion criteria and were referred to the Principle Investigator (PI) for recruitment.

Recruitment Process

Following Institutional Review Board approval, the PI presented an informational demonstration to the residents and facility administration, displayed a recruitment poster announcing the study, and followed up individually with each resident meeting the inclusion criteria. Of the 33 eligible participants, 30 (91%) were interested in participating. Those ($n = 30$) providing verbal consent were randomly allocated to either the treatment (dance plus usual routine) group or the control (no dance plus usual routine) group using a randomized complete block design method. Married couples were randomized together.

Three of the eligible participants chose not to participate due to medical reasons, leaving 15 in the treatment and 12 in the control group ($n = 27$), resulting in 45% of the total population participating in the study. Details of the progression of the participants are outlined in Figure 1.

Intervention

The treatment group was asked to attend 18 dance sessions, 3 times each for 6 weeks. Each session lasted 45 min. Multiple sessions were offered at various times along with make-up sessions. The number of sessions in the intervention was based on a pilot study conducted in 2008 (Krampe et al., 2010), related dance-based therapy studies to impact balance and mobility (Federici, Bellagamba, & Rocchi, 2005; Hackney, Kantorovich, Levin, & Earhart, 2007), and other studies using TLM (Sandel et al., 2005).

The PI was certified in TLM and led the dance-based therapy intervention. As this study was focused on persons able to stand without assistance for short periods of time, participants were taught both seated and standing options for each dance allowing for day-to-day adjustments according to energy levels. Participants had chairs at their sides so they could stop and rest at any time.

The sessions included 10 min of lymphatic warm-up movements, 30 min of more active movement dance-based therapy, and 5 min of cool down. The dance therapy included low-impact aerobics and stretching mixed with dance

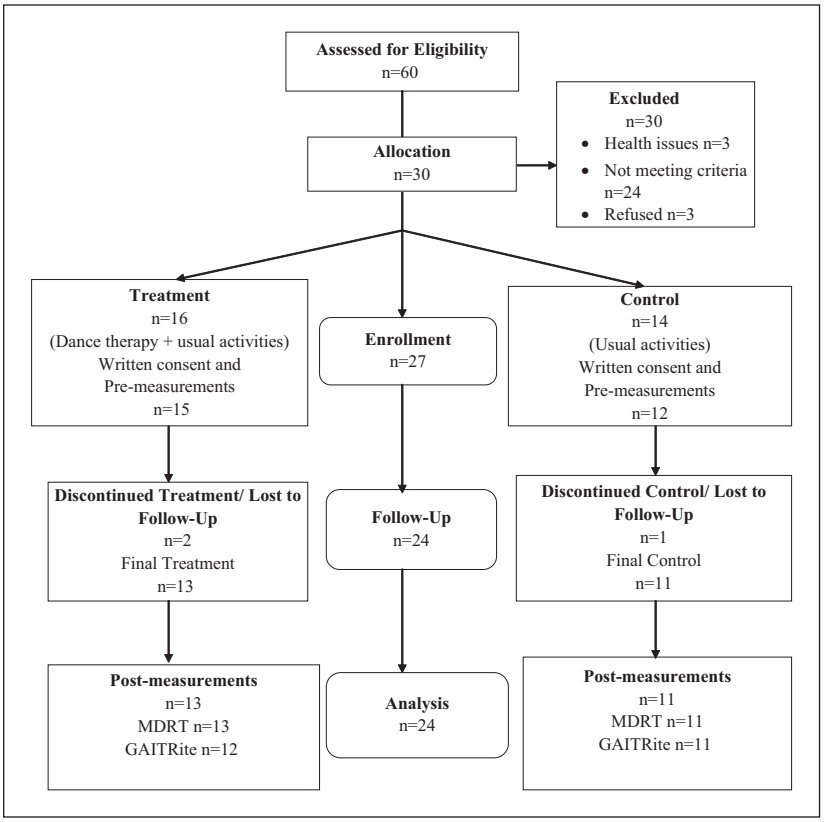

Figure 1. Dance-based therapy: Eligibility, enrollment, allocation, follow-up, and analysis
Note: MDRT = Multidirectional Reach Test.

movements. The dance movements, based on simple jazz and ballets steps choreographed specifically for older adults, using upbeat and familiar music along with fun boa and hat props, comprised of shifting weight, reaching arms in every direction, lifting legs, and flexing feet.

Dance steps were designed to improve balance by shifting the body and relocating the center of gravity. The same dance sequences were used throughout the 18-session intervention, so the participants could develop confidence in performing the routine and experience a cumulative effect (Lebed, 2002). Participants were given a US$25.00 Wal-Mart gift certificate as an incentive after completing the postmeasurements.

To minimize bias, a doctoral prepared Physical Therapist (PT), Physical Therapy research assistant, and a student nurse completed the balance and mobility assessments for the study. As these raters were involved in other projects in the facility, they were not blinded to the treatment and control groups.

Measures

Balance. The MDRT (Newton, 2001) allows for analysis of a person's voluntary postural control. It is used to evaluate how far one is able and/or willing to lean away from a stable base of support in multiple directions. The further one can reach without losing balance, the lower the fall risk, with forward reach scores of less than 6 or 7 inches indicating limited functional balance, along with an increased fall risk (Duncan, Weiner, Chandler, & Studenski, 1990). Newton (2001) reported a Cronbach's alpha as .84 and intraclass correlation for test–retest reliability greater than .92.

Mobility. The GAITRite System electronic walkway was used to measure the temporal (timing) and spatial (two dimension geometric position) parameters of the participants' mobility patterns (GAITRite CIR Systems, 2007). The 20-foot walkway captures multiple gait elements without the use of additional sensors or placement of any devices on the participant. Velocity, SLD, and a FAP score were automatically recorded in real time.

Velocity was obtained after dividing the distance traveled by the ambulation time. A person needs to ambulate with 98 cm/s velocity to safely cross a street (Guralnik et al., 2000). Step length was measured along the line of progression, from the heel center of the current footprint to the heel center of the previous footprint on the opposite foot. In older adults, asymmetry of step length increased the risk for falling. Mbourou, Lajoie, and Teasedale (2003) have reported the first step length variability of older adult fallers was more than twice than observed for nonfallers. The FAP scoring system, developed by Nelson and colleagues (1999), integrates selected time and distance parameters to provide a single, numerical representation of gait in adults. The FAP score comprised the linear relationship of step length / leg length ratio to step time when the velocity is normalized to leg length in healthy adults. The FAP score ranges from 95 to 100 points in the healthy adult population.

Analysis. To examine each of the hypotheses, the change in the outcome measure for each participant (postintervention minus preintervention scores) was calculated. As data were from a small sample that included outliers and

limited assumptions could be made about the underlying distributions, a nonparametric test was used (Wilcoxon signed rank test). Statistical significance was set at alpha level .05. Statistical support was provided by biostatisticians at the University of Missouri Medical Research Office. Although this was a pilot study and not intended to be fully powered, a projection for one measurement was completed to help identify a target number of participants for recruitment. The study was projected to have about 80% power to detect a difference of 3 inches between the two Forward Reach group means with a total sample size of 28.

Results

Sample

The participants (n = 27) included 17 females and 10 males. A total of 26 participants were Caucasian and 1 was Asian. Age or functional limitations were not used as factors in assigning the treatment and control groups; subsequently, the ages ranged from 63 to 96 years, with mean age of 85 (±7.5).

The treatment group included 15 (73%) females, and 12 (50%) of the control group were female. The ages in each group were almost identical with the mean age in the treatment group being 85 (±8.49) and mean age in the control group being 85 (±8.86) as well. A total of 100% of the treatment group was Caucasian.

Of the 13 participants, 7 treatment participants (54%) participated in the complete 18-session dance-therapy intervention. Of the remaining 6 participants, 3 (23%) attended between 10 and 15 sessions and 3 (23%) attended between 3 and 7 sessions. The reasons for limited attendance were related to medical issues, including illness, hospitalizations, and depression. One person required a break during the 8-week study due to medical issues but returned to complete a total of 13 sessions. Two participants who completed 3 sessions were not able to continue due to medical reasons but were included in the postmeasurements. One person who completed 18 sessions was not able to complete the GAITRite postmeasurement assessment due to frailty issues that increased from the premeasurement period. Three participants were lost to postmeasurement follow-up due to death of a spouse, hospitalization, or illness, leaving the postmeasurement total to 24. Not all participated in each measure. Figure 1 provides details of the progression of the participants through the postmeasurement phase. There were no adverse events related to the dance-based therapy intervention.

Hypotheses 1: Improved Balance

Balance

Even though there was a distributional difference in premeasures between two groups, the data did not show that postmeasures for balance in the treatment group improved significantly as compared with the control group. Due to the pilot nature of this RCT's small sample size, a secondary analysis of effect size (ES) was conducted, using Cohen's *d* standardized differences between two groups. An ES analysis was first conducted for the entire intervention group ($n = 13$) versus the control group ($n = 11$). Given the variable attendance at intervention sessions, an ES analysis was then conducted separately for participants who had high attendance, defined as at least 14 (approximately 80%) of the 18 sessions ($n = 9$). Feeley et al. (2009) advised that all outcomes from a pilot RCT should be interpreted with caution.

Forward Reach

The results displayed in Table 2 indicate a moderate effect on the Forward Reach for the study participants with high attendance using Cohen's *d* ES measurements for two independent groups defined as mild (0-.2), moderate(.2-.5), and large (.5-.8) effect (Cohen, 1988).

Extreme examples of mean changes were further analyzed. Although the age difference is not significant between the treatment and control group, the treatment group measurements represent an overall lower level of function, prior to the dance intervention, as noted in the mean premeasurements for the treatment group, compared with the control group. For example, the mean premeasurement Forward Reach for the treatment group is functionally lower at 9.88 inches, versus the control group 13.20 inches (Duncan et al., 1990).

Right, Left, and Backward Reach

The dance-therapy intervention focuses on movements to increase upper body range of motion. A mild ES of the intervention, the Right Reach, was measured for participants with high attendance, along with a moderate effect on Left and Backwards Reach. The dance movements, repeated several times, included gently stretching that the participants may not do during usual activities.

Hypotheses 2: Improved Mobility

The data did not show that postmeasures for mobility in the treatment group improved significantly compared with the control group. However,

Table 2. Between Groups Effect of Dance-Based Therapy on Balance and Mobility

Measurements	Dance-Based Therapy *M* (*SD*) (*n*)	Control *M* (*SD*) (*n*)	Wilcoxon Rank Sum Test	Effect Size Between Groups All Participants	Effect Size Between Groups High Attendance Participants (*n* = 9)
Forward reach (in.)					
Preintervention	9.88 (4.28) (13)	13.20 (3.06) (11)			
Postintervention	9.02 (2.62) (13)	11.45 (1.57) (10)	0.52	.27a	.35a
Difference	−0.86 (3.49)	−1.75 (3.09)			
Right reach (in.)					
Preintervention	6.90 (2.33) (13)	8.73 (2.56) (11)			
Postintervention	7.71 (2.73) (13)	9.34 (1.76) (10)	0.82	.10b	.19b
Difference	0.81	0.61			
Left reach (in.)					
Preintervention	7.96 (2.94) (13)	9.59 (2.31) (11)			
Postintervention	8.56 (2.91) (13)	9.57 (1.93) (10)	0.52	.26a	.38a
Difference	0.60	−0.02			
Backward reach (in.)					
Preintervention	4.75 (2.31) (13)	5.48 (2.23) (11)			
Postintervention	2.5 (1.36) (13)	2.27 (1.23) (10)	0.23	.48a	.43a
Difference	−2.25	−3.21			
Velocity (cm/s)					
Preintervention	61.84 (31.10) (12)	67.80 (22.42) (11)			
Postintervention	65.00 (28.13) (12)	71.77 (21.51) (10)	0.37	.01b	.16b

(continued)

Table 2. (continued)

Measurements	Dance-Based Therapy *M* (*SD*) (*n*)	Control *M* (*SD*) (*n*)	Wilcoxon Rank Sum Test	Effect Size Between Groups All Participants	Effect Size Between Groups High Attendance Participants (*n* = 9)
Difference	4.16	3.97			
Step length differential (cm)					
Preintervention	2.88 (2.45) (12)	3.91 (2.35) (11)			
Postintervention	2.67 (2.28) (12)	3.72 (2.47 (10)	0.98	.01b	.02b
Difference (lower number = greater symmetry)	−0.21	−0.19			
Functional ambulation profile (%)					
Preintervention	71.85 (19.93) (12)	75.82 (15.87) (11)			
Postintervention	72.92 (14.47) (12)	78.00 (14.50) (10)	0.27	.14b	.12b
Difference	1.07	2.18			

Note: Effect size = Cohen's *d*.
[a]Moderate.
[b]Mild.

the secondary ES analysis did show an effect on all components of the mobility patterns. It is also noted that even though the control group measurements were higher on each component of mobility, an effect for the intervention group was noted for the participants with high attendance.

Velocity

The results displayed in Table 2 indicate a mild effect on the velocity outcome for the study participants with high attendance compared with the control group.

FAP

The FAP provides an overall mobility score. Although the mean control group measurement was 3% higher at preintervention, the high-attendance intervention group ES was noted as mild.

SLD

A lower measurement of SLD equates to a higher level of symmetry between right and left steps. This effect (.02) measured in the high-attendance group compared with the control group indicates a very mild effect, with the treatment group improving slightly more.

Discussion

Although nonsignificant, dance-based therapy in this pilot study had a mild or moderate effect on several components of balance and mobility in older persons. These findings support and add to the results from the prior study (Krampe et al., 2010). This pilot study provided outcome data on intervention effects of dance therapy as an interim step in a larger, fully powered trial.

The treatment dose and duration of dance-based therapy over days and weeks needs to be looked at closely (Conn, Rantz, Wipke-Tevis, & Mass, 2001). This pilot study offered multiple sessions weekly for 6 weeks, with make-up sessions available during an additional 2 weeks, and the participants were asked to attend 3 sessions weekly for a total of 18 sessions. The preliminary study offered sessions each Monday, Wednesday, and Friday for 6 weeks, and the participants were asked to attend every session for a total of 18 sessions (Krampe et al., 2010). The percentage of participation was similar in both studies. Although the treatment dose for this study was

based on previous studies (Krampe et al., 2010), related dance-based therapy studies to impact balance and mobility (Federici et al., 2005; Hackney et al., 2007), and other studies using TLM (Sandel et al., 2005), the dose may have been insufficient to measure a larger effect.

Sherrington and colleagues (2008) reviewed multiple trials of exercise programs with older persons and recommended a minimal effective exercise dose as a twice weekly program running over 25 weeks. This finding has important implications for research and practice because most programs are offered for shorter periods than this. Although the dose and duration of dance-based therapy in previous studies has been approximately 6 weeks, this finding suggests 50 doses, versus 18, are needed. More study is necessary to confirm effective dosage. There is limited research measuring the effect of similar dance-based therapy as an intervention for older persons, therefore, future study should be considered to test variations of dose and intervention intensity, weighed against the demand on the participants (Conn et al., 2001).

Hackney and colleagues (2007) reported trends in mobility improvements in using the Timed Up and Go Test following twenty 1-hr progressive Tango sessions completed within 13 weeks for participants with Parkinson's disease ($n = 9$; ES = 0.37), compared with traditional exercise ($n = 10$; ES = 0.02). A consideration of greater emphasis on lower body movements focused on mobility, modeled after the intensity used in the Hackney and colleagues study, should be considered as future interventions are developed. TLM can be instructor modified and enhanced to increase the focus on upper or lower body movements, depending on the participants.

A potential limitation in the study rigor was the lack of the PT and Physical Therapy student and nursing student conducting the pre- and postassessments not blinded to treatment and control groups. As previously noted, they had contact with the participants throughout the duration of the study and were in the facility at times during the intervention. Although the logistics prohibited blinding for this pilot study, at minimum, a single-blinded study should be considered for a future RCT. A double-blinded study with a control group or alternate intervention for additional rigor should also be considered using multiple facilities.

The recruitment, intervention, and retention process for a study using dance-based therapy with older persons resulted in the maximum number of participants possible from the facility. Additional research is needed with a larger sample size and longer duration; therefore, multiple sites should be considered for recruitment in the future as well as a sample of participants that would be generalizable. Trombetti and colleagues (2010) recently

reported a study evaluating the effects of music-based multitask training on fall risk in 135 older persons over a 6-month period. The sample size for this study was calculated to account for 10% mortality and 20% dropout rates. The researchers reported a reduction in stride length variability ($p < .002$) and improved balance and functional tests compared with the control group. Thus, future study should include oversampling to reach a similar number and extend the dance therapy to several months.

This study showed success in recruiting older adults across the continuum from active to frail. As all Lebed Method movements can be done seated or standing, this activity is an exercise option for all adults, regardless of physical limitations. Future study should explore specific populations, including totally seated groups, focused on maintaining upper body range of motion, balance, and lower body strength.

A universal challenge beyond the initial participation in a movement activity is the continued participation. Due to the request from the administration and older adults in the previous Lebed Method study (Krampe et al., 2010), weekly dance-based therapy sessions were initiated and have been sustained for more than 2 years along with additional sessions added. Likewise, due to the interest for continued dance therapy following the most recent study, the AIP facility has initiated dance therapy as activity option several days each week. This supports a person-centered approach for identifying activities older adults will continue to do, promoting adherence and enhancing motivation (Lima & Vieira, 2007; Keogh et al., 2009).

This study was the first randomized clinical trial using TLM™ with older persons. Although this study was focused on balance and mobility, a broader issue related to maintaining overall function is relevant to both the aging population and anyone with a chronic illness. Future study researching the impact of dance-based therapy on additional functional measures in chronic illness, for example, osteoarthritis, should be explored.

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