Original Research

The Effects of a Movement-to-Music (M2M) Intervention on Physical and Psychosocial Outcomes in People Poststroke: A Randomized Controlled Trial

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Abstract *Objective:* To investigate the effects of a 12-week movement-to-music (M2M) intervention on physical and psychosocial outcomes in people poststroke.
Design: Two-arm randomized controlled trial.
Setting: A community-based fitness facility.
Participants: Participants (N=47) with stroke between 18 and 65 years old were randomized to M2M (n=23) or waitlist control (n=24).
Interventions: Participants in M2M completed 3 60-minute exercise sessions per week for 12 weeks. Controls received biweekly educational newsletters via mail.

Main Outcome Measures: Primary outcomes included Six-Minute Walk Test (6MWT, in meters), Five Times Sit-to-Stand Test (FTSST, in seconds) and Timed Up and Go (TUG, in seconds). Secondary outcomes were self-reported measures using Patient-Reported Outcomes Measurement Information System Fatigue and Pain Interference Short Form 8a. Outcomes were collected at baseline and postintervention. Analyses involved descriptive statistics and adjusted linear mixed models.

Results: Mixed models adjusted for the respective baseline values and demographic variables showed that M2M participants had longer 6MWT distance (least square mean difference [LSM], 14.5; 95% confidence interval [CI], −12.9 to 42.0), more FTSST time (LSM, 2.0; 95% CI, −4.5 to 8.5), and less fatigue (LSM, −3.0; 95% CI, −7.2 to 1.2) compared with controls postintervention. When controlling for baseline TUG and demographic variables, there was a larger increase in 6MWT distance (LSM, 37.9; 95% CI, −22.7 to 98.6), lower FTSST time (LSM, −6.1; 95% CI, −18.5 to 6.2), and decrease in fatigue (LSM, −6.5; 95% CI, −13.1 to 0.2) in the M2M group compared with controls. Moderate effect sizes were observed for improving 6MWT (d=0.6), FTSST (d=−0.6), and fatigue (d=−0.6). There was no group difference in change in TUG time and pain interference, with trivial effect sizes (d=−0.1).

Conclusion: M2M may be a valuable exercise form for adults with stroke. Future studies are needed to determine optimal exercise doses for improving health and function in this population.

Stroke is a leading cause of disability worldwide, resulting in 1 or more physical and/or cognitive impairments,[1-5] which are often accommodated by sensory, perceptual, emotional, and social conditions that may affect quality of life.[6-8] Regular exercise has been recognized as a critical behavior for chronic disease prevention and overall health improvement in the general population.[9,10] For people poststroke, exercise can also be beneficial, with evidence demonstrating its positive effects on physical function,[11] cognition,[12] and quality of life.[11,13-16] It may also reduce the risk of further cardiovascular events including a recurrent stroke.[13,15,17-19] Despite these benefits, many people poststroke do not engage in sufficient physical activity to receive health-enhancing benefits.[20] English et al[21] investigated sitting and physical activity and reported that adults poststroke spent significantly more time sitting and less time performing transportation, household, and leisure activities compared with their age-matched healthy counterparts.[22] Therefore, it is imperative to identify strategies to promote engagement in physical activity among people poststroke.

Enjoyment remains an important aspect of an exercise intervention because individuals are more likely to continue their exercise regimen after the intervention ends.[23] However, there are few evidence-based programs for people poststroke that extend beyond conventional exercise modalities that involve repetitive movements such as stationary arm or leg cycling.[24,25] Incorporation of music within an exercise program has the potential to enhance engagement and performance.[26] In fact, a meta-analysis has demonstrated that music-supported therapies can be effectively used to enhance physical function in people poststroke.[27] Potential explanations for improvements in physical function include enhanced motivation and engagement or even positive neuroplastic changes.[28,29] To date, there are only a few dance-based or rhythmic exercise programs that aim to improve physical function and quality of life in people poststroke.[30,31] The use of music to facilitate exercise remains an underutilized modality.

There is a need to provide alternative forms of exercise that can positively affect the physical function and health of people poststroke. Movement-to-Music (M2M) was created for people with disabilities as a novel rhythmic-based exercise intervention that uses combinations of movement patterns choreographed with music. M2M targets 4 training components: range of motion, muscle strength, cardiorespiratory fitness, and balance. In a previous M2M trial,[32] participants with multiple sclerosis demonstrated improvements in mobility and walking endurance after a 12-week intervention. Given that people poststroke experience similar benefits from exercise as people with multiple sclerosis,[24,25] the potential benefits of M2M for people poststroke warrant investigation. Thus, the purpose of this study was to examine the effects of M2M[32] on health and functional outcomes in adults poststroke.

Methods

Study design

This study was a 2-arm randomized controlled trial comparing the effects of M2M to a waitlist control (WC) group. Using a computer-generated randomization list, participants were randomly assigned to M2M or WC after completing informed consent and baseline assessments. The randomization list was undertaken by a study statistician who was not involved in the intervention, and the group assignments were sealed in opaque envelopes opened by each participant. Given the nature of this study design, group assignments were not blinded to participants and study staff involved in the intervention delivery. All outcome assessors were blinded. Participants in WC were offered a 12-week home-based M2M after completing postintervention assessments.

Participants

Potential participants were recruited through a community-based fitness facility that served individuals with disabilities, physician referrals, flyers, informational mailings, and

Table 1 Overall structure of Movement-to-Music

Training Component\Week		1	2	3	4	5	6	7	8	9	10	11	12
							Duration (Minutes)						
Warm-up	Upper body	5	5	5	5	4	4	4	4	3	3	3	3
Range of motion	Lower body	5	5	5	5	4	4	4	4	3	3	3	3
Upper extremity muscle Strength		5	5	5	5	5	5	5	5	5	5	5	5
Cardio		5	5	6	6	7	7	8	8	9	9	10	10
Cardio+Imagery		5	5	6	6	7	7	8	8	9	9	10	10
Lower extremity muscle strength		10	10	8	8	8	8	6	6	6	5	4	4
Balance	Static	5	4	4	3	3	2	2	1	1	1	0	0
	Dynamic	0	1	2	3	4	5	6	7	8	9	10	10
Cool-down		5	5	5	5	5	5	5	5	5	5	5	5
Total minutes		45	45	46	46	47	47	48	48	49	49	50	50

word of mouth. A sample size of 60 was determined for the purpose of estimating effect sizes for future studies.[33] Potential participants who expressed interest were enrolled if they were between the ages of 18 to 65 years and more than 6 months poststroke (self-reported). Additional inclusion criteria included (1) physician clearance and (2) ability to maintain balance sitting, standing, and walking with or without a mobility aid. Exclusion criteria included (1) participation in a similar intervention in the last 6 months, (2) use of tobacco products in the last 6 months, (3) unstable weight, (4) cognitive impairment (Mini-Mental State Exam score<24), (5) active pressure ulcer, and (6) any contraindications to exercise based on the American College of Sports Medicine guidelines.[34]

Adverse events (AEs) were monitored following types defined by the Behavior Change Consortium of the National Institutes of Health,[35] which included falls, cardiovascular-related episodes, musculoskeletal-related events, and health care use. The study was approved by the institutional review board of the institution and was conducted as part of a clinical trial protocol registered at ClinicalTrials.gov.

Interventions

Movement-to-Music

The general structure of M2M intervention is shown in table 1, which was consistent with the previously M2M trial for people with multiple sclerosis.[32] The intervention included 3 60-minute sessions per week for a total of 12 weeks delivered by M2M instructors who had a background in dance and received training in adapting and delivering exercises for people with disabilities. The class contents and checklists are presented in Supplemental Appendix 1 (available online only at http://www.archives-pmr.org/). All 36 sessions were designed to progressively improve mobility using various movement combinations that were choreographed to music. Each session began with 2 seated warm-up routines that focused on range of motion of the upper and lower extremities. It then transitioned to an upper extremity muscle strengthening routine performed in a seated position, followed by cardiorespiratory endurance, lower extremity muscle strengthening, and balance routines that could be performed either seated or standing with or without support of a dance barre. The goal of the lower

extremity muscle strengthening routine was to strengthen the muscles required for balance and eventually transition participants to more cardiorespiratory endurance and balance exercises. Thus, duration of the lower extremity muscle strengthening routine decreased as the duration of cardiorespiratory endurance and balance routines increased over time to keep all sessions within 1 hour. Other class equipment included chairs and wrist weights.

All M2M sessions were delivered in person in an exercise room at the fitness facility. Resting blood pressure,[a] resting heart rate,[b] and peripheral arterial oxygen saturation[b] were recorded before and after each class. Participants also reported rating of perceived exertion at the end of each class. For safety purposes, participants were asked to report any discomfort and their exercise heart rate was monitored[c] during class.

Waitlist control

Participants in WC were instructed to maintain their usual activities throughout the 12-week period. They also received 6 biweekly newsletters that provided educational information on nutrition, fatigue, health policy and advocacy, inclusion, and motivation and coping, with a topic on physical activity provided in the last newsletter at the end of the control period. The content was obtained from the National Center on Health, Physical Activity and Disability.

Outcome measures

Primary and secondary outcomes were collected at baseline and post 12-week intervention. In addition, demographic characteristics (age, sex, and race), health history, and anthropometric measures (height, weight, and body mass index) were collected. All data collection was performed by qualified exercise physiologists using standardized protocols.

Primary outcomes

The primary outcomes included changes in walking endurance, lower extremity functional strength, and mobility and balance.

Six-Minute Walk Test (6MWT). The 6MWT was used to assess walking endurance, in which total distance traveled over a 6-minute period was recorded in meters.[36,37] The test

has been reported to have excellent test-retest reliability (intraclass correlation coefficient [ICC]=0.97) in the post-stroke population.[38]

Five Times Sit-to-Stand Test (FTSST). The FTSST was used to measure lower extremity functional strength[39-42] by recording the time required to stand up and sit down (seat height=47.5cm) as quickly as possible 5 times without assistance. The FTSST is a valid measure of functional strength in the lower extremities, with excellent test-retest reliability in the poststroke population.[41]

Timed Up and Go (TUG). The TUG test was used to assess mobility and balance and recorded the time required to rise from a chair, walk to a 3-m mark, turn around, walk back to the chair, and sit down.[43,44] The test is a valid test of mobility, balance, and walking ability in people poststroke, with excellent test-retest reliability (ICC=0.96).[45]

Secondary outcomes

The secondary outcomes were changes in self-reported scores for fatigue and pain interference over the past 7 days. Fatigue was assessed with the National Institutes of Health Patient-Reported Outcomes Measurement Information System (PROMIS)[46] Fatigue-Short Form 8a (adult v1.0),[47] which contains 8 items with 5 response options ranging from 1 (*not at all/never*) to 5 (*very much/always*). The influence of pain on performing daily activities was assessed with the PROMIS Pain Interference-Short Form 8a (adult v1.0),[47] which contains 8 items on a 5-point Likert scale that ranges from *not at all* (1) to *very much* (5). Both forms have raw scores ranging from 8 to 40, with higher scores indicating more fatigue or pain interference. Both instruments have been validated in various populations, with adequate to excellent test-retest reliability (ICC=0.68-0.98[48,49] in fatigue and ICC=0.58-0.83 in pain interference[48,50]).

Program adherence was determined based on number of classes participants attended divided by number of classes offered (including make-up sessions). A percentage was then calculated.

Statistical analysis

The primary analysis was an intent-to-treat analysis and focused on comparing outcomes between M2M and WC using multivariable adjusted linear mixed models, with the corresponding baseline and demographic variables (age, sex, and race) as covariates. A secondary analysis was conducted with baseline TUG and the demographic variables as covariates. The intervention (delivered in 3 12-week iterations) was included as a fixed effect. When items on the PROMIS Short Forms were unanswered with a minimum of 4 items answered as required by the instrument, a total prorated raw score was calculated using the following formula:

Total prorated score

$$= \frac{(\text{Raw sum} \quad \times \text{number of items on the short form})}{\text{Number of items hat were ctually answered}}.$$

The total raw or prorated score was then translated into a T score for analyses.[51]

Descriptive statistics were used to summarize participant baseline characteristics. Continuous outcomes are presented as means±standard deviation (n) and categorical outcomes are presented as percentages (n). Least square mean (LSM) differences with 95% confidence intervals (CIs) and corresponding effect sizes (Cohen's *d*)[52] were estimated for each outcome. Effect sizes were interpreted as small (*d*=0.2), moderate (*d*=0.5), and large (*d*=0.8). All analyses were performed using Statistical Analysis System v9.4 (SAS Institute, Inc, Cary, North Carolina). Statistical significance was accepted at *P*<.05.

Results

One hundred twenty-five individuals were approached between August 2016 to August 2017, with 47 participants enrolled in the study (n=23 in M2M and n=24 in WC). Figure 1 provides the CONSORT diagram showing participant flow.

Participant baseline characteristics including age, sex, race, height, weight, body mass index, and secondary health conditions are presented in table 2. The majority of participants were African American (69.6% in M2M and 75.0% in WC). Both groups fell into the obesity category with body mass indexes>30 kg/m^2. The average time since stroke was 9.4±10.2 years in M2M and 9.2±7.7 years in WC.

Primary outcomes

Table 3 presents the descriptive and statistical indices for the 6MWT, FTSST, and TUG. Mixed models adjusted for the respective baseline and demographic variables showed that when compared with WC postintervention, M2M participants had longer 6MWT distance (LSM difference [95% CI]=14.52 [−12.9, 42.0]) and more FTSST time (2.0 [−4.5, 8.5]). However, when controlling for baseline TUG and demographic variables, M2M participants showed longer 6MWT distance (37.9 [−22.7, 98.6]) and reduced FTSST time (−6.1 [−18.5, 6.2]). Though these group differences were not statistically significant, moderate effect sizes were observed for improving walking endurance (6MWT, *d*=0.6) and lower extremity functional strength (FTSST, *d*=−0.6). There was no group difference on TUG postintervention. The effect size for improving mobility and balance was trivial (*d*=−0.1).

Secondary outcomes

All descriptive and statistical indices for fatigue and pain interference are presented in table 3. Participants in M2M showed less fatigue compared with WC postintervention after controlling for the baseline and demographic variables, with a moderate effect size (LSM, −3.0; 95% CI, −7.2 to 1.16; *d*=−0.6). When controlled for baseline TUG and demographic variables, the group difference in change in fatigue increased (LSM, −6.5; 95% CI, −13.1 to 0.2). There was a small reduction in pain interference in M2M participants compared with WC after controlling for baseline TUG and demographic variables. However, the effect size was trivial (*d*=−0.1).
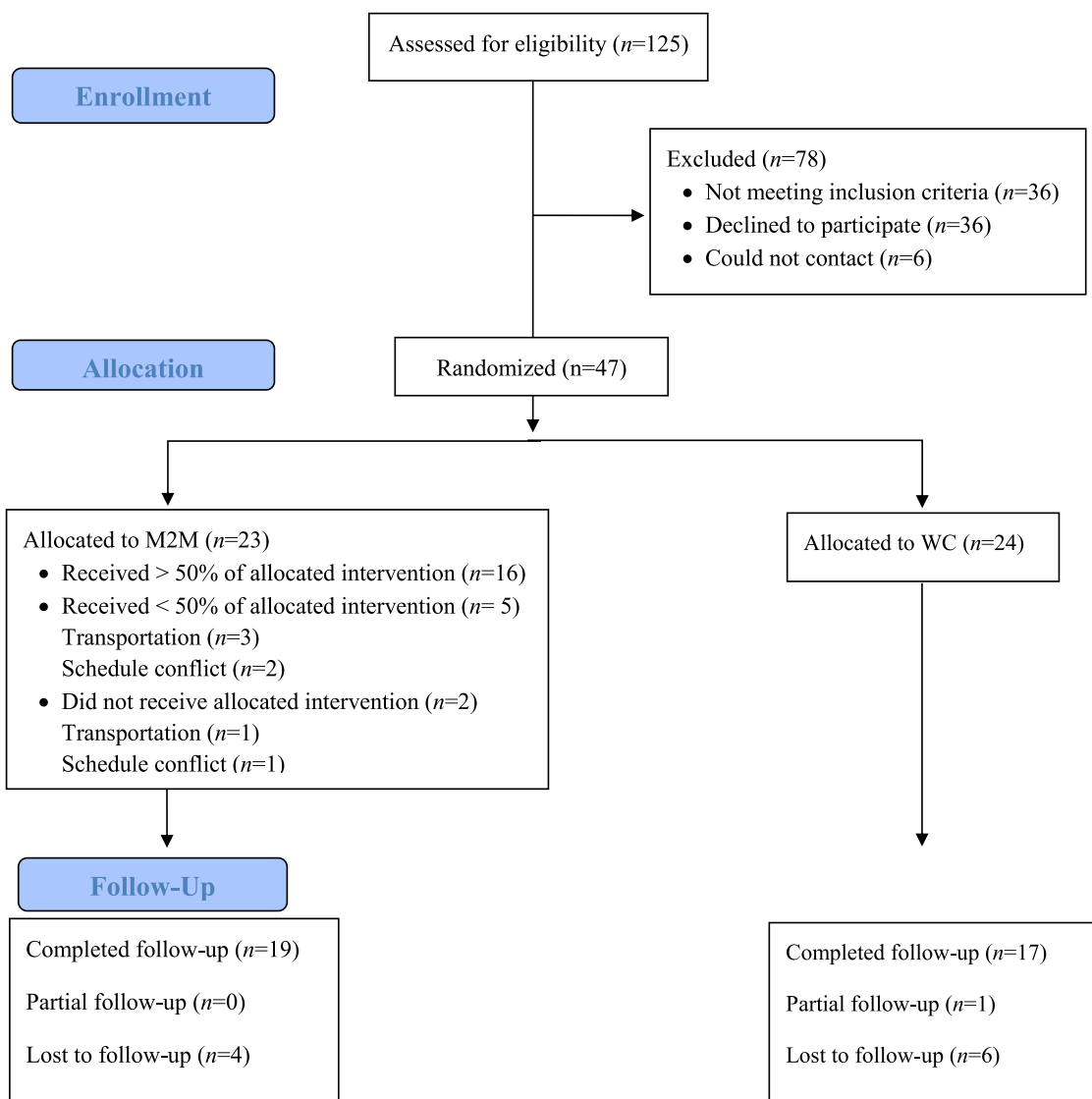
Fig 1 CONSORT (Consolidated Standards Of Reporting Trials) diagram reflecting flow of participants through the study. Partial follow-up indicates that participants did not complete the entire set of postintervention assessments.

Adherence and AEs

Average attendance was 69.1%. An overview of study-related and non-study-related AEs is presented in table 4.

Discussion

The present study examined the effects of M2M on the health and functional outcomes in adults poststroke. The primary findings are that after adjusted for the corresponding baseline values and demographic variables, M2M participants had a mean increase in 6MWT distance by 14.5 m, increase in FTSST time by 2.0 seconds, and reduction in fatigue by 3.0 points compared with WC postintervention. When baseline TUG and demographic variables were controlled for, M2M participants showed a mean increase in 6MWT distance by 37.9 m, decrease in FTSST time by 6.1 seconds, and reduction in fatigue by 6.5 points. Though these group differences were not statistically significant,

moderate effect sizes were observed. There were no group difference on TUG and pain interference.

Despite the nonstatistically significant findings, improvements in walking endurance and lower extremity functional strength were observed. Tang et al[53] suggested that the minimally clinically important difference (MCID) for 6MWT in people poststroke was 34.4 m. In the present study, mean 6MWT distance increased by 37.9 m in M2M participants compared with WC postintervention when the baseline TUG and demographic variables were controlled, which exceeds the reported MCID in this population. In addition, at postintervention, M2M participants had a mean decrease in FTSST time by 6.1 seconds compared with WC. Though no MCID cut point of FTSST is available in the stroke population, an MCID in FTSST time $\geq$2.3 seconds has been reported in people with vestibular disorders.[54] It should also be noted that 3 M2M participants went from unable to perform the FTSST at baseline to being able to perform the test postintervention, which can be a significant indicator of clinical improvement. Interestingly, when the corresponding baseline values were

Table 2 Baseline characteristic of the participants

	Movement-to-Music (n=23)	Control (n=24)
Age (y)	49.6±13.8	52.1±9.8
Sex, % (n)		
Male	43.5 (10)	37.5 (9)
Female	56.5 (13)	62.5 (15)
Race, % (n)		
Caucasian	30.4 (7)	25.0 (6)
African American	69.6 (16)	75.0 (18)
Height (cm)	167.9±10.0	172.1±11.0
Weight (kg)	90.2±25.6	100.4.0±29.2
Body mass index (kg/m^2)	31.8±7.9	34.0±10.4
Time since stroke (y)	9.4±10.2	9.2±7.7

NOTE. Data reported as mean±standard deviation or % (n).

controlled instead of the baseline TUG values (along with the demographic variables), a smaller magnitude of increase in 6MWT distance and an opposite direction of change in FTSST time were observed in M2M participants compared with WC postintervention. One possible explanation is the wide mobility range of M2M participants at baseline (baseline TUG time ranged from 4.7 to 64.5 seconds). Though exercise adaptations were provided in class, it is plausible that the substantial heterogeneity in functional mobility at baseline may have limited the ability of some participants to achieve a training effect. In future studies researchers should consider targeting a more functionally homogeneous group to determine whether a greater effect can be achieved when the intervention is designed and delivered to participants with a narrower range of physical function.

For mobility and balance, the baseline mean TUG time was 15.4±10.6 seconds in the M2M group and 20.5±15.2 seconds in WC participants. Both groups had a mean TUG time that was greater than the reported cutoff score (>15 seconds) for higher risk of falls in the stroke population.[55] Despite the moderate effect sizes observed in increased 6MWT distance and reduced FTSST time, there was no change in TUG time observed in M2M participants postintervention. A potential explanation is that the TUG test involves a more complex movement sequence that requires participants to dynamically transition from sitting to standing, standing to walking, walking while turning, and walking to sitting. Such a movement sequence utilizes different kinematics and motor control compared with sit-to-stand and walking motions.[56,57] Future investigation with a larger sample size should continue examining specific elements of movement-based interventions and adequate exercise dosing that can lead to improvements in mobility and balance in the stroke population.

Although fatigue is one of the most common symptoms in people poststroke,[58] participants in both M2M and WC had a mean baseline fatigue score that was close to a T score of 50,[59] suggesting that the fatigue level of the participants was similar to the average of the US general population. Nevertheless, our data indicated that M2M had a moderate effect on fatigue reduction in participants with stroke. The present study cannot determine whether the observed

Table 3 Descriptive and statistics for primary and secondary outcomes

	Study Group					Primary Analysis	Secondary Analysis
	M2M (n=23)		WC (n=24)			Covariates: Demographic Characteristics + Baseline Scores	Covariates: Demographic Characteristics + Baseline TUG Scores
	Baseline	Post	Baseline	Post	d	LSM Differences (95% CI)	LSM Differences (95% CI)
Primary outcomes							
6MWT (m)	287.5±135.1 (20)	316.8±157.4 (17)	232.2±117.3 (19)	228.7±132.2 (14)	0.6	14.5 (−12.9 to 42.0)	37.9 (−22.7 to 98.6)
FTSST (s)	13.6±4.3 (17)	25.1±28.7 (16)	23.2±12.1 (17)	34.7±32.9 (13)	−0.6	2.0 (−4.5 to 8.5)	−6.1 (−18.5 to 6.2)
TUG (s)	15.4±10.6 (20)	15.0±12.6 (18)	20.5±15.2 (21)	22.0±15.2 (16)	−0.1	0.3 (−3.3 to 3.9)	0.3 (−3.3 to 3.9)
Secondary outcomes							
Fatigue, T score	50.3±9.7 (20)	48.8±8.5 (18)	54.4±11.7 (21)	54.3±10.5 (17)	−0.6	−3.0 (−7.2 to 1.2)	−6.5 (−13.1 to 0.2)
Pain interference, T score	51.5±9.1 (20)	52.4±8.2 (18)	53.7±10.4 (20)	53.1±11.2 (17)	−0.1	0.5 (−3.5 to 4.5)	−1.2 (−8.4 to 6.1)

NOTE. Data reported as mean±standard deviation (n) or (95% CI). Linear mixed models accounting for the fixed effect of intervention iteration, comparing M2M with WC (reference). Demographic characteristics used for covariates included age, sex, and race.
Abbreviations: LSM, least square means; M2M, movement-to-music; WC, waitlist control; TUG, timed Up and Go; 6MWT, six-minute walk test; FTSST, five 5 times sit-to-stand.

Table 4 Overview of study and non-study-related adverse events

	Movement-to-Music (n=23)	Control (n=24)
AEs related to the study (n)		
Falls	1*	0
Cardiovascular-related episodes		
High blood pressure	1[†]	0
High resting heart rate	1[‡]	
Musculoskeletal-related events	0	0
Health care use	0	0
AEs not related to the study (n)		
Falls	3	0
Cardiovascular-related episodes		
High blood pressure	1	0
Musculoskeletal-related events	0	0
Health care use	3	0

* Participant lost balance and fell when performing standing hamstrings stretch while holding the dance barre. No injury was identified and participant walked out of the class with family member.

† One participant reported feeling of fatigue prior to class with blood pressure lower than their typical values but wanted to still participate. During class, participant's heart rate decreased to 50 bpm and reported feeling dizzy. Paramedics were called and participant's blood pressure and heart rate returned to normal. Participant reported feeling better after approximately 15 minutes and declined ambulance.

‡ One participant presented with high heart rate (∼105 bpm) at the end of class and remained high 30-minute after class. Participant requested to be released with the understanding of the risk of high resting heart rate and signed off a release form. Study physician was consulted and the maximum resting heart rate value for safety monitoring was adjusted to 110 bpm.

fatigue reduction was a result of the music, movement, or a combination of both given the multifaceted nature of the M2M intervention. However, this clearly suggests some interesting areas for further investigation.

There are very few options for rhythmic-based exercise programs for people poststroke. Such programs may serve as a nonconventional opportunity for people poststroke to obtain regular exercise. In the previous M2M trial for people with multiple sclerosis, M2M participants had statistically significant improvements in mobility and walking endurance compared with control.[32] Though it is currently unknown why such improvements were not observed in the participants poststroke, it is plausible that exercise dosing may need to be better adjusted by mobility and functional levels in this population. Different exercise adaptations were required for participants with and without hemiparesis. When such adaptations are provided in a group class setting, it could lead to participants without hemiparesis not receiving adequate training dose of exercise compared with participants with hemiparesis. It is imperative for future exercise programming to establish practical and effective ways to provide exercise adaptations that cover the diverse needs of people poststroke. In addition, it should be noted that the present study enrolled participants who were 6 months poststroke, with an average of 9.3 years since stroke. Though previous literature suggests that recovery

after a stroke is critical within the first 3 to 6 months,[15,60] some literature has also demonstrated that exercise was able to continue improving functional outcomes after this therapeutic time frame.[61,62] Further research is needed to compare effectiveness of different exercise interventions and examine optimal dosing and initiation of exercise for continuing and sustaining the improvements in physical function and quality of life among people poststroke.

M2M is a novel form of exercise used for the first time with people poststroke. It is important to recognize that the goal of M2M is to incorporate various patterns and quality of rhythmic movement to target different fitness components and thus is not restricted to 1 dance style (eg, ballet, jazz, salsa). Care should be taken when extrapolating the results of this study to other dance interventions that use a specific dance style.

Study limitations

The present study had limitations. First, individuals who had a Mini-Mental State Exam score <24 were excluded from the study to minimize potential influence of cognitive function for completing questionnaires and understanding exercise instructions and thus could affect generalizability of the findings. Second, whether the physical activity level of the WC participants was maintained could not be objectively confirmed because their activities were not monitored during the study period. Third, the present study experienced recruitment challenges and thus had a relatively small sample size. Therefore, the observed results should be interpreted with caution and should not be generalized to the stroke population. Finally, the study experienced barriers such as transportation and scheduling conflicts that are similar to those found in exercise studies in other disability groups.[63] These barriers reduced some participants' ability to attend all intervention sessions. These limitations should be considered and addressed in future research.

Conclusions

The present study suggests moderate effect sizes of a 12-week M2M intervention on improving walking endurance, lower extremity muscle strength, and fatigue in participants poststroke. Future studies should determine optimal doses of exercise for M2M in improving fitness and function in people poststroke as well as examine individual and combined effects of movement and music. Given the limited availability of rhythmic-based exercise interventions that are performed to music in people poststroke, there is a strong need to continue examining the effects of this form of exercise in this population.

Suppliers

a. Fingertip Pulse Oximeter SpO$_2$ PR Monitor, ChoiceMMed.
b. MDF 840 Professional Blood Pressure Monitor, MDF Instruments Direct.
c. Bioharness 3, Zephyr Technology.
d. Statistical analysis System v9.4, SAS Institute.

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Acknowledgments

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