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Feature Article

Sign Chi Do and physical function: A pilot study

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ABSTRACT

Participating in strength, balance, and flexibility training reduces the risk for decreased physical function for older adults. This pilot study tested the effect of an exercise intervention on physical function. A pretest/posttest single-group design was used to test the effect of a 12-week Sign Chi Do (SCD) exercise intervention on upper body strength (arm curls) and lower body strength (chair stands); balance (Timed Up & Go and one-leg stance), and flexibility (back scratch). Five community-dwelling older adults not participating in strength, flexibility, or balance training completed the study. Strength scores improved by at least 2 arm curls or chair stands for those at risk for loss of physical function. Timed Up & Go scores improved by an average of 3.83 (range 1.98–4.98) seconds for those at risk for falls. All flexibility scores remained in the upper 75th percentile. Continued practice of SCD has the potential to improve physical function for older adults.

The population of older adults over age 65 will increase by twofold in the next 20 years and will be accompanied by an anticipated 20% increase in older adults with disabilities.[1]

The path to disability includes the presence of disease and pathology and inactivity, physical and cognitive impairment, and functional limitations.[2–4] Given the rapidly aging demographics in the United States, it is of significant public health importance to develop and test theory-based, holistic interventions to reduce the risk of disability among older adults who experience chronicity and functional limitations.

There is strong evidence that minimizing risk for disability while maximizing physical function is modifiable by promoting participation in regularly scheduled physical activity.[5,6]

Research has demonstrated that the physical functioning loss trajectory may be modified by improving strength, flexibility, and balance.[7-10] Participating in regular physical activity that includes balance, flexibility, and strength training to build endurance is appropriate for sedentary older adults with chronic disease and functional limitations.[11–13] With less than 20% of older adults participating in strength or flexibility training, there is a need to develop and test novel exercise interventions that include these key factors.[14]

Mind-body practices such as Meditative Movement (MM), defined as a blending of physical movement or postures and a focus on the breath and mind to achieve deep states of relaxation include yoga, tai chi, qigong, and a less familiar form called Sign Chi Do (SCD), are feasible, acceptable, and efficacious modes of physical activity for older, frail persons.[15–20]

MM interventions have reported improved physical function in populations of older adults.[10,21–23] Less understood is the effect of SCD on upper and lower body strength and flexibility.[10,20,24]

This study builds on our research that showed significant improvement in physical function measured by Timed Up & Go (TUG) test, 6-minute walk, and weekly physical activity following a 12 week Sign Chi Do intervention compared with a sedentary control group. This article extends our work to explore the effect of SCD on upper body strength and flexibility and lower body strength. A 12-week SCD exercise intervention was tested to determine its descriptive efficacy on physical function of upper and lower extremities among older adults who were not participating in regular strength, balance, and flexibility training. Measures include upper body (arm curls) and lower body (chair stands) strength, balance (TUG and one-leg stance [OLS]), and flexibility (back scratch).

1. Sign Chi Do

SCD was selected as a low-impact physical activity (PA) intervention to improve functional fitness outcomes among sedentary

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older adults. Participating in low-impact forms of MM such as SCD are feasible and acceptable for older adults and have demonstrated significant improvements in measures of functional fitness.[10,20,23] Research demonstrated that PA interventions among older adults were more effective when the intervention targeted only activity behavior, incorporated self-monitoring, and were presented in a group setting.[25] Other considerations for effective PA interventions include cost, enjoyment of PA, and variety of choices.[26–28] There are no degree prerequisites to becoming a SCD facilitator. SCD is a low-cost program that can be easily replicated with the use of DVD-supported facilitators in churches and senior centers. It is also easy to perform, and previous participants reported they would like to continue to participate in this novel PA.[23,29]

SCD is an exercise form of MM. It was designed to use gentle movements, breathing, and meditative state to achieve a deep state of relaxation, consistent with the definition of MM[17] but with the addition of isometric and isotonic activities and choreographed signed gestures to enhance the meaning of spiritual concepts.[15] A sign gesture is a movement of the body, including mostly hand and arm movements to express ideas and concepts as opposed to specific words.[30]

The sign gestures are adapted from American Sign Language.[31,32] In SCD, the mind, body, and spirit are connected by integrating the physical movements with cognitive thought processes of expressing an emotion. Sign gestures are taught in a 3-step process to facilitate the meditative state by first learning the physical form and coordinating the movement with breath, then visualizing the meaning of the word by creating a personal image, and third by experiencing feelings associated with the sign gesture and personal image. The meditative effect is achieved via repetition of this 3-step process. The fundamental difference between tai chi and SCD that is important to this pilot study is that the movements are a series of choreographed sign gestures with consistent use of large upper body muscle groups. The intervention has been previously defined.[23]

2. Physical function

The ability to perform activities of daily living (e.g., dressing oneself, rising from a chair, eating, drinking) and recreational activities (e.g., gardening, dancing) is reliant on strength, balance, endurance, and flexibility.[2] Strength is the force produced in a single movement, and power is the ability to generate movement rapidly.[2] The amount of force a muscle produces determines the strength function. The best measurement of muscular strength of upper and lower body is the arm curl and chair stand. Balance is defined as the process through which we control the body's center of mass in relation to the base of support, whether it is static (stationary) or dynamic (moving). Maintaining both static and dynamic balance are reliant on contraction and cocontraction of muscle groups to control the position of the center of mass contributing to gait performance in the different phases.[33] The TUG is considered to be a good measure of the combined attributes of power, flexibility, balance, and speed required for dynamic balance. The OLS is the best measure of static balance. Endurance is the capacity to maintain physical performance over time.[34] Flexibility is the range of motion around multiple or single joints.[2] Unused joints loose muscle length, resulting in reduction of range of motion. Flexibility is maintained by participating in activities that move a joint through its complete range of motion and by using the joint. The best field measurement of flexibility is the back scratch.

The physical function health benefits found for tai chi can be expected from the physical practice of SCD because the basic principles of MM are followed.[17] Previous studies have reported significant improvements in strength, balance, and flexibility following MM interventions.[10,23] The isometric and isotonic movements of the arms and legs during practice are designed to strengthen the muscles of the upper and lower extremities.[2,35] Repetitive and flowing movements of arms and shifting weight of legs from front to back and side to side promote greater range of motion, resulting in improved joint flexibility and balance.[35] Improved motor coordination from learning and repeating the movements contribute to increases in performance measures of strength, flexibility, and balance.[2,24,36]

3. Methods

3.1. Design

A single-group 12-week SCD intervention with pre–post measures was used for this study. Measurement time points were selected based on preliminary work demonstrating significant changes in outcomes at 12 weeks.[23]

3.2. Recruitment and retention strategies

The study was approved by the institutional review board of the authors' affiliated University. The study was funded by a university small study grant with 6 months to complete all aspects of the research. Strategies for recruitment included scheduled 10-minute presentations to senior center participants, demonstration of SCD during lunch announcements, and posting flyers at the sites.

To support retention in the study, all participants were compensated with a $25 gift card following completion of each data collection session. Telephone calls were used to remind participants of scheduled data collection times. Attendance rosters were checked weekly. If participants missed a class, they received a phone call in an effort to bring them back on schedule as soon as possible, identifying the reason for the absence, resolving possible problems, and reviewing content missed in class.

3.3. Sample and screening

The participants in this study were community-dwelling adults, without cognitive impairment, at risk for functional decline, and over age 60. The risk for functional decline was defined as currently sedentary or not participating in strength, balance, or flexibility training. Eligible participants were between the ages of 60 and 89; had no history of neurological or muscular disorders that resulted in restriction of shoulder range of motion; had normal or adjusted hearing and vision; were right-handed; were currently sedentary or not participating in strength, balance, or flexibility training; were safe to participate in at least moderate intensity physical activity; and were able to speak English.

3.4. Measures

To determine physical activity during the past year, participants completed the Stanford Brief Physical Activity Survey. This is a brief survey designed to rapidly assess level of physical activity in the past year.[37] Work and leisure-time activity are rated according to inactive, light-intensity, moderate-intensity, hard-intensity, and very hard-intensity. Sedentary is defined as reporting inactive or light-intensity activity. Participants who scored moderate-intensity were further questioned, and if the reason for participating in physical activity included walking or riding a stationary bicycle

with no report of strength, balance, or flexibility training, they were allowed to participate in this study. The reason for this clarification was the focus of this study was to explore the effect of SCD on balance, strength, and flexibility changes. Walking and stationary cycling are aerobic activities that are not intended to affect the selected measures of strength, flexibility or balance. Cognitive function was assessed by the Mini-Cog examination and participants who scored 3–5 on the Mini-Cog scale were allowed to participate in the study.[38] All participants were screened for safe participation in moderate-intensity physical activity by the Physical Activity Readiness Questionnaire.[39] If a participant responded yes to one of the questions or was over age 69, clearance to participate was obtained from the participants' health care provider.

Participants were recruited from 2 senior centers in a metropolitan area in the southwestern United States that deliver services to approximately 4000 older adults annually. Approximately 80 older adults attended the recruitment presentations. Fourteen participants were screened with 7 meeting inclusion criteria. Of the 7 meeting inclusion criteria, 2 were unable to commit to the 12-week class, and thus 5 participants were enrolled in the study.

3.5. Sign Chi Do intervention

The SCD intervention followed an established protocol. The timing of the delivery was 1-hour sessions, 2 days per week over 12 weeks. The content for each week was presented using a manualized protocol that outlined the content to be presented each week. This served to control for monitoring SCD participation, and if a participant missed 1 class in a week, he or she had the opportunity to learn the content at the following session. Each session included a 5-minute warm-up and cool-down time with 50 minutes for instruction and participation in SCD according to the protocol established by Borik.[15] Participants who were unable to stand were asked to perform movements from a seated position and visualize performance of the movements from a standing position. For safety, all participants stood beside a chair to maintain stability. SCD word phrases were taught in a 3-step pattern: *do* the movement, *visualize* what the phrase means, and *feel* the word phrase. Although the physical form of each word phrase was defined by the facilitator, participants were encouraged to create their own visual representation and feeling of the word phrase. This was intended to promote the spiritual exploration. As part of the intervention, participants were given a copy of an instructional DVD, music CD, flash cards, and a personal activity log to facilitate practice of movements at home, between classes. Participants were encouraged to practice at least 10 minutes, 2 times between classes the first week, increasing the time to include up to the recommended 30 minutes, 5 days a week. Table 1 outlines the intervention. Details of the intervention are reported elsewhere.[23]

3.6. Treatment fidelity

We evaluated treatment fidelity based on the Behavior Change Consortium Model of Treatment Fidelity with regard to design, training, delivery, receipt and enactment.[40] The design of the study was described earlier. Treatment fidelity was monitored in the following ways to address training and delivery and receipt and enactment of the intervention. Training the provider was an important consideration. One certified SCD instructor (1 author, CER) with more than 6 years of experience taught the intervention classes; the instruction was observed and rated by the founder of SCD for consistency. The classes were taught according to the intervention manual. The instructor completed weekly checklists of completion of program content to monitor delivery of the SCD intervention. The checklists were reviewed for adherence to program content and process and scored accordingly. Participants were asked to attend a total of 22 biweekly Sign Chi Do classes during the 12-week study period. (Twenty-four classes were initially scheduled but were reduced to 22 because the center was closed for 1 class and instructor travel for another.) To monitor receipt of the intervention, weekly attendance at the class was recorded, and the instructor observed the participants' ability to perform the movements in class. Class discussion also included time to share the visualization and feeling of the words associated with the movements. Attendance at class sessions was reported as number and percent of sessions attended by participant and the number of attendance at class sessions by week. Reasons for missed classes were also reported. To monitor enactment of the SCD intervention, home practice of SCD was measured by self-report minutes of practice per day per week. Each class begins with time for discussion regarding the home practice during the previous week.

3.7. Measures

3.7.1. Descriptive information

Demographic variables included 1) age in calendar years, 2) gender, 3) current chronic illness (self-report of history of cardiovascular disease, respiratory disease, diabetes, cancer, arthritis, chronic pain, or other), 3) level of education in years, 4) body mass index, and 4) ethnicity and race per National Institutes of Health guidelines. The independent variable was participation in a 12 week, 60 minutes for 2 days a week SCD intervention and home practice. Class participation was measured by attendance records and home practice was reported on a self-report log.

3.7.2. Outcome measures

The outcome measures to assess physical function were self-report and performance based. Participants in the study completed self-report exit surveys to objectively measure changes. Questions on the surveys asked how active they were before and after the class and if the class improved their strength and balance. All responses were scored on a 5-point Likert scale (*Not at all* to *Extremely*). Objective measures included balance (10-foot TUG and OLS), strength (30 second arm-curl and chair stand tests), and flexibility (back scratch).

3.7.2.1. Balance. Balance was measured with the TUG and OLS. The TUG has prior evidence of reliability and validity [41–43] The TUG is considered to be a good measure of combined attributes (power, flexibility, balance, and speed) and measures the time it takes one to stand from a seated position, walk 10 feet, turn around, and return to the chair and sit down.[41] Following a demonstration and practice demonstration, the participant repeated the test 3 times and the scores were averaged for the final score in seconds. The OLS is a valid and reliable measure of static balance.[44] It measures how long one can stand (up to 60 seconds) on their dominant foot without touching the other foot on the floor. This test was administered with the participants holding both eyes open and with their shoes removed.

3.7.2.2. Strength. Upper and lower body strength were measured with the arm curl and chair stand tests. These tests have prior evidence of reliability and validity among older adults.[45] The arm curl test involves counting how many times one can hand curl a hand weight (5 pounds for women and 8 pounds for men) in 30 seconds.[46] The chair stand measures how many times one can stand from a seated position with their arms placed across their chest in 30 seconds.[46] The participant was seated in the middle of a chair with arms across the chest and rise to a full stand, then

Table 1
Sign Chi Do intervention used in this study.

- Begin with warm-up.
- Initial form is taught from seated position, then standing. Participants are to stand beside their chairs for safety reasons. If needed, the chair is there for balance. Those who cannot stand are asked to contract leg muscles in place of stepping forward movement and relax when stepping back.
- Practice all movements on right first, then left to create balance.
- Repetition of movements is key.

Warm-up 5–10 minutes: All movements begin with Postural alignment (Sitting or standing): Shoulders relaxed and in alignment with hips and feet and all facing forward. When standing, feet start shoulder width apart.	Begin with deep breath and raise arms in front of body, exhale as arms lower. Next breath, raise arms to side on inhale and lower on exhale.	Next do 5 forward and backward shoulder rolls followed by arm circles, front and back.	Place 1 hand on opposite shoulder. Raise elbow to shoulder height. Open opposite hand with palm facing ceiling and place under elbow. Lower elbow while giving resistance with hand under elbow. Inhale as you raise elbow and exhale as you lower with resistance. Repeat 5 times.
	Front leaning stance: Step forward 1 stride length, toes first and facing forward as knee bends. Maintain feet shoulders width apart. Opposite foot, toes slightly turned out (30°) and leg straight. Shift weight to back foot. Bend back knee and straighten front knee when shifting weight to back foot. Both feet remain flat on floor at all times. Connect breath and arms with leg movements (as weight shifts forward, raise arms and take in a deep breath, as shifting back, exhale). Repeat 5–10 times as able. As legs strengthen, may increase stepping distance.	L stance: Step back with 1 foot, making an L with feet (creating a 90° angle). Feet should be a comfortable distance apart and the heel of the back foot should land in line with front foot. Shift weight to back foot, and front foot should be settled on heel with toes pointing up in the air. Most of weight on the back foot with knee bent and front knee is straight. Shift weight from back to front foot and bend front knee as back knee straightens. Connect breath and arms with leg movements (as weight shifts forward, raise arms and take in a deep breath, as shifting back, exhale). Repeat 5–10 times as able.	One-leg stance: Plant 1 foot firmly on floor. Fix gaze on wall in front of you to assist with balance. Hold onto chair and raise opposite leg, making a 90° angle at knee. Hold as long as possible. Once conditioned to this movement, add by tucking foot behind knee of the supporting leg. Repeat 2–3 times initially and increase as able.
Example of 3 sign gesture movements: physical form includes isometric and isotonic muscle contractions balanced with muscle relaxation Practiced from seated position, then standing incorporating a modified front leaning stance	Healthy: Bring hands to chest with palms open. Extend arms forward in a powerful manner with hands clenched into fist as muscles in forearm and upper arm tighten, assuming the boxer's posture. Hold form for a count of 4 or follow timing of music.	Breath: Breathe in as hands placed on chest. Breathe out as arms extended.	Intention of word: Imagine strength or power emanating from your body. This move suggests that not only your body but also mind and soul are healthy. Practice with music and repeat 3–4 times.
	Happy: Rolling your hands upward and outward, starting low in your abdomen. This rolling motion is continuous.	Breath: Breathe in as hands move in a continuous motion rolling outward. Breathe out: continuous motion.	Intention of word: The sign gesture shows emotion at the level of your gut. Imagine a belly laugh.
	Holy: The right index and middle finger (the H sign) glide across the palm of your left hand extending upward and out on an angle.	Breath: Breathe in as the right fingers are placed on the palm of left hand. Breathe out as fingers brush across palm and extend upward and outward.	Intention of word: Imagine wiping away or cleansing the slate. Allow yourself to feel connected as you extend your arm upward.
Learn movements with a 3-step process:	First learn physical form of the sign gesture, engaging the body.	Second, visualize what the phrase means (engaging the mind).	Third, feel the word phrase (engaging the emotional and spiritual exploration).
Meditative effects:	Intention of practice: set aside time to practice with purpose and thought.	Attention: feeling and visualizing the meaning of the word phrase.	Attitude: without judgment, but recognition of feelings experienced.
Spirituality/deep state of relaxation and overall well-being enhanced via:	Body movement or posture.	Focus on breath.	Clearing of the mind through the focus on meaning of the sign gesture.

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return to a fully seated position as many times possible in 30 minutes.

3.7.2.3. Flexibility. Shoulder flexibility was measured with the back scratch test. This is the best known test for measuring overall shoulder flexibility.[34,46] To complete the back scratch, the participant was asked to reach one hand over the shoulder and down the back as far as possible and with the opposite hand, reach around the waist and up to the middle of the back, to bring the fingers of both hands together.[46] The distance between the extended middle fingers was measured in inches (plus or minus) for the preferred position (best hand over the top).[46] Following 2

warm-up trials, the test was administered twice, and the better score was recorded as the final score.

3.7.3. Analysis

Descriptive statistics include means with standard deviation and frequencies for age, gender, level of education, race and ethnicity, and presence of chronic illness, height and weight, and systolic and diastolic blood pressure. The balance scores were evaluated to determine whether they were reported within the normal range established by national normative data by age. For the remaining outcomes, individual scores were ranked by percentile scores according to national normative data by age and gender. The pre- and post-intervention percentile scores were compared to determine if clinical changes in scores occurred after the 12 week SCD intervention.

4. Findings

All 5 participants enrolled in the study completed the pre–post assessments. The average age was 67.8 (SD = 8.04) years with a range of 61 to 80 years. Participants were White ($n = 2$), American Indian ($n = 2$), and African American ($n = 1$). Most of the participants were female ($n = 4$); 3 completed at least 4 years of college education and 2 completed some high school. All of the participants reported a history of cardiovascular disease including hypertension, most ($n = 4$) reported a history of arthritis, and 1 each reported a history of cancer and prediabetes. The participants were obese (average body mass index 30.58, SD = 3.10). The average systolic blood pressure was 142 (SD = 10.95) and diastolic blood pressure 81.2 (SD = 5.76). Individual scores for physical function, age and gender normative scores, and percentile rankings pre- and post-intervention are reported in Table 2.

4.1. Physical function outcomes

Physical function was measured using self-report surveys and performance measures of TUG and OLS for balance, arm curls and chair stands for strength, and back scratch for upper body flexibility. Most of the participants in this study had below average scores for balance and strength and above average upper body flexibility at baseline (Table 1). Strength and balance scores improved for most of the participants, and flexibility remained above the highest percentile for their age and gender. The participants self-reported they were low to moderately active before SCD class participation, and this changed to moderate to very active after the 12 weeks (average 2 to 3.75 respectively). They reported moderately to very improved levels of balance and strength (average 3.25 and 4.3 respectively).

Three participants reported TUG scores above 10 seconds at baseline, indicating a risk for falls among older adults. Following the 12-week SCD intervention, their scores improved by an average of 3.83 (range 1.98–4.98) seconds, indicating participating in SCD improved balance for those at risk for falls. The 1 participant who remained above the average TUG score for her age improved by 4.55 seconds. The 2 participants who reported normal scores for TUG at baseline were below average for the OLS. They improved the scores by an average of 6 seconds. All of the participants improved balance measured by TUG or OLS following the 12-week intervention.

Baseline scores for upper arm strength were below the 25th percentile for 3 participants, within the 50th percentile for 1 and above the 75th percentile for 1 participant. Following the 12-week SCD intervention, 4 of 5 participants were within or above the 50th percentile. All of the women increased the percentile scores (1 to the 20th percentile and 2 to the 50th percentile range, and 1 to the 75th percentile range), and the only male remained above the 75th percentile. Baseline scores for chair stands were below the 25th

Table 2
Individual pre and post scores, age and gender norms, and percentile rating.

ID #	Measure	Pre	Post	Age and gender average/ normal range[a]	Percentile pre	Percentile post
1	TUG	10.68	8.7	8.1 (CI 7.1–9.0)[b]	Above[c]	Within
	OLS	41.88	55.87	27.0 (CI 20.4–33.7)[b]	Above[d]	Above
	Arm curl	10	12	13–19	10th	20th
	Chair stand	10	14	12–17	15th	45th
	Back scratch	10	10	−3 to +1.5	95th	95th
2	TUG	9.08	8.4	9.2 (CI 8.2–10.2)	Within	Within
	OLS	7.91	14.38	17.2 (CI 11.6–22.8)	Below	Within
	Arm curl	13	17	12–17	40th	75th
	Chair stand	8	12	10–15	10th	45th
	Back scratch	0	2	−4 to +1	70th	80th
3	TUG	7.6	7.6	11.3 (CI 10.0–12.7)	Below	Below
	OLS	4.78	11.41	8.5 (CI 1.0–16.1)	Within	Within
	Arm curl	23	19	13–19	95th	75th
	Chair stand	12	17	10 –- 15	50th	90th
	Back scratch L	8	8	−9.5 to −2	95th	95th
4	TUG	14.73	10.18	8.1 (CI 7.1–9.0)	Above	Above
	OLS	3.59	2.4	27.0 (CI 20.4–33.7)[a]	Below	Below
	Arm Curl	12	14	13–19	20th	35th
	Chair Stand	8	10	12–17	5th	15th
	Back Scratch L	5.5	4	−3 to +1.5	95th	90th
5	TUG	12.78	7.8	8.1 (CI 7.1–9.0)	Above	Within
	OLS	6.09	6.02	27.0 (CI 20.4–33.7)[a]	Below	Below
	Arm curl	13	15	13–19	25th	40th
	Chair stand	10	11	12–17	15th	20th
	Back scratch R	6	4.5	−3 to +1.5	95th	90th

CI, confidence interval; L, left; OLS, One-leg stance; R, right; TUG, Timed Up & Go.
[a] TUG normative scores from Bohannon,[47] OLS from Bohannon,[44] and rest from Rikli and Jones.[46]
[b] Age normative comparison only, mean and 95% CI.
[c] Below average score indicates better dynamic balance.
[d] Below average score indicates poorer static balance.

percentile for all female participants and in the 50th percentile range for the male participant. The percentile ratings improved for all participants with 3 out of 5 in the 50th percentile range or above postintervention.

Baseline and postintervention scores for flexibility were above the 95th percentile for 4 participants. Participant 2 was within the average 50th percentile preintervention and increased to the above average or 75th percentile postintervention.

4.2. Intervention fidelity

The instructor completed weekly checklists of completion of program content. The weekly checklists reported 100% of the content was delivered according to the intervention manual, indicating the intervention was delivered as designed. The overall attendance rate was more than 73%. The total number of classes attended was 16 (73%) for 3 participants, 18 (82%) classes for 1 participant, and 19 (86%) classes for 1 participant. Two participants attended class all 12 weeks, 1 participant attended 11 weeks, and 2 participants attended 10 weeks. Reasons for missing classes were health related (10 classes) and non-health-related reasons, such as prior commitment, family needs, forgot to come to class, lack of transportation, or scheduled travel (15 classes). The average home practice of SCD and combined class and home was 55 (range 5–105) and 141 (range 85–186) minutes per week respectively.

5. Discussion

The purpose of this pilot study was to determine feasibility and descriptive efficacy of the SCD intervention. SCD as a form of MM combines gentle flowing movements to improve upper and lower body strength and flexibility and balance. The findings of this small pilot study are promising. All participants completed the study, the attendance rates were generally acceptable, and the participants demonstrated improvement in the study objective and subjective outcomes. It is important to note that this was a small group, and future studies are needed to determine large group effect.

SCD class facilitators do not need formal training, and the weekly class material has been developed in a DVD format to provide consistent delivery of the intervention. This SCD intervention is a low-cost, low-impact intervention. The movements are safe for older adults to perform. Traditional weight training known to improve strength does not appeal to older women who have not previously learned such a strategy, and it does not affect balance and flexibility.[46] Additionally, traditional forms of MM such as tai chi focus on lower body strength and balance. SCD uses sign gestures in a choreographed sequence to increase joint range of motion and isometric and isotonic strength of the upper body. Upper body strength and joint flexibility are important for the performance of many activities and maintenance of independence for older adults.[2] Our previous research demonstrated significant improvement in balance, physical activity, and endurance. Participants enjoyed the 12-week SCD intervention and would continue with the practice. This pilot study adds to the feasibility and descriptive efficacy of SCD on upper body strength and flexibility and lower body strength.

Objective and subjective measures of strength and/or balance improved for all of the participants in this small pilot study. The shoulder flexibility scores remained above average. The decrease in TUG scores was a greater improvement than reported by participants in our previous SCD study which reported an average change score of −2.53 seconds.[23]

Consistent with the gender norms, the male participant had higher strength scores than the females. Participants 1, 4, and 5 reported a recent history of walking on a treadmill or cycling at least 3 days per week. Their strength and TUG scores were worse at baseline than the other 2 participants, showing that aerobic activity alone does not affect strength and balance. Participants 1, 2, 4, and 5 reported a history of arthritis of the lower extremities, and the latter 2 missed some of the classes because of joint pain. Despite the presence of known arthritis, the strength and balance scores improved overall following this 12-week SCD intervention.

Joint flexibility is important for activities of daily living that require reaching and bending. The shoulder flexibility scores were all high at baseline, and flexibility was maintained by the participants. Although scores were high for this small group, it is important to consider the benefits of maintaining flexibility because there is a trend for older adults to decrease flexibility as they age. The inclusion criteria required participants to be free from neurological or muscular disorders that result in restriction of shoulder range of motion. Future research should include participants with restricted shoulder range of motion to determine if SCD improves shoulder joint flexibility and include an assessment of lower body flexibility.

5.1. Limitations

The small sample size limits generalizability of findings to the general population. The small sample size also limits the ability to control for changes in function based on age, gender, or number of chronic conditions which are know to effect physical function. Although not powered for efficacy, the purpose of this study was to determine feasibility and descriptive efficacy of SCD as an intervention for frail older adults. Future studies are needed to determine if this SCD intervention can be replicated in the community and demonstrate significant improvement in these functional outcomes for older adults. Including only participants free from restricted shoulder range of motion limited the ability of this study to determine if SCD improves shoulder flexibility. The eligibility criteria for future studies should include participants with shoulder joint mobility restrictions. Another limitation was that this study did not control for the use of nonsteroidal antiinflammatory drugs or symptoms such as joint pain that may influence physical function and participation in physical activity among community-dwelling older adults.

6. Conclusions

Sedentary behavior is a known risk for decreased physical function among older adults. Despite the limitations, these findings are promising. The selection of measures with normative scores by age and gender identifies individuals at risk for functional decline at baseline and post intervention. Recommendations for future research include 1) randomized controlled trial with a larger sample based on effect size to calculate statistical significance; 2) control for age, gender, chronic conditions, symptoms, and medication changes; 3) use of previously successful recruitment strategies; 4) include older adults with limited shoulder range of motion; and 5) inclusion of lower body flexibility, endurance, and physical activity measures.

This 12-week SCD intervention improved physical function for older adults who were not participating in strength, balance, or flexibility training. This provides valuable information contributing to the design of future theory-based intervention research of SCD. Continued practice of SCD has the potential to improve and maintain physical function for older adults required to perform activities of daily living and maintain independence.

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