

Translation of an Effective Tai Chi Intervention Into a Community-Based Falls-Prevention Program

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Tai Chi—Moving for Better Balance, a falls-prevention program developed from a randomized controlled trial for community-based use, was evaluated with the RE-AIM framework in 6 community centers. The program had a 100% adoption rate and 87% reach into the target older adult population. All centers implemented the intervention with good fidelity, and participants showed significant improvements in health-related outcome measures. This evidence-based tai chi program is practical to disseminate and can be effectively implemented and maintained in community settings. (*Am J Public Health*. 2008;98:1195–1198. doi: 10.2105/AJPH.2007.120402)

Falling is a significant public health problem among community-living older adults in the United States^{1–4} but is preventable through regular exercise.^{5–9} Randomized controlled trials have shown the efficacy of tai chi in reducing the frequency of falls and risks of falling among older adults.^{10–12} However, little evidence indicates whether scientifically validated falls-prevention programs can be translated and disseminated to reach broader community-based senior service providers. Thus, the primary objective of this study was to evaluate Tai Chi—Moving for Better Balance,¹³ an evidence-based falls-prevention program developed for use in community-based organizations such as senior centers. The utility of the program

was examined via RE-AIM, a framework for the systematic planning and evaluation of interventions intended to produce public health effect.^{14,15} The major focus was on the RE-AIM elements of Reach, Adoption, and Implementation, with secondary aims of evaluating program Effectiveness and Maintenance.

METHODS

Design

The research involved a single-arm tai chi intervention with a pretest–posttest within-participants design. Twice-weekly 1-hour classes were implemented in local senior centers in Lane County, Oregon, for 12 weeks. A 12-week postintervention follow-up assessed short-term program maintenance. Trained community tai chi instructors delivered the program. All data were collected between April 2006 and April 2007.

Settings and Participants

The dissemination area was 5 cities in Lane County: Eugene, Springfield, Santa Clara, Junction City, and Cottage Grove (range in population = 4721–137 893). The program was targeted at senior service organizations providing community health resources and social services, including physical or recreational activities, to local community-living older adults. Six senior centers, chosen for the size of their service area and the volume of daily service use, were approached to participate. Once an agreement was reached for adoption, a plan that covered program logistics, class setup, and recruitment of participants was developed. Eligible participants were (1) 60 years or older, (2) physically mobile, and (3) without severe mental deficits.¹⁶ Recruitment was achieved primarily through communitywide promotions using each center's direct mailings, promotional flyers, and word of mouth.

Tai Chi Classes

Each session of Tai Chi—Moving for Better Balance¹³ began with warm-up exercises (5–10 min), was followed by teaching and practicing individual forms of the 8-form

tai chi program (40–45 min), and ended with cool-down exercises (5 min).¹⁰ In addition, copies of the videotape or DVD and users' guidebook were distributed to all participants who were encouraged to use these materials to practice at home.

Program Evaluation and Measures

Reach. Reach was calculated as the number of eligible individuals qualified per study criteria divided by the total number of individuals who responded to the program promotion multiplied by 100. The representativeness of the target population was determined by comparing participants' demographic characteristics and their use of the center with those of all users through center records.

Adoption. Adoption was defined as the percentage of local community senior centers approached that agreed to participate and implement the program.

Implementation. Implementation was defined as the extent to which providers and instructors successfully implemented key elements of the program, including adherence to the implementation plan provided, maintenance of a twice-per-week program schedule, attainment of a class attendance rate of 75% or higher over the 12-week class period, and documentation of an average of 30 minutes or longer of in-home practice per week.

Effectiveness. Effectiveness was defined as change in measures of physical performance and quality-of-life, including (1) functional reach test¹⁷; (2) up and go test¹⁸; (3) time to rise from a chair (chair stands)¹⁹; (4) the 50-foot speed walk²⁰; and (5) the Short-Form 12-item Physical and Mental Health Summary Scale.²¹ Monthly frequency of falls among participants was monitored using a falls calendar.¹⁰

Maintenance. At the setting level, maintenance was defined as the center's (1) willingness to consider tai chi as part of a center's programs and (2) continuation of the program after completion of the intervention. At the participant level, maintenance was defined as the extent to which participants continued their tai chi practice during the 12 weeks following class termination.

RESULTS

Reach

From the 6 participating centers, a total of 287 individuals responded to the promotion and signed up for the class. Of this total, 249 individuals were eligible per study criteria. As a result, the reach of the study was 87% (249 respondents of 287 eligible individuals). This also represents an approximately 45% reach of the participants ($n=555$) who usually attend activities at these centers. Of those who qualified, 157 individuals were enrolled in the class, and 92 were placed on a wait list. Of the 157 individuals accepted, 17 did not show up at the class (because of reasons such as health or time conflicts), resulting in participation by 89% of those eligible and interested (140 of 157). Baseline characteristics of the participants are shown in Table 1. Participants in this study did not differ from the general population of senior center users on demographic variables of age, socioeconomic status, gender, or race.

Adoption

All 6 centers that were invited agreed to participate, resulting in a 100% adoption of the program at the setting level. These centers represented typical senior service providers. The average daily client attendance across these centers ranged from 25 to 200 people (median = 83). All centers provided physical activity classes (annual range = 9–120; median = 47), with an average 70% to 85% program attendance rate (median = 85%) over any given month. All centers were nonprofit organizations that have been in existence between 6 and 50 years (with number of regular staff ranging from 2 to 30; median = 8).

Implementation

All participating centers successfully implemented the program. In addition, each class progressed as designed, and all 5 instructors successfully completed teaching the program routine.¹³ A total of 35 participants (25%) withdrew during the intervention because of health problems and other reasons (e.g., time commitment, inconvenience). Among those who completed the program ($n=105$), session attendance averaged

TABLE 1—Participant Characteristics at Baseline: Tai Chi—Moving for Better Balance, Lane County, OR, April 2006–April 2007

Measure	Result
Total, no.	140
Female, no. (%)	120 (85.7)
Age, y, mean (\pm SD)	70.57 (\pm 8.79)
White, no. (%)	134 (95.7)
Education, no. (%)	
Less than high school diploma	49 (35.0)
College or more	91 (65.0)
Household income, \$, %	
5 000–14 999	37.1
15 000–39 999	33.6
\geq 40 000	29.3
Body mass index, %	
<25 kg/m ² (normal)	31.4
25–29 kg/m ² (overweight)	36.4
\geq 30 kg/m ² (obese)	32.2
Resting blood pressure, mean (\pm SD)	
Systolic, mm Hg	131.94 (\pm 18.82)
Diastolic, mm Hg	75.23 (\pm 9.78)
Falls in past 6 mo, no. (%)	
Yes	33 (23.6)
No	107 (76.4)
Afraid of falling, no. (%)	
Yes	95 (67.9)
No	45 (32.1)
Health status, no. (%)	
Poor or fair	9 (6.4)
Good	36 (25.7)
Very good or excellent	95 (67.9)
Habitual physical activity, ^a mean (\pm SD)	116.36 (\pm 57.78)

^aMeasured with the Physical Activity Scale for the Elderly.²²

80% (range = 75%–89%), and the average time spent practicing tai chi at home was 32 minutes per week (median = 27 min).

Exit interviews with staff at each participating center indicated that the program was well received and successfully implemented, with acceptable class attendance rates (>85%). More important, all participating centers expressed the intention to adopt the program as part of their routine programming. Exit interviews with participants (Table 2) indicated that, among other things,

they enjoyed the class, thought that the program not only benefited them physically and mentally but also helped their balance, and believed that the program would help prevent falls. They also reported that the videotape or DVD and users' guidebook were useful learning materials. All participants indicated their intention to continue tai chi if it were offered in the community.

Effectiveness

At the end of the 12-week intervention, participants showed significant preintervention to postintervention improvements in functional reach (32.31 cm pretest, 34.39 cm posttest; $P<.001$), the up and go test (7.40 seconds pretest, 7.17 seconds posttest; $P<.001$), chair stands (10.60 seconds pretest, 10.07 seconds posttest; $P<.001$), and the 50-foot speed walk (12.78 seconds pretest, 12.14 seconds posttest; $P<.001$). No significant change (i.e., decline) in these measures occurred between the end of the intervention and the 12-week postintervention follow-up. Participants also showed significant improvements in the SF-12 physical ($P<.001$) and mental health ($P<.001$) summary scores.

Of the 135 participants who provided data, 7 reported 1 or more falls during the first 6 weeks of the class, but no further falls were reported by anyone from week 7 through the end of the 12-week program. Of the 105 participants contacted during the 12-week postintervention follow-up, only 2 participants reported a single fall each.

Maintenance

All participating centers expressed strong interest in continuing the program. Since the completion of the study, 5 centers continued offering a tai chi class, and 1 was waiting on instructor availability. Twelve-week follow-up data indicated that 97 of the 105 participants (92%) individuals reported continued tai chi practice, either on their own (56%) or by attending a class (29%). Fifteen of these individuals reported doing both.

DISCUSSION

There is wide recognition within public health that proven programs must be

TABLE 2—Exit Interview Responses of Participants (N = 105): Tai Chi—Moving for Better Balance, Lane County, OR, April 2006–April 2007

Survey Item	% Responding “Yes”	% Responding “Somewhat”
Program enjoyment and satisfaction	100	0
Understanding movement instructions	94	6
Easy to learn and perform	94	6
Movements were appropriate and safe to perform	100	0
Made me more confident in walking	100	0
Balance has improved	94	6
Help functional independence	100	0
Help improve confidence in performing daily activities	100	0
Intend to continue doing tai chi	100	0
Recommend it to others	100	0

translated, implemented, and adopted to have widespread effect.^{14,15,23} Findings from this brief 12-week program evaluation indicated good reach, an excellent adoption rate, and good program fidelity and maintenance. Currently, the Oregon Department of Human Services, in partnership with 4 counties in Oregon, has implemented the program as part of its efforts to disseminate evidence-based interventions to promote physical activity and reduce falls among community-living older adults. Classes are being offered in locations such as senior centers, hospitals, and assisted living and senior housing complexes and through a county adult education program. These dissemination results indicate that an evidence-based tai chi program can be implemented in urban and rural community settings.

Tai chi has been considered a low-cost exercise activity²⁴ because no equipment and few facilities are needed. In our study, the total cost of class implementation (i.e., room rental, instructor's pay, and class materials) was \$15 130, for an average of \$108 per individual, or approximately \$4.50 per person per session. These program expenditures, however, did not include the development of the program, costs to reach individuals, data collection, and outcome evaluation.

Although the program results were promising, continued efforts are needed to address several translation, implementation, and evaluation issues. These include implementation

of the program in diverse community settings (e.g., primary care settings, religious organizations) and the long-term effects of the intervention on falls, including a sufficient observation period to monitor more definitively changes in fall risks, for which the program was designed. Other needs include measuring program sustainability, at both the service-provider level and by the instructors, and conducting cost–benefit, cost-utility, or cost-effectiveness analyses of the program. The latter is important to document whether this program can improve health while reducing health care costs. ■

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Note. The findings and conclusions in this brief are solely the responsibility of the authors and do not necessarily represent the official views of the Centers for Disease Control and Prevention or the US Department of Health and Human Services.

Contributors

F. Li originated the study, supervised all aspects of its implementation, performed data analysis, and wrote the brief. P. Harmer assisted with the implementation, analysis, interpretation, and writing of the brief.

R. Glasgow contributed to the interpretation, writing, and revisions of the brief for important intellectual content. K. A. Mack and D. Sleet provided scientific support for the project and contributed to the writing of the brief. K. J. Fisher contributed to the concept and design of this research project. M. A. Kohn, L. M. Millet, and J. Mead contributed to the writing of the brief. J. Xu, B. Sutton, and Y. Tompkins assisted with the development and evaluation of the program package and contributed to the writing of the brief. M.-L. Lin and T. Yang contributed to critical revision of the brief for important intellectual content.

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Human Participant Protection

The research protocol was approved by the institutional review board of both the Oregon Research Institute and the Centers for Disease Control and Prevention.

References

- Centers for Disease Control and Prevention. Falls among older adults: an overview. Available at: <http://www.cdc.gov/ncipc/factsheets/adultfalls.htm>. Accessed July 22, 2007.
- Alexander BH, Rivara FP, Wolf ME. The cost and frequency of hospitalization for fall-related injuries in older adults. *Am J Public Health*. 1992;82:1020–1023.
- Englander F, Hodson TJ, Terregrossa RA. Economic dimensions of slip and fall injuries. *J Forensic Sci*. 1996;41:733–746.
- Stevens JA, Corso PS, Finkelstein EA, Miller TR. The costs of fatal and non-fatal falls among older adults. *Inj Prev*. 2006;12:290–295.
- Chang JT, Morton SC, Rubenstein LZ, et al. Interventions for the prevention of falls in older adults: systematic review and meta-analysis of randomised clinical trials. *BMJ*. 2004;328:680–688.
- Cumming RG. Intervention strategies and risk-factor modification for falls prevention: a review of recent intervention studies. *Clin Geriatr Med*. 2002;18:175–189.
- Gillespie LD, Gillespie WJ, Robertson MC, Lamb SE, Cumming RG, Rowe BH. Interventions for preventing falls in elderly people [published update appears in *Cochrane Database Syst Rev*. 2003;(4):CD000340]. *Cochrane Database Syst Rev*. 2001;(3):CD000340.
- Province MA, Hadley EC, Hornbrook MC, et al. The effects of exercise on falls in elderly patients: a preplanned meta-analysis of the FICSIT Trials. Frailty and Injuries: Cooperative Studies of Intervention Techniques. *JAMA*. 1995;273:1341–1347.
- Shekelle P, Maglione M, Chang J, et al. *Falls Prevention Interventions in the Medicare Population*. Balti-

more, MD: RAND Corporation; 2003. RAND-HCFA Evidence Report Monograph, HCFA Publication HCFA-500-98-0281.

10. Li F, Harmer P, Fisher KJ, et al. Tai chi and fall reductions in older adults: a randomized controlled trial. *J Gerontol A Biol Sci Med Sci*. 2005; 60:187–194.
11. Voukelatos A, Cumming RG, Lord SR, Rissel C. A randomized, controlled trial of tai chi for the prevention of falls: the Central Sydney tai chi trial. *J Am Geriatr Soc*. 2007;55:1185–1191.
12. Wolf SL, Barnhart HX, Kutner NG, McNeely E, Coogler C, Xu T. Reducing frailty and falls in older persons: an investigation of tai chi and computerized balance training. Atlanta FICSIT Group. Frailty and Injuries: Cooperative Studies of Intervention Techniques. *J Am Geriatr Soc*. 1996;44:489–497.
13. Li F, Harmer P, Mack KA, et al. Tai Chi: Moving for Better Balance—development of a community-based falls prevention program. *J Phys Act Health*. 2008;5: 445–455.
14. Glasgow RE, Vogt TM, Boles SM. Evaluating the public health impact of health promotion interventions: the RE-AIM framework. *Am J Public Health*. 1999;89: 1322–1327.
15. Glasgow RE, Emmons KM. How can we increase translation of research into practice? Types of evidence needed. *Annu Rev Public Health*. 2007;28:413–433.
16. Pfeiffer E. Short Portable Mental Status Questionnaire. *J Am Geriatr Soc*. 1975;23:433–441.
17. Duncan PW, Weiner DK, Chandler J, Studenski S. Functional reach: a new clinical measure of balance. *J Gerontol*. 1990;45:M192–M197.
18. Podsiadlo D, Richardson S. The timed “up & go”: a test of basic functional mobility for frail elderly persons. *J Am Geriatr Soc*. 1991;39:142–148.
19. Lord SR, Murray SM, Chapman K, Munro B, Tiedemann A. Sit-to-stand performance depends on sensation, speed, balance, and psychological status in addition to strength in older people. *J Gerontol A Biol Sci Med Sci*. 2002;57:M539–M543.
20. Reuben DB, Siu AL. An objective measure of physical function of elderly outpatients: the Physical Performance Test. *J Am Geriatr Soc*. 1990;38: 1105–1112.
21. Ware JE Jr, Kosinski M, Keller SD. *SF-12: How to Score the SF-12 Physical and Mental Health Summary Scales*. 2nd ed. Boston, MA: The Health Institute, New England Medical Center; 1995.
22. Washburn RA, Smith KW, Jette AM, Janney CA. The Physical Activity Scale for the Elderly (PASE): development and evaluation. *J Clin Epidemiol*. 1993;46: 153–162.
23. Sogolow E, Sleet D, Saul J. Dissemination, implementation, and widespread use of injury prevention interventions. In: Doll LS, Bonzo SE, Mercy JA, Sleet DA, Haas EN, eds. *Handbook of Injury and Violence Prevention*. New York, NY: Springer; 2006: 493–510.
24. Li F, Harmer P, McAuley E, et al. An evaluation of the effects of tai chi exercise on physical function among older persons: a randomized controlled trial. *Ann Behav Med*. 2001;23:139–146.