Tai Chi Enhances Self-Efficacy and Exercise Behavior in Older Adults

Fuzhong Li, Edward McAuley, Peter Harmer, Terry E. Duncan, and Nigel R. Chaumeton

The article describes a randomized, controlled trial conducted to examine the effects of a Tai Chi intervention program on perceptions of personal efficacy and exercise behavior in older adults. The sample comprised 94 low-active, healthy participants (mean age = 72.8 years, \(SD = 5.1\)) randomly assigned to either an experimental (Tai Chi) group or a wait-list control group. The study length was 6 months, with self-efficacy responses (barrier, performance efficacies) assessed at baseline, at Week 12, and at termination (Week 24) of the study. Exercise attendance was recorded as an outcome measure of exercise behavior. Random-effects models revealed that participants in the experimental group experienced significant improvements in self-efficacy over the course of the intervention. Subsequent repeated-measures ANOVA revealed that participants’ changes in efficacy were associated with higher levels of program attendance. The findings suggest that self-efficacy can be enhanced through Tai Chi and that the changes in self-efficacy are likely to improve exercise adherence.

Key Words: aging, self-efficacy, Tai Chi

Emerging evidence suggests that Tai Chi, a slow, low-impact traditional form of Chinese exercise that is gaining popularity in the West, can enhance quality of life, especially in the elderly (Tse & Bailey, 1992; Wolf et al., 1996; Yan & Downing, 1998), by improving agility, balance, posture control, and psychological health (Chinese Sports Editorial Board, 1986; Ryan, 1974). This complements a growing literature that argues that vigorous physical activity is not necessary for health benefits (Pate et al., 1995). Considered a “low-technology” activity for physical conditioning (Blair & Garcia, 1996; National Institute on Aging, 1996), Tai Chi has several advantages over more popular exercise activities such as swimming, jogging/walking, resistance training, and aerobics. First, it is performed in a noncompetitive, self-controlled, rhythmic manner, making it amenable to older

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adults for improving movement confidence and controlling balance. Second, it can be performed at any time or place and requires no special equipment, features attractive to older individuals, who are often constrained by transportation and other limitations. Finally, psychogenic influences on organic health are specifically targeted through the controlled-breathing and meditation components of Tai Chi.

Although there is evidence that Tai Chi training improves physical and physiological functions such as strength, posture, and cardiovascular fitness (Lan, Lai, Chen, & Wong, 1998; Schaller, 1996; Wolf et al., 1996; Yan, 1998; Young, Appel, Jee, & Miller, 1999), as well as components of psychosocial well-being (Chen & Sun, 1997; Jin, 1992; Kutner, Barnhart, Wolf, McNeely, & Xu, 1997; Li et al., 2001), these benefits can only be fully realized if participants continue to engage in the activity. One of the most important paradigms for understanding the drive to adopt and maintain physical activity is self-efficacy theory (Bandura, 1986, 1997). There is a considerable amount of evidence to support an exercise–self-efficacy relationship wherein individuals with low perceived efficacy beliefs about an activity tend to avoid it while those with high perceived efficacy will be inclined to be involved (see McAuley, 1994; McAuley & Katula, 1998). As advancing age is often associated with reductions in personal efficacy/control relative to physical performance (Baltes & Baltes, 1990), functional decline as a result of avoiding physical activity is common (Huang et al., 1998).

Nonetheless, an important component of self-efficacy theory is the fact that efficacy expectations are malleable and can be enhanced by mastery experiences (Bandura, 1986). Given the desirable characteristics of Tai Chi, understanding how participation influences self-efficacy perceptions and is, in turn, mediated by them as a result of mastery experiences in Tai Chi is important for several reasons. First, identifying mechanisms that encourage continued participation in Tai Chi for the resultant physiological and psychological benefits is inherently valuable. Second, given that deficits in physical function are partially a product of reduced physical efficacy (Bandura, 1997) and that low efficacy in performing common daily tasks is a potent determinant of decline in activities of daily living (Mendes de Leon, Seeman, Backer, Doucette, & Tinetti, 1996), exploring Tai Chi’s role in strengthening perceptions of control is theoretically important as a test of efficacy theory in aging research. Third, enhancing self-referent beliefs about capability and confidence to engage in Tai Chi has the potential to change exercise habits, which could then translate to considerable public health and medical cost benefits.

Therefore, the purposes of this study were to (a) examine the effects of a 6-month Tai Chi intervention on the efficacy expectations of older adults and (b) examine the association between changes in self-efficacy and levels of exercise participation. These two research questions were examined in a randomized controlled trial. Self-report measures of self-efficacy regarding movement confidence were assessed at baseline, in the middle, and at termination of the study. Exercise attendance was recorded as an outcome measure of exercise behavior. It was expected that, compared with a control group, individuals in the Tai Chi group would increase in self-efficacy measures over the course of a 6-month period, and that changes in efficacy resulting from Tai Chi would be associated with improved exercise behavior (i.e., better class attendance).
Method

PARTICIPANTS

A total of 148 individuals responded to local newspaper advertisements and flyers at senior centers seeking volunteer participation in a longitudinal study. Inclusion criteria were (a) age 65 years or older; (b) low active, defined as noninvolvement in a regular exercise program (either structured or unstructured) in the month prior to the study; (c) healthy to the degree that participation in an exercise program would not exacerbate any existing negative health symptoms; and (d) willingness to be randomly assigned to a treatment condition. To screen for prior physical activity level, each respondent was interviewed by telephone using a short version of the Physical Activity Scale for the Elderly (PASE; Washburn, Smith, Jette, & Janney, 1993), which measured the frequency of leisure and household activities over the previous month.

Low-active older adults \( (N = 98) \), 65–96 years old \( (M = 73.2 \text{ years, } SD = 4.91) \), who were qualified for the study were recruited to participate in the 6-month randomized controlled exercise trial. Most study participants (88%) indicated that they were engaging in some level of household activity (e.g., vacuuming, washing dishes, gardening) but were not involved in any sport or recreational activities.

INTERVENTION ASSIGNMENTS

Individuals who met the physical activity criteria, agreed to participate, and gave written informed consent were randomized to either Tai Chi practice or a waiting list. Four individuals assigned to the Tai Chi group dropped out of the study after randomization but before the intervention began because of time conflicts. Therefore, the intervention group had 49 participants (mean age = 72.8 years, \( SD = 4.7 \)) who actually underwent the intervention. The mean age for those in the control group \( (n = 45) \) was 72.7 \( (SD = 5.7) \).

EXPERIMENTAL PROTOCOL

Participants in the intervention group attended a 60-min Tai Chi practice session twice a week for 6 months. The Tai Chi intervention was a classical Yang style (24 forms; see Yan & Downing, 1998) incorporating elements of balance, postural alignment, and concentration. The sessions consisted of a 15-min warm-up, 30 min of Tai Chi, and a 15-min cool-down. During the practice, participants were led by an instructor and replicated the motions, postures, and movement speed of the instructor.

Participants in the control group were instructed to maintain their routine activities and not to begin any new exercise programs. These participants were promised a 4-week Tai Chi program at the end of the intervention study.

MEASURES

Background Information. A short inventory was administered at baseline to assess demographic characteristics such as age, gender, education, income, and race/ethnicity.
Self-Efficacy. Two aspects of self-efficacy were measured: barriers and performance efficacy (McAuley & Mihalko, 1998). The barriers scale comprised 5 items designed to assess participants' perceptions of their ability to perform Tai Chi regularly in the face of obstacles or barriers (e.g., "I was bored by the Tai Chi activity," "I felt pain or discomfort when doing Tai Chi"). Participants were asked to rate each barrier on a 0–100 confidence scale (0 = very little confidence, 100 = complete confidence). Preliminary data indicated that the measure had satisfactory reliability at each time point, alpha coefficient ≥ .81. The second measure of self-efficacy was a 3-item, task-specific, time-based performance-efficacy scale (Bandura, 1986; McAuley & Mihalko). Participants were asked to indicate their degree of confidence in their ability to successfully perform a series of slow, rhythmically changing body-position movements (i.e., I believe that I can move my whole body in a slow, rhythmical fashion continuously for 2 min, . . . 5 min, . . . 10 min). The items were scored in the same manner as the barriers-efficacy measure. The reliability was acceptable across the three time points, alpha ≥ .92.

Class Attendance. Participants' exercise behavior was assessed for each practice session via the class attendance recorded by the instructor. The attendance score was aggregated to provide a continuous measure of frequency and used as an exercise-behavior outcome variable.

PROCEDURES

Before the intervention, individuals received a letter about the nature and purpose of the study and what their participation would entail. Follow-up screening phone calls were made about 1 week after the letters were mailed.

All participants completed the measures described previously during an initial group-orientation meeting (Week 1). Before beginning, they signed consent forms indicating the voluntary and anonymous nature of the study. Instructions were read aloud by the researcher, and sample questions were provided before the administration of the questionnaire. In addition, participants were encouraged to ask questions or clarify any confusion they might have with regard to the questionnaire. No problems were encountered with participants understanding the questions or completing the questionnaire.

Participants from the experimental group completed these measures a second (Week 12) and third (Week 24) time either at the end of class or at home within 1 week. Participants in the control group completed their second and third assessments by mail.

COMPLIANCE

Of the 94 participants, 72 completed baseline (Week 1), middle (Week 12), and program-termination (Week 24) assessments. Nine participants in the Tai Chi group dropped out of the study (18% attrition rate) for reasons such as traveling, time conflicts with the class, or other family-related commitments. Thirteen dropped out of the control group (29% attrition rate) because of reluctance to have to wait to join the class at the end of the study. Thus, the total attrition rate at the end of the study was 23%. Class attendance was recorded for each subject. The average attendance rate (two times/week, a total of 48 possible sessions) in the Tai Chi group was
approximately 90%, with a median compliance of 41 sessions and a range of 29–47 sessions.

**DATA ANALYSIS**

We employed growth-curve-modeling analysis (Bryk & Raudenbush, 1992) to determine the effects of Tai Chi on self-efficacy expectations over time and conventional repeated-measures ANOVA in our analysis of the efficacy–exercise behavior relationship. To characterize treatment-group differences in the tested model, we used group status to represent a dummy-coded effect (Tai Chi = 1, control = 2). In addition to analyzing change resulting from Tai Chi practice, we examined whether the experimental conditions were different on demographic variables of age, gender, education, and income.

Because the data contained missing values, an intent-to-treat (ITT) strategy (Little & Yau, 1996) was adopted. The ITT approach is based on two principles: (a) that all participants be included in the analysis and (b) that the data of all participants be analyzed as randomized, irrespective of the number of treatments they actually received or the group to which they belonged. Note that this requires including data from participants who leave a study prematurely.

We conducted a missing data analysis under the ITT method using random-effects pattern-mixture models (Hedeker & Gibbons, 1997), which handle and describe the influence of missing data in longitudinal studies. For this analysis, a simple contrast of completers (defined as those who completed the study) with dropouts (defined as those who provided less than three time-point data) was made using this status as a grouping variable in the random-effects pattern-mixture model. The SAS (SAS Institute, 1990) statistical program was used to obtain the random-effects and random-effects pattern-mixture regression estimates.

**Results**

Analyses using baseline data for the variables of interest indicated that randomization resulted in a distribution of participants that was comparable across the two experimental groups. Analyses by group assignment indicated no differences in age ($p = .32$), education ($p = .45$), income ($p = .89$), or gender ($p = .22$) or on the general items assessed by the PASE (Washburn et al., 1993). The $t$ tests for independent samples by group assignment also indicated no statistical differences between experimental and control groups on baseline self-efficacy responses.

**INTERVENTION EFFECTS ON SELF-EFFICACY**

Means and standard deviations for barrier and performance efficacy are presented in Table 1. Change in mean values of the two efficacy measures across experimental conditions is depicted in Figures 1 and 2. Overall, the observed means indicated that both types of efficacy responses increased over time for participants in the intervention group, with an initial boost from the baseline to the third month assessment (Week 12), followed by a maintenance period. In contrast, there were observable declines over time for participants in the control group on these two
Table 1  Means and Standard Deviations of the Dependent Measures

<table>
<thead>
<tr>
<th>Treatment condition</th>
<th>n</th>
<th>Barrier Efficacy</th>
<th>Performance Efficacy</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>M</td>
<td>SD</td>
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<tr>
<td><em>Tai Chi</em></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>baseline</td>
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<td>38.575</td>
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<tr>
<td>middle</td>
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<tr>
<td>termination</td>
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<td>42.888</td>
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<tr>
<td><em>Control</em></td>
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</tr>
<tr>
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<tr>
<td>termination</td>
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<td>31.844</td>
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**Figure 1.** Change in barrier efficacy between Tai Chi and control conditions.

**Figure 2.** Change in performance efficacy between Tai Chi and control conditions.

efficacy expectations. In spite of the leveling out of efficacy perceptions at the program’s end in the intervention group, the difference between the intervention and control groups on the two measures of efficacy was maximized at the end of the study.
Parameter estimates from the random-effects pattern-mixture model indicated that participants in the intervention group and control group did not significantly differ at baseline, $\beta_1 = -0.419, p = .41$ (where $\beta_1$ denotes the average difference in efficacy scores at baseline between the intervention and control groups), and $\beta_2 = -0.851, p = .12$, for barrier efficacy and performance efficacy, respectively. This result indicates that there was no difference in the initial level of the two efficacies across the experimental conditions.

A significant Group $\times$ Time interaction was found for both efficacy measures, however, indicating that group differences in efficacy responses varied across time. Estimates showed that the intervention group increased levels of efficacy over time in relation to the control group, $\beta_2 = -5.469, p < .001$ (where $\beta_2$ represents the average difference in trend lines between the intervention and control groups), for barrier efficacy, and $\beta_2 = -2.628, p < .05$, for performance efficacy. This set of results indicated that individuals receiving Tai Chi had better outcomes than those on the waiting list did on efficacy measures.

Finally, on the analysis of completion status, results revealed a nonsignificant Group $\times$ Attrition Status $\times$ Time interaction. This indicates that attrition status (i.e., being a dropout) did not differentially influence any changes in self-efficacy over and above the influences of group, time, and Group $\times$ Time. It further suggests that the significant Group $\times$ Time interaction (i.e., the difference between intervention and control group completers in average self-efficacy time trend lines) found previously was unaffected by dropout participants.

**RELATIONSHIPS BETWEEN CHANGES IN SELF-EFFICACY AND EXERCISE BEHAVIOR**

To test our second hypothesis (that changes in self-efficacy cognitions were related to exercise participation), we examined the relationship between self-efficacy and class participation using class attendance for individuals in the intervention group. A repeated-measures ANOVA was conducted wherein attendance was treated as a within-factor covariate. Results indicated that class attendance was significantly predicted by changes in the two types of efficacy cognitions, $F(1,36) = 14.74, p < .001$ for barrier efficacy and $F(1,36) = 22.58, p < .001$, for performance efficacy. An inspection of regression coefficients indicated that efficacy expectations were significantly related to class attendance, $\beta = .213, t = 2.135, p < .04$ for barrier efficacy and $\beta = .489, t = 2.859, p < .007$ for performance efficacy, suggesting that changes in self-efficacy cognitions were significantly related to class adherence.

**Discussion**

A relatively simple Tai Chi exercise program was applied in an older population to examine its effect on personal efficacy and exercise behavior. The results presented provide support for the a priori hypotheses regarding self-efficacy and exercise behavior, indicating that a 6-month Tai Chi program is effective in improving personal efficacy regarding movement performance in the elderly, and that change in self-efficacy, in turn, is likely to relate to exercise participation.

With regard to the first objective of the study, our findings indicate that a relatively short-term Tai Chi exercise program can significantly enhance perceptions
of task-specific personal efficacy in older adults. In particular, we noted an initial boost in efficacy from baseline to the middle of the intervention, with the improvement then being maintained. In contrast, participants in our wait-list control group exhibited a linear decrease in efficacy over the 6-month period, with between-group differences being maximized at the last measurement point. These effects were not influenced by study-completion status (i.e., dropouts vs. completers).

These data provide support for a social-cognitive perspective (Bandura, 1986) that posits that exposure to an exercise stimulus acts as a source of efficacy information, and the findings are consistent with a number of other exercise studies of middle-aged and older adults. For example, in a recent study, McAuley, Katula, et al. (1999) reported that older, formerly sedentary adults increased their self-efficacy responses over a 6-month randomized controlled exercise trial (aerobic, stretching/toning), although declines in self-efficacy at the 6-month follow-up were observed. The present study is the first, however, to demonstrate that Tai Chi—a simpler, nonconventional exercise program—can also have these effects.

Our second objective was to determine the extent to which improvements in self-efficacy paralleled or were related to continued physical activity patterns. We found support for the contention that participants in the Tai Chi group who developed higher perceptions of efficacy adhered better to the exercise program (i.e., attended more sessions) and, as such, spent more time engaged in exercise. Thus, the hypothesis of enhanced exercise adherence was supported. This result has important implications for the public health concerns of a rapidly aging society; that is, enhancing movement efficacy through Tai Chi leads to better exercise adherence, which should result in improved physical ability and reduced rates of functional limitation and subsequent dependency in older adults.

The outcomes have a number of implications. First, they support the use of social-cognitive theory (Bandura, 1986, 1997) to study the Tai Chi—self-efficacy relationship. To our knowledge, this is the first study to adopt this framework for examining cognitive and behavioral changes in Tai Chi and, subsequently, providing preliminary evidence for conducting intervention studies that take a social-cognitive approach to changing behavior. Second, from a practical standpoint, self-efficacy can be improved through a Tai Chi exercise program, which indicates that Tai Chi might be valuable for older adults as a method of improving and maintaining efficacy perceptions in the face of functional and cognitive declines. The benefits might be multifaceted in that self-efficacy has been shown to influence other aspects of psychological well-being (e.g., self-esteem, affect; McAuley, Blissmer, Katula, & Duncan, 1999; McAuley, Mihalko, & Bane, 1997) that affect individual evaluations of quality of life.

Third, and relatedly, for older individuals with sedentary lifestyles, engaging in Tai Chi can be an effective and practical alternative to more conventional types of exercise (see also Young et al., 1999). Fourth, the relationship between self-efficacy and exercise adherence suggests that Tai Chi can be used as an efficacy-enhancement program to promote healthy behavior among older adults. Thus, participation in Tai Chi has the potential to produce change in exercise habits that might have considerable public health and medical cost benefits for the aging population. Finally, our Tai Chi intervention was logistically simple, with a relatively low attrition rate, arguably because it was a novel activity with easy accessibility, low cost, and quick implementation. The fact that a Tai Chi program
like this can be inexpensively initiated in widely distributed facilities throughout the community or in participants’ own homes makes it an attractive option for enhancing physiological and psychological function in older individuals.

There are a number of substantive topics related to Tai Chi’s effects on psychological function that warrant further investigation. For example, it is well-documented that fear of falling is a prevalent condition among older adults (e.g., Nevitt, Cummings, Kidd, & Black, 1989; Tinetti, Speechley, & Ginter, 1988). Although there is evidence to show reduction in fear of falling and the rate of falls in the elderly as a function of Tai Chi participation (Wolf et al., 1996), it is not clear to what extent efficacy cognitions play a buffering role in reducing fear of falling or balance perturbations in the context of Tai Chi for older adults. Therefore, identifying the interrelationships among Tai Chi, self-efficacy, balance, and fear of falling might well be a useful avenue of inquiry. Also, given that we have demonstrated Tai Chi’s ability to enhance self-efficacy, it would be interesting to compare its effectiveness at change with other modes of physical activity (e.g., muscle toning, walking, yoga) and to determine whether these patterns of change are consistent across activity modes.

In summary, the findings of this study suggest that self-efficacy in older adults can be enhanced significantly through Tai Chi. In addition, the study indicates that change in self-efficacy appears related to exercise behavior and thus provides important information regarding the relationships between Tai Chi, efficacy beliefs, and exercise behavior. We conclude that, given the host of functional problems occurring in the aging process (e.g., loss of balance, flexibility, mobility), Tai Chi—a low-cost and low-technology activity—is a useful form of exercise for promoting personal efficacy and exercise behavior for older adults.

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