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## Literature Review

# Comprehensive Therapeutic Benefits of Taiji A Critical Review

**ABSTRACT**

Klein PJ, Adams WD: Comprehensive therapeutic benefits of Taiji: A critical review. *Am J Phys Med Rehabil* 2004;83:735–745.

This literature review offers physical rehabilitation professionals an update on the current breadth and strength of research evidence regarding comprehensive therapeutic benefits of Taiji practice. A critical analysis distinguishes between what is known from controlled clinical research and what is suggested in preliminary research. Of >200 published reports examined, 17 controlled clinical trials were judged to meet a high standard of methodological rigor. Controlled research evidence was found to confirm therapeutic benefits of Taiji practice with regard to improving quality of life, physical function including activity tolerance and cardiovascular function, pain management, balance and risk of falls reduction, enhancing immune response, and improving flexibility, strength, and kinesthetic sense. Preliminary research on implementation feasibility of Taiji programming exists for a variety of clinical populations. Further controlled clinical study is justified for a wide variety of clinical contexts.

**Key Words:** Taiji, Exercise, Literature Review, Evidence-Based Practice

**T**aijiquan or T'ai Chi Chuan (translated as supreme ultimate boxing<sup>1</sup>), with origins predating the 17th century,<sup>2</sup> encompasses both a profound and varied Chinese martial art and a health regimen with a common set of core principles, movements, and exercises. Taiji practice is recognized by its characteristic dance-like, slow, circular, fluid movement patterns. Although there are a number of schools of Taiji, the essential difference between health-promoting applications and more martial arts-oriented forms is the slower pace and

absence of any explosive or high-impact actions in the forms practiced primarily for health benefit.

In Eastern traditional Chinese medicine, theoretical foundations for the therapeutic effect of Taijiquan are holistically explained within the conceptual framework of freeing *Qi* or life energy.<sup>3</sup> Although the concept of *Qi* is fundamental to traditional Chinese Medicine, it can only be peripherally defined in conventional Western medicine. However, a bridge between the two seemingly disparate medical paradigms (East meets West) may be partially found in the field of psychoneuroimmunology,<sup>4-7</sup> which describes and attempts to explain phenomena of the mind-body connection and potential therapeutic value.

Increasing frequency of reference to Taijiquan in public media and Western medical and health-related publications<sup>8-19</sup> raises legitimate inquiry regarding the level of scientific evidence supporting attributions of therapeutic benefits of regular Taiji practice. The goals of this literature review report are to (1) describe the growing body of research assessing clinical applications of Taiji and (2) use a method of critical analysis to determine strength of evidence. Consistent with principles of evidence-based practice, critical analysis separates what is only suggested in preliminary research from what can be concluded from analysis of controlled clinical trials. Conclusions of the literature review may serve as justification for rehabilitative program initiatives and new directions for research.

## METHODS

The investigation was conducted as a systematic literature search that also included a critical review of selected controlled clinical trials (1985-2003). Two concurrent and independent computerized searches of electronic databases were conducted.

Electronic databases included MEDLINE and CINAHL, accessed through both EBCOT and OVID search engines, and PUBMED. Searches were limited by key words: Tai chi, T'ai Chi, Taiji and related topic words, and English language. Citation results of the two concurrent searches were compared and combined to form one comprehensive bibliography. Then, identified article titles and abstracts were screened for topic relevance. Next, reference lists of articles were scanned to identify any additional topic-related titles for review consideration. All clinical studies were annotated and considered in descriptive analysis of breadth of research. Studies identified as original clinical research were categorized for level of evidence using a hierarchical classification system (levels I-IV) developed by Sackett et al.<sup>20</sup>

Because the internal validity of research conducted without comparison controls is justifiably suspect, only level I (randomized clinical trials) and level II (controlled clinical trials) studies were subjected to critical analysis. As part of critical analysis, a process of scoring of methodological rigor developed by Chan and Bartlett<sup>21</sup> was employed. From the >25 methodological rigor scoring tools available, the Chan and Bartlett<sup>21</sup> scoring system was selected because their published work relates to Taiji, and interrater reliability with Chan and Bartlett<sup>21</sup> could be verified as follows.

To confirm the current review's adherence to established scoring methods, the primary author rated seven studies cited and described in work published by Chan and Bartlett.<sup>21</sup> Their scoring system assesses 18 methodological design characteristics (score range, 18-49). Average mean score generated by the primary author for the seven selected articles was 40.4 (SD, 5.1). Published mean score for the same articles, rated independently by Chan and Bartlett,<sup>21</sup> was 38 (SD, 3.7). Scoring consistency

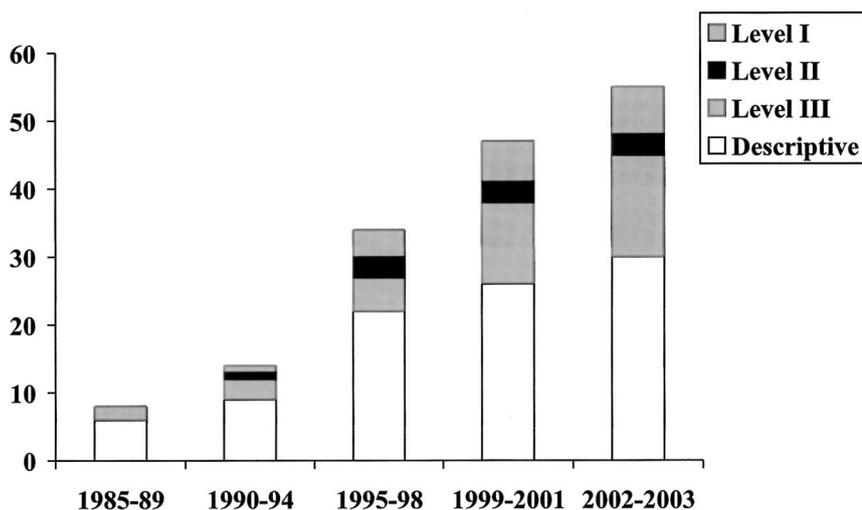
between the author and published data was found to be  $r = 0.94$ .

After establishing interrater reliability consistency of scoring, the primary author scored all 17 controlled clinical studies under review. At the same time, a biostatistician, with extensive research experience, was recruited to act as the second critical reviewer for this investigation. Once instructed in standardized scoring procedures, the second reviewer conducted an independent critical analysis of the 17 studies included. For each study, total score recorded by each of the two reviewers (the primary author and the second reviewer) were summed and then averaged to generate mean total score.

## RESULTS

Results of the literature search and critical review of controlled clinical trials are presented as (1) an overview of the breadth of total body of research identified, (2) a historical summary of existing literature reviews, and (3) results of objective critical analysis of methodological rigor of the controlled clinical research evidence ( $n = 17$  studies).

*Overview of the Breadth of Clinical Research.* Of the >300 topic-related articles identified through electronic search of the literature, >200 of those titles were judged to be original, topic-relevant scholarly or scientific reports. Global clinical and research interest is evident within this body of published literature. Geographic distribution of publications examined includes scientific study conducted in the United Kingdom, United States, Canada, Australia, Israel, Peoples Republic of China, Taiwan, and South Korea. Also included as part of the bibliographic reference body are one doctoral dissertation,<sup>22</sup> a report of the Paris Task Force on management of back complaints,<sup>12</sup> a Cochrane review,<sup>13</sup> and presenter comments from a 2003 Taiji Teachers



**Figure 1:** Pattern of proliferation of reports related to Taiji. Sources: medical and health-related English language publications from the past two decades, subcategorized by level of evidence ( $n = 154$  clinically-based articles). *Level I*, randomized clinical trials (randomized group assignment); *Level II*, controlled clinical trials (non-randomized group assignment); *Level III*, correlational and observational, including one group or case study with pretesting/posttesting; *Descriptive*, scholarly discussions and literature reviews.

Exchange symposium addressing special populations.<sup>23,24</sup> All but 13 articles identified as relevant to the review were successfully retrieved. Among the titles identified in the literature search but not accessible for review were full text English translations of the earliest studies published out of the People's Republic of China.

A chronological descriptive analysis of dates of publications, the number, and the design rigor categorized as levels I-IV evidence reveals that the amount and strength of research evidence has exponentially increased in the past 5 yrs. Topic-related output within that time period has more than doubled the output for the previous 20 yrs (Fig. 1). Within the larger body of scientific reports and clinical studies including levels I and II (controlled clinical and randomized clinical trials) and levels III and IV evidence (observational case studies, pilot studies, and one group trials), a variety of clinical populations were studied. These include children with attention deficit,<sup>25</sup> adults with cardiac dysfunction,<sup>10,26,27</sup> and individuals with rheumatoid arthritis,<sup>28-30</sup> fibromyalgia,<sup>31</sup> chronic back pain,<sup>32</sup> osteoporosis,<sup>33,34</sup>

hemophilia,<sup>35</sup> osteoarthritis,<sup>36,37</sup> ankylosing spondylitis,<sup>38</sup> Alzheimer's disease,<sup>24</sup> multiple sclerosis,<sup>39,40</sup> head trauma,<sup>41</sup> Parkinson's disease,<sup>23</sup> acquired immunodeficiency syndrome,<sup>24</sup> and immune vulnerability.<sup>42</sup> The number of clinical applications addressed in the literature and the variety of areas of benefit attest to the comprehensiveness of effect and utility of application.

**Literature Reviews.** The historical perspective provided by examination of results of previous literature reviews substantiates how conclusions about the efficacy of Taiji intervention and directions for research are being guided by emerging knowledge. In the mid-1970s, Kauz<sup>43</sup> was one of the first Western voices to optimistically herald Taijiquan's growing popularity and the need for clinical validation of practitioner claims. In the early eighties, Koh<sup>44</sup> confirmed the continued lack of scientific study assessing therapeutic effect of Taiji. At that time, Koh<sup>44</sup> renewed the earlier challenge for the health and medical communities to generate research evidence to scien-

tifically assess the health-promoting and healing benefits of Taiji practice.

Literature reviews published between 1999 and 2001 began to offer conclusions based on review of clinical study from a discipline or a focused clinical area perspective. Chen and Snyder<sup>45</sup> reviewed the growing evidence assessing Taiji as a potential nursing intervention. They discussed nine original studies, with the most recent citation from 1997. Only five of the studies referenced were controlled clinical trials (level I or level II). As a result of their 1999 review, Chen and Snyder<sup>45</sup> concluded that Taiji practice had demonstrated benefits of balance improvement, falls prevention, cardiovascular enhancement, and stress reduction. These same authors encouraged leaders in the nursing disciplines to learn more about Taiji and to become more actively involved in Taiji research.

In a 2001 publication, Li et al.<sup>46</sup> reviewed 31 topic-related articles, including both controlled experimental clinical trials and descriptive or case control studies, designed either to assess physiologic response or general health and fitness effect of Taiji practice. These authors concluded that Taiji is "a moderate intensity exercise that is beneficial to cardio-respiratory function, immune capacity, mental control, flexibility, and balance control; it improves muscle strength and reduces risk of falls in the elderly."<sup>46</sup> After an extensive review of relevant literature assessing the effects of Taijiquan on physical and psychological health that included over 30 topic-related articles published before 2001, Fascko and Grueninger<sup>47</sup> confirmed conclusions of Li et al.<sup>46</sup>

These three literature reviews suggest that by 2001, there was a moderate level of evidence to support Taiji as a therapeutic intervention with applications in main stream health and wellness promotions and in rehabilitative intervention. All three reviews conclude that although

**TABLE 1**

*Synopsis of level I and level II evidence investigating therapeutic benefits of Taiji by research design, subjects, intervention, salient findings, and score for methodological rigor (MR)*

Study Authors (Year Published)	Design, Subjects	Intervention	Results	MR Score <sup>a</sup>
Irwin et al. <sup>42</sup> (2003)	Level I RCT, 36 older adults	20 Tai chi chih movements, 15 wks, 3 times/wk, 45-min classes compared with wait-listed controls	Significant increases in: SF-36 scores for role-physical and physical functioning and varicella zoster virus-specific cell-mediated immunity (↑ 50%) in Taiji group	42.5
Hartman et al. <sup>36</sup> (2000)	Level I RCT, 33 adults with lower limb osteoarthritis	Nine-form Yang Style, 12 wks, twice-weekly supervised exercise compared with controls instructed to maintain normal activities	Taiji group experienced significant increases in self-efficacy for arthritis symptoms, total arthritic self-efficacy, level of tension, and satisfaction with general health status	44.5
Bhatti et al. <sup>32</sup> (1998)	Level I RCT, 51 adults with a diagnosis of chronic back pain	11 Taiji movements, 6 wks, once-weekly supervised exercises compared with controls	Significant reductions in average, lowest, and worst pain experienced in the last week and mood improvement	36.5
Li et al. <sup>46</sup> (2001)	Level I RCT, 94 seniors	24-simplified form Yang style, 6 mos, twice weekly compared with controls instructed to maintain normal activities	Taiji group reported significant improvements in physical functioning	43
Adler et al. <sup>58</sup> (2000)	Level I RCT, 16 adults diagnosed with chronic arthritis pain	Traditional Wu-style form Tai Chi, 10 wks, once-weekly supervised exercise compared with controls instructed to maintain normal activities	Taiji group pain intensity scores significantly decreased as compared with controls; no changes in quality-of-life score were found	33.5
Young et al. <sup>59</sup> (1999)	Level I RCT, 62 sedentary older adults	Mini lecture and instruction in 13 movements from Yang Style, 12 wks, twice-weekly supervised exercise augmented with home exercise compared with controls engaged in program of aerobic activities	Both groups had reductions in systolic and diastolic blood pressure (systolic blood pressure adjusted mean changes of -7.0 for Taiji group and -8.4 for exercises group; diastolic blood pressure adjusted mean changes of -2.4 for Taiji group and -3.2 for exercises group); body fat did not change in either group	42.5
Wolf et al. <sup>60</sup> (1997)	Level I RCT, 72 inactive older adults (a subgroup of the FICSIT trials)	Ten movements from 108-form Yang style, 15 wks, twice-weekly supervised exercise compared with a balance training group and a control group	Balance training group had significant improvement in platform balance measures; Taiji group members were less afraid of falling	40
Channer et al. <sup>27</sup> (1996)	Level I RCT, 126 patients 3 wks postdischarge after acute myocardial infarction	Wu Chian-Ch'uan Taiji, 11 sessions over 8 wks as compared with aerobic exercising group and nonexercising support group	Taiji group showed trends in decreasing diastolic blood pressure; Taiji and aerobic exercising groups both showed trends in systolic blood pressure lowering; Taiji group had high exercise program persistence	40
Wolf et al. <sup>61</sup> (1996)	Level I RCT, 200 seniors ≥70 yrs of age, FICSIT	Ten movements from 108-form Yang style, 15 wks, twice-weekly supervised exercise compared with a balance training group and a control group	Taiji was found to reduce risk of falls by 47.5% and lower blood pressure; no significant changes were seen across intervention groups in the remaining biomedical, functional status, and psychosocial variables	41
Sun et al. <sup>62</sup> (1996)	Level I RCT, 20 Hmong older adults ≥60 yrs of age	Mini lecture and Taiji movements, 12 wks, once-weekly supervised exercise compared with controls instructed to maintain normal activities	Lower resting systolic and diastolic blood pressures, reduction in perceived stress, and increase in shoulder and knee flexibility	40
Brown et al. <sup>63</sup> (1995)	Level I RCT, 180 healthy older sedentary adults	Taiji-type activity with visual imagery, 16 wks, 3 times/wk of supervised exercise compared with moderate-intensity walking, low-intensity walking, low intensity walking plus relaxation response or control	Psychological benefits: women in visual imagery Taiji-type activity group experienced reductions in mood disturbances; women in moderate-intensity walking group noted greater satisfaction with physical attributes; men in the moderate-intensity walking group reported increased positive affect	39
Jin <sup>64</sup> (1992)	Level I RCT, 96 Taiji practitioners	Long form, Yang style, or Wu style Taiji, one Taiji episode compared with brisk walking, or meditation and neutral reading	After all treatments, salivary cortisol levels dropped significantly; stress reduction measure by heart rate, blood pressure, and urinary catecholamine changes for Taiji group were similar to those for brisk walking group	42

**TABLE 1**  
*Continued*

Study Authors (Year Published)	Design, Subjects	Intervention	Results	MR Score <sup>a</sup>
Lan et al. <sup>26</sup> (1999)	Level II CCT, 20 postcoronary bypass graft patients (naïve to Taiji) were followed for 1 yr	Yang style 108-form Taiji, daily 50-min sessions (mean attendance, 3.8 times/wk) compared with home exercise group	After 1 yr, Taiji group showed increased peak VO <sub>2</sub> as compared with control group, and the Taiji group reported higher program persistence	41
Lan et al. <sup>65</sup> (1998)	Level II CCT, 38 Taiwanese older adults	108 Yang style, 12 mos (mean, 4.6 times/wk group exercise), compared with controls instructed to maintain normal activities	Taiji group improved time on balance and smoothness of rapid-aiming arm movements	39
Chen and Sun <sup>66</sup> (1997)	(Group assignment method unreported) 36 older adults	24-movement Yang style, 16 wks, twice-weekly supervised exercise compared with controls instructed to maintain normal activities	Taiji group had significant improvement in flexibility (sit'n reach box) and muscle relaxation measure by electromyography	41
Jacobson et al. <sup>67</sup> (1997)	Level II (Group assignment method unreported) 24 healthy adults	108 Yang style, 12 wks, 3 times/wk supervised exercise compared with controls instructed to maintain normal activities	Taiji group had significant improvements in lateral body stability, kinesthetic sense at 60 degrees, and strength of the dominant knee extensors	37
Xusheng et al. <sup>68</sup> (1990)	(prospective case-control) 48 older adults, experienced Taiji practitioners <i>vs.</i> matched non-Taiji exercisers	88-style Taijiquan, one session of 20 mins in duration, compared with matched controls who did not participate in Taiji exercise between pretesting and posttesting	Results suggest improved immune response from a single episode of exercises and enhanced immune effect with long-term practice	33

RCT, randomized clinical trial; SF-36, Medical Outcomes Study Short Form; CCT, controlled clinical trial.

<sup>a</sup> Score for MR generated using the scoring format of Chan and Bartlett.<sup>21</sup> The maximum MR score possible is 49.

scientific evidence was growing, further research is needed. Given the range of effect of Taiji, the challenges of potential research agenda are both stimulating and formidable. As recently as 2002, Wu<sup>48</sup> concluded, from analysis from three cross-sectional, 11 longitudinal, and one follow-up study, that research agenda and conclusions on the effects of Taiji practice on balance were “scattered and inconsistent” due to lack of consistency in intervention mode and research protocols.

Most recently, in March 2004, Wang et al.<sup>49</sup> published a systematic review of Taiji as a therapeutic intervention for chronic conditions. They reviewed nine randomized critical trials, 23 nonrandomized controlled studies, and 15 observational studies. The authors' conclusions include that Taiji seems to have physiologic and psychosocial benefits in the areas of balance, cardiovascular and respiratory function, flexibility, immune system, arthritis, muscular strength, and psychosocial domains.

**Critical Analysis of Level I and Level II Evidence, 1985–2003.** Although the origins of the art of Taiji exist de facto, the body of scientific evidence investigating its effect is dynamic. Given the exponential increase in the number of reports of randomized clinical study published within the past 5 yrs, an updated and more critical analysis of the scientific evidence is warranted. Therefore, in addition to the preceding descriptive literature analysis, an exploratory critical analysis of the existing controlled clinical research (1985 through 2003), assessing the therapeutic effects of Taiji practice, is provided.

The topic-related body of published studies and scholarly discussion was found to be relatively large; therefore, only those studies judged to meet a high standard of methodological rigor are presented for review. The current search identified 23 studies for consideration: 14 randomized clinical trials and nine controlled clinical trials. Seventeen of those studies met inclusion criteria of (1) controlled research,

(2) Taiji intervention defined as an independent variable, and (3) research methodology found to be free from any known major threats to internal validity. Among studies judged not to meet inclusion criteria of level I or level II evidence were seven studies<sup>28,29,50–55</sup> frequently cited in earlier publications. Two<sup>36,56</sup> of the 23 identified controlled clinical trials were excluded because reported overall dropout rate and exercise noncompliance were considered substantial threats to internal validity. Three additional studies<sup>30,57</sup> were excluded because research reports were only published as abstracts, precluding execution of the scoring component of critical review. One randomized clinical trial<sup>55</sup> was excluded because the Taiji intervention was a maintenance program applied after a strength training intervention, and therefore, independence of Taiji effect was questioned.

Mean score for methodological rigor for the 17 clinical trials<sup>16,27,32,36,42,46,58–68</sup> included in this analysis, using the Chan and Bartlett<sup>21</sup> scoring system, was 39.8 (SD, 3.067)

out of a possible 49 points (Table 1 provides a synopsis of research by author, design, subjects, and outcomes and an article mean score for methodological rigor).

In aggregate ( $n = 17$  studies), a total of 1,035 subjects participated in the research studies included in the critical review. Demographic distributions, when available, consisted of at least 70% of the subjects being older adults, 60% or more were women, and >80% of subjects represented nonclinical populations. Taiji intervention, when described in sufficient detail, most often conformed to characteristics of Yang style<sup>1</sup> and most often included simplified forms modified from the traditional Yang style 108 (movements) form.<sup>69</sup> The lengths of Taiji intervention training ranged from 6 wks to 12 mos. Frequencies of supervised intervention ranged from once to three times weekly. Activity durations ranged from <15 mins to >1 hr per session. The wide variance in definitions of Taiji practice and ranges of frequency and duration of Taiji intervention in these studies justifies future research to determine mode and dose effect.

Of the >22 outcome areas examined in the 17 studies, statistically significant benefit was reported >60% of the time. All studies reported statistically significant benefit in at least one outcome measure. In addition, positive trends were reported another 15% of the time, with no studies reporting deleterious effects. The documented variety of benefits realized from Taiji practice supports the attribute of comprehensiveness of therapeutic effect. Of the dependent variables examined in controlled research, improved indicators of quality of life were most often assessed and validated. Quality of life is a complex construct encompassing multiple and overlapping domains of life function. For purposes of this analysis, effects related to general health and wellness, psychological, social, cognitive, and behavioral foci were grouped

together under the collective subheading of quality of life.

The second most frequently studied beneficial effect was improved physical function. Physical function is also a complex multidimensional construct. Study outcomes identified under this category of effect included improved activity capacity, self-rated physical function, falls prevention, and smoothness of rapid aiming arm movements. Evidence of additional effects included benefits in pain management, improved cardiovascular function in terms of reduction of blood pressure, improved balance, reductions in risk of falls in the approaching frail elderly, enhanced immune response, and improved flexibility, strength, and kinesthetic sense attributed to Taiji practice (Fig. 2 illustrates the distribution of therapeutic effect revealed in the 17 studies included in the critical analysis).

## DISCUSSION

Scholarly discussion of specific study results can serve as the basis for proposing directions for new program initiatives and guide future research. Improved quality of life is the therapeutic benefit most often documented in the research studies (Fig. 2). As such, an in-depth discussion of the therapeutic effects of Taiji practice could generate an entire research report in itself. Therefore, it is judiciously considered beyond the reasonable scope of this report. Interested clinicians are referred to a recent literature review on psychological benefits of Taiji practice by Sandlund and Norlander.<sup>70</sup> All other major areas of effect are addressed. In addition, Taiji programming utility and feasibility are also discussed.

*Physical Function Related to Aerobic Conditioning and Cardiovascular Effect.* One intriguing finding of the current research has to do with evidence of conditioning effect at low

training heart rates. Young et al.<sup>59</sup> reported that, in a randomized control study, individuals exercising regularly performing Taiji with mean exercising heart rate of 75 beats/min had the similar beneficial cardiovascular response related to decreased resting systolic blood pressure (mean change, 7.0 mm Hg for resting systolic blood pressure) as compared with a comparison group who participated in a walking program at a mean heart rate of 112 beats/min (mean change, 8.4 mm Hg for resting systolic blood pressure). In a year-long clinical trial,<sup>26</sup> individuals who had recently undergone coronary bypass graft surgery ( $n = 20$ ) were nonrandomly assigned to either a Taiji practice group or a home-based exercise group after completion of an aerobic cycling cardiac phase II exercise program. The Taiji group members were found to exercise at an intensity of 48–57% maximum heart rate range. Graded exercise tests performed before and after 1 yr of intervention found that those in the Taiji group showed significant increase in  $O_2$  peak (10% increase) and peak work (12% increase) as compared with the home-based exercise control group.

In another cardiac-related study, an 8-wk randomized clinical trial<sup>27</sup> ( $n = 126$ ) was conducted to evaluate the effect of Taiji practice for individuals with recent myocardial infarct. Results revealed that both the aerobic exercise group and the Taiji group had trends in reduced systolic blood pressure, but only the Taiji group showed trends of reduced diastolic blood pressure, suggesting that Taiji practice outcomes may be mildly superior to aerobic exercises programs for this clinical population. Conclusions of this study were limited because the retention rate (4%) for a nonexercising control group were too low to allow for meaningful comparative data analysis. This collective research evidence, with respect to cardiac rehabilitation applications, supports that Taiji practice is

Outcome effect	# studies (study reference identifier)						
	1	2	3	4	5	6	7
Quality of Life/Mood/Stress	(32)	(36)	(42)	(57)	(61)	(62)	(63)
↑ Physical function	(26)	(36)	(42)	(46)	(64)		
↓ Pain	(32)	(35)	(52)				
↓ Blood pressure	(58)	(60)	(61)				
↑ Balance	(64)	(66)					
↑ Immune response	(42)	(67)					
↑ Flexibility	(61)	(65)					
↑ Strength	(67)						
↑ Kinesthetic sense	(67)						

**Key:** Physical function = includes measures of improved aerobic conditioning

**Figure 2:** Summary of frequency of outcome benefits of Taiji practice. Source: 17 level I (randomized clinical trials) and level II (controlled clinical trials). *Physical function* includes measures of improved aerobic conditioning.

a safe, effective, low-intensity exercise regimen suitable for use as an exercise option with this vulnerable clinical population. Although the mechanism of effect is not fully understood, the possibility of increasing aerobic capacity without stressing a compromised cardiac system is desirable. Although collaborating clinical research is needed, there is theory-based rationale to generalize these conclusions to pulmonary rehabilitation as well.

**Pain Management.** Taiji practice has been shown to be effective in pain management. Bhatti et al.<sup>32</sup> reported preliminary findings of a randomized clinical trial ( $n = 51$ ) investigating the efficacy of Taiji practice as a strategy to manage chronic pain. Adult subjects with long-standing diagnosis

of chronic back pain were assigned to either a control group or a Taiji exercise group. Study results after 6 wks of Taiji practice revealed significant reductions in average, lowest, and worst pain experienced in the last week, measured on a visual analog scale, and self-reported improvements in mood.

In a randomized clinical trial of adults with lower limb osteoarthritis ( $n = 33$ ), Hartman et al.<sup>36</sup> found that after 12 wks of twice-weekly supervised exercise sessions, subjects in the Taiji group reported significant increases in self-efficacy for arthritis symptoms and improved satisfaction with general health as compared with controls. Similarly Adler et al.<sup>58</sup> demonstrated, in pilot study, that pain intensity scores for individuals ( $n =$

16) with chronic arthritis pain decreased as compared with controls. The experimental intervention employed was a 10-wk program of once-weekly supervised Taiji exercise.

**Improved Balance and Its Role in Falls Prevention.** Improved balance is one of the most commonly attributed benefits of Taiji practice. One of the earliest well-known studies addressing this effect comes from a correlational study.<sup>49</sup> In their article published in 1992, Tse and Bailey<sup>50</sup> reported balance abilities among experienced Taiji practitioners observed to be superior to balance abilities among more sedentary peers. This early work has become part of the justification for the belief that Taiji practice had potential use in falls reduction programs. In a review of 11 research reports published from 1992 through 2001, Komagata and Newton<sup>71</sup> concluded that Taiji was effective for balance improvement but not for reduction in falls. However, the research available at that time was predominantly one group and correlational studies. Only two studies<sup>60,67</sup> reported in the review by Komagata and Newton<sup>71</sup> meet the standards of methodological rigor employed in the current critical analysis.

At least one randomized controlled research study observed balance improvement with a relatively short duration of Taiji practice among nonclinical subjects. Using a stability platform, Jacobson et al.<sup>67</sup> observed improved lateral balance stability in healthy volunteer adults ( $n = 24$ ) after just 12 wks of Taiji practice. In a prospective controlled clinical study ( $n = 38$ ), Lan et al.<sup>65</sup> observed improved time on balance in the Taiji group as compared with controls. Subjects were older Taiwanese adults, and the study was conducted over a 12-mo period. Reported mean frequency of practice was 4.6 times per week. The style of Taiji practiced in both studies was the 108 Yang form. The differences in length

of observations and choice of measurement tools between the two studies raises interesting questions regarding consistency in research protocols for meta-analysis among future studies and dose effect.

A dominant belief among Taiji instructor experts regarding balance improvement attributed to Taiji practice is not whether Taiji improves balance, but rather how to scientifically demonstrate beneficial changes. Chan and Bartlett<sup>21</sup> recommend measuring dynamic stability with functional tests such as the Berg Balance test.<sup>72</sup> Mak and Ng<sup>73</sup> recommend measuring sway in the medio-lateral direction during single-leg stance by using a computerized force or balance testing system. Balance tests used in previous studies, as described by Wu,<sup>48</sup> included self-report, single-leg stance, Romberg stance, postural (force) platform measures, and lateral tilt (balance) board. In the conclusion of her 2002 review of the evidence for effectiveness of Taiji on improving balance and falls prevention, Wu<sup>48</sup> offered the suggestion that future studies should choose consistent and sensitive balance tests and include a measure of falls prevalence. Wu's<sup>48</sup> judicious caution is that improvement in balance may not necessarily correlate with the functional goal of falls prevention.

Research evidence supporting clinical use of Taiji in the areas of falls prevention comes in major part from the well known multiple-center FICSIT (Frailty and Injuries: Cooperative Studies on Intervention Techniques) studies.<sup>60,61</sup> The Atlanta group of the federally-funded, prospective FICSIT study randomly assigned community-dwelling older adults ( $n = 200$ ) to one of three groups: a 15-wk course of Taiji exercises, computerized balance training, or education (control). Subjects were grouped in cohorts of 10–12. The Taiji groups met twice weekly, and the balance training and control groups met once weekly. Biomedical,

functional, and psychosocial outcome variables were measured immediately and 4 mos postintervention. Although improvements in physiologic response to exercise were found in the Taiji group, the most cited finding of the follow-up study report<sup>61</sup> is a nearly 50% reduction in falls risk or delay of next fall in the Taiji group. Wolf et al.<sup>60</sup> observed no significant gains in balance performance for the Taiji group as compared with the control group, suggesting that the mechanism related to falls risk reduction or delay of next fall may not be directly attributable to the component of balance as measured in by the FICSIT study protocol.

Whereas the FICSIT studies suggested reduction of falls, a more recent randomized clinical trial ( $n = 163$ ) conducted in Australia provides primary evidence. Barnett et al.<sup>74</sup> randomly assigned community dwelling elders known to have a risk of falling to either a control or a Taiji exercise group. The Taiji intervention consisted of weekly group instruction in Taiji combined with daily home practice. Physical performance and general health measures were assessed through repeated measures. After 1 yr of Taiji practice, the experimental group was found to have a 40% reduction in falls.

**Immune Response.** A potential immune response effect of Taiji practice is a frequent claim of Taiji enthusiasts. Preliminary evidence of this phenomenon was provided in a two-group study of Taiji practitioners who reported 6 yrs or more of regular Taiji practice. Xusheng et al.<sup>68</sup> found positive changes in humoral activity attributed to a single episode of practice and indications of humoral immunity associated with long-term Taiji practice.

Clinical evidence to assess the effect of Taiji practice on immune response within novice Taiji practitioners is just emerging. In a randomized clinical trial ( $n = 36$ ), Irwin et al.<sup>42</sup> ex-

posed older adults with no previous Taiji experience to 15 wks of practice, with practice encouraged at a frequency of three times a week. Results revealed significant increases in Medical Outcomes Study short form (SF-36)<sup>75</sup> scores for role-physical and physical functioning. In addition, a nearly 50% increase in varicella zoster virus specific, cell-mediated immunity was found in the Taiji group as compared with demographically similar, wait-listed controls. Evidence of this enhanced immune effect suggests clinical applications for the elderly who naturally experience some decline in immune response and for immune-suppressed individuals. This is an under-researched area with great potential.

### *Flexibility, Strength, and Kinesthetic Sense.*

In physical rehabilitation, it is commonly acknowledged that a reduction of impairment does not directly translate to an improvement in function. However, there is also agreement that a relationship can exist between impairment and level of function. Variables such as flexibility, strength, and kinesthetic sense are impairments that are associated with the complex construct of physical function. Evidence, generated through controlled clinical research, has demonstrated the beneficial effects of Taiji practice on these three variables. In addition to improvements in lateral body stability related to balance, Jacobson et al.<sup>67</sup> found significant improvements in leg extensor strength and kinesthetic sense in healthy subjects after 12 wks of Taiji. Sun et al.<sup>62</sup> observed lower resting systolic and diastolic blood pressure and increases in shoulder and knee flexibility in older Hmong adults who participated in a 12-wk program of Taiji exercises as compared with randomly assigned controls. In a prospective controlled trial ( $n = 36$ ), Chen and Sun<sup>66</sup> observed increased flexibility measured using a sit'n reach box. The Taiji intervention employed in the latter study consisted of the Yang-style 24-movement form

and was conducted over 16 wks at a frequency of twice-weekly classes. Such demonstrations of beneficial changes in physical variables, often addressed as goals of physical rehabilitation, make Taiji practice an exercise intervention option with potential to achieve improved flexibility, strength, and kinesthetic sense.

**Programming Feasibility.** It is not enough to know that a treatment has effect; it must also have utility and feasibility for adoption in clinical practice. From the current controlled research, at least two aspects of program utility and feasibility can be explored: exercise persistence and cost effectiveness. Level of client willingness to follow therapeutic recommendations is important for treatment efficacy. Exercise persistence in diabetic management and cardiac rehabilitation maintenance programs have been reported to be as low as 10% and rarely higher than 50%.<sup>76</sup> It is notable that in the two studies addressing cardiac populations,<sup>26,27</sup> rates of exercise persistence were high. These findings, and participant testimonials,<sup>17,31</sup> support the belief that Taiji practice is an engaging activity with justified expectations of client willingness to follow therapeutic recommendations.

Cost is also a prime consideration when choosing intervention options. In an economic analysis, Wilson and Datta<sup>77</sup> predicted the cost/benefit of implementing Taiji as part of a falls prevention program in a typical nursing home. They estimated an annual program direct cost of just under \$9,000 annually for two classes per week of Yang-style Taiji instruction. Using risk ratios derived from the FISCIT studies and 2001 medical cost data, they predicted a net institutional saving of \$1,274.43 per participant per year in falls prevention. Although this analysis suggests economic feasibility, Wilson and Datta<sup>77</sup> cautioned facility administrators that confirming empirical

evidence of Taiji's utility within a nursing home setting was advisable before program adoption. The work by Wilson and Datta<sup>77</sup> can be used as a model to predict cost effectiveness when planning new programming.

**Future Research.** In an environment of escalating health care costs, with emphasis on evidence-based practice, current review findings should be sufficient to make the goal of learning more about integrating Taiji practice into therapeutic exercise regimen a high priority among physical rehabilitation specialists. The challenge to strengthen the research base by qualifying therapeutic mode, dose, context, and prescriptive validity lies ahead. These goals may be expeditiously advanced by identification and consensus agreement on standardized outcomes measures to facilitate quantitative meta-analysis of independent or multiple-center research and by conducting controlled trials targeting defined clinical subpopulations.

## SUMMARY

The body of knowledge validating the physical and physiologic therapeutic effects of regular Taiji practice has grown exponentially over the past 5 yrs. The documented range of benefits validates the attribute of comprehensiveness of effect. Evidence supports benefits of improved quality of life; physical function including cardiovascular, pain management, balance, and risk of falls reduction; enhanced immune response; and improved flexibility, strength, and kinesthetic sense attributed to Taiji practice. Based on evidence generated from controlled clinical trials (1985–2003), Taiji program exploration is justified in the areas of cardiac rehabilitation, chronic pain management, falls prevention programs, and health and wellness intervention for individuals who are immune suppressed and for fitness exercise programs for the elderly and

individuals with exercise precautions due to arthritis-related conditions. Applied theory and preliminary research serve as justification for future controlled clinical study of the benefits of Taiji intervention with individuals with neurologic disease: particularly multiple sclerosis, Parkinsonism, neurodevelopmental motor performance dysfunction, pulmonary insufficiency, and systemic musculoskeletal disorders. Potential application of Taiji as a behavioral intervention was not directly addressed in this report. However, it is anticipated from existing research and the mind/body theoretical model that potential benefits from Taiji practice could be expanded to include both physical and behavioral applications.

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