

Tai Chi as an Adjunct to Cardiac Rehabilitation Exercise Training

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■ Heart disease is a chronic condition needing lifetime secondary prevention measures to decrease morbidity and mortality, and to improve quality of life. Cardiac rehabilitation exercise training, one aspect of cardiac recovery, traditionally includes some form of aerobic fitness and, more recently, muscle strength training to improve exercise tolerance. Tai chi, widely practiced in China for centuries, is a popular form of exercise among older Chinese persons associated with enhanced well-being and health among traditional Chinese practitioners. Recent research has reported improvement in cardiorespiratory function, balance and postural stability, fall prevention, and stress reduction. A review of the literature suggests potential benefits from tai chi exercise performed as an adjunct to cardiac rehabilitation exercise training. Tai chi is cost-effective and facilitates a lifestyle of health-related behavior practices.

KEY WORDS

tai chi

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Despite advances in medicine and clinical care, heart disease continues to be the leading cause of morbidity and mortality in the United States.¹⁻³ Global cardiovascular disease (CVD) mortality accounts for one third of all deaths, with two thirds of those deaths occurring in developing countries.^{4,5} Projected global CVD deaths are expected to rise significantly, increasing CVD burden in developing countries over the next two decades. In developing countries alone, CVD mortality currently represents 24.5% of all deaths, and an increase to 34% is predicted by 2020.² In China, death attributable to CVD rose from 12.1% in 1957 to 35.8% in 1990.² Cigarette smoking among males in China reportedly exceeds 60% and is expected to increase.⁶ In Hong Kong, diseases of the circulatory system accounted for 25% of all deaths in 1998, with heart disease listed as the second leading cause of death, representing 61% of that mortality.⁷ There is concern that the prevalence of heart disease will continue to rise because of increased affluence and adoption of a Westernized lifestyle, with increased levels of smoking, high cholesterol intake, stress, and a sedentary lifestyle among Chinese persons

living in Hong Kong, as well as other affluent cities around the world.⁸ Moreover, ethnic Chinese are the largest group of Asian immigrants in the United States, and heart disease is listed as the leading cause of mortality among them, representing 29.4% of all deaths.⁹

Secondary prevention through cardiac rehabilitation can contribute significantly to improving the functional status of known cardiac patients, modifying coronary risk factors, and improving quality of life while reducing mortality and morbidity.¹⁰ Findings have shown secondary prevention to be effective for a variety of cardiac conditions including angina pectoris (stable), myocardial infarction, coronary bypass surgery, intracoronary revascularization (angioplasty, stenting, rotablator, laser angioplasty), valve replacement, and heart failure.¹⁰⁻¹² Cardiac rehabilitation exercise training, one element of cardiac recovery, has been shown to decrease cardiac risk factors by improving blood lipid profile, symptoms associated with angina and heart failure, and psychosocial well-being; by reducing stress, blood pressure, and mortality; and by aiding weight control.^{10,11} Research evidence also has found that cardiac rehabilitation exercise

training leads to improvements in various measures of psychological status and functioning.^{10,13} Moreover, physical fitness among persons qualifying for cardiac rehabilitation has been shown to serve as an independent predictor of mortality.^{12,14}

The most common types of exercise training have included some form of aerobic fitness, and more recently muscle strength training, to improve exercise tolerance.^{14,15} Exercise intensity of 50% to 70% of the predicted maximum heart rate is safe and appropriate for coronary patients.¹¹ Light to moderate physical activity has been reported to reduce coronary heart disease mortality.¹⁶ Tai chi, a traditional Chinese exercise that originated in China hundreds of years ago, is based on principles found in the ancient Chinese philosophies of Confucianism, Taoism, and Buddhism. As a healing art, it is widely used by Chinese doctors to treat conditions of hypertension, stress, depression, mental strain, chronic indigestion, insomnia, and arthritis. Tai chi is associated with enhanced well-being and health among traditional Chinese practitioners.^{17,18} Only recently has attention been given by the West to its potential health benefits.¹⁹⁻²¹ Recent research has reported improvements in cardiorespiratory function, balance and postural stability, fall prevention, and stress reduction.²² Tai chi requires no special facility or expensive equipment, and can be performed either individually or in groups. Tai chi movements are ideally suited for persons of all ages, regardless of previous exercise experience and aerobic capacity.¹⁷

THEORETICAL FRAMEWORK

The scientific foundations of exercise physiology and psychoneuroimmunology serve as the theoretical framework for understanding how tai chi may function as an adjunct to cardiac rehabilitation exercise training. Psychoneuroimmunology is the study of how psychological variables, such as anxiety, stress, or depression and the nervous, endocrine, and immune systems communicate. This mind-body communication is thought to occur through two distinct pathways, the sympathetic-adrenal-medullary axis and the hypothalamic-pituitary-adrenal-cortex axis, via neurotransmitters, neuropeptides, hormones, and immunomodulator. To maintain homeostasis, the pathways connecting the mind and body enable an integrated response to behavioral, physiologic, or immunologic threats.^{23,24} Substantial evidence suggests that exercise is related also to improvements in mental health, neuroendocrine, and immune functioning.^{23,25}

LITERATURE REVIEW

Tai chi has been practiced widely in China for thousands of years as a method of meditation, exercise, and

self-defense. The art and philosophy of tai chi is based on the collective philosophies of Taoism, Confucianism, Buddhism, and the study of nature. The various forms of the exercise, called movements, come from animals and birds. The function of these movements is to guide breathing and circulation as a means of helping vital energy flow through the body and have beneficial effects.^{18,22} Slow, controlled graceful movements characterize tai chi, integrating mental concentration and breathing control. Movements flow from one to another without excess energy expenditure from unnecessary muscle contraction.¹⁹ Each posture, performed evenly from beginning to end with the same continuous rhythm, is thought to improve circulation and breathing and strengthen internal organs. Masters of tai chi have reported benefits of health, vigor and longevity, which are thought to result from the relation among the movements, breathing, and meditation.^{18,26}

The philosophy behind tai chi is based on the Tao as a coming together of opposites called “yin” and “yang.” In the performance of tai chi, these principles of movement and rest while the individual is breathing in and out, are direct applications of the yin and yang principle of opposites. This dualism has been the basis for the Chinese understanding of health and illness since ancient times. Chinese believe that good health requires a balance of yin and yang forces within the body.^{27,28} Heaven, day, male, arteries, exhalation, and movement are thought to be yang, whereas earth, night, female, veins, inhalation, and rest are viewed as yin.

The basic physiologic foundation of tai chi involves circulation of “chi,” or energy, throughout the body through channels or meridians. These concepts of physiology are important to Chinese although quite different from Western models of physiology because they do not refer to any physical entity that can be seen or measured scientifically.^{18,28} Tai chi integrates both body and mind. The mind is used to direct the chi and move the limbs. The movement is thought to facilitate blood circulation, which in turn aids functioning of the internal organs. Traditional Chinese medical practitioners claim that health benefits may be gained for the heart and lungs through the breathing techniques and improvement of circulation resulting from free-flowing chi within the body. Tai chi is presumed to aid in the removal of toxins in the liver, help the kidney to function properly, improve balance, prevent backaches, and improve joint stiffness associated with arthritis. Finally, tai chi is thought to develop calm, peace, relaxation, and clarity of mind, which in turn aid an individual in controlling daily mental and emotional distress such as tension, anxiety, fear, depression, and anger.^{18,26-28}

Currently, several styles of tai chi, are currently practiced. The Chen style has quick and slow large movements, whereas the Yang style, the most popular, has slow large movements. The Wu style is mid-paced with

compact movements, whereas the Sun style has quick, compact movements.²² In addition, there are a few simplified or modified forms of tai chi. One modified version of tai chi, termed "tai chi chih," is easily learned and consists of only 20 simple movements.²⁹ In contrast to other forms of tai chi, the individual does not have to master the entire routine before benefiting from exercise training.²⁹ Tai chi chih is best learned from a certified instructor in a group setting, and performance of the entire routine requires approximately 30 minutes. Once movements are learned, they can be performed alone. The feasibility of using tai chi chih among elderly persons and those with heart failure has been demonstrated in prior research.^{30,31} Although several styles of tai chi currently are practiced, they all share common beliefs and philosophies.

Tai chi is suitable for people of all ages, although it is very popular with older Chinese persons. These movements are ideal for elderly people, high percentages of whom are likely to require cardiac rehabilitation exercise training, regardless of previous exercise experience and aerobic capacity.¹⁷ Tai chi requires only moderate work intensity. Estimated energy costs range between 4.1 and 4.6 metabolic equivalents (METs),^{32,33} with work intensity not exceeding 50% of an individual's maximum oxygen uptake.³³

Recently, the exercise intensity during performance of the classical Yang style among experienced tai chi practitioners was reported by Lan et al³⁴ to be at 55% of the subjects' peak oxygen uptake and 58% of their heart rate range. Zhou et al³³ reported that a simplified form of tai chi requires 2.9 METs on the average and a maximum oxygen uptake of less than 40%, suggesting that tai chi is an appropriate exercise for older adults and those with cardiovascular disease. The energy requirements for tai chi chih movements are estimated at 1.5 to 2.6 METs,³⁵ depending on whether the subject is sitting or standing, whereas the energy costs for the breathing component of tai chi chih were estimated at 3.0 to 3.6 METs.³⁵ The maximum heart rate reported by Fontana³⁵ was 43% to 49% of the predicted maximum heart rate. No differences were reported in response to this exercise by gender. Thus, the exercise intensity of tai chi is not fixed, and can be adjusted easily by the height of the postures and the duration of the practice session to accommodate sedentary individuals or those with a chronic condition.³⁴

Tai chi facilitates a lifestyle that incorporates a practice of health-related behavior among people of all ages. A recent cross-sectional study by Chen et al³⁶ examined various facilitators and barriers to the practice of tai chi among elders in Taiwan. Participants matched for age and gender were compared as tai chi practitioners and nonpractitioners. Both groups reported similar chronic illnesses, with heart disease and hypertension accounting for 46% of these.

Positive attitudes toward tai chi exercise included encouragement from others and perceived health benefits of feeling relaxed and peaceful, more energetic, and capable of thinking more clearly. Other factors that facilitated tai chi practice were convenience, manageability, and a better social life developed by new friendships acquired through practicing tai chi in a group setting.

However, many older Chinese adults in Taiwan never even considered tai chi as a form of exercise, whereas others stated that they had no time to perform it. Other difficulties reported by Chinese elders included feeling too weak physically, being too old or too fat, or not knowing where to go to learn tai chi. Furthermore, among the perceived barriers, the Chinese elders reported that tai chi was too complicated to learn, or that they had no patience to learn the movements or no interest in learning. Similar barriers to exercise participation among elders in the United States have been reported.³⁶

Clinicians may need to emphasize not only the health benefits associated with exercise, but also the social and recreational aspects of exercise when performed in a group setting, as with tai chi. Furthermore, clinicians may want to emphasize tai chi's portability, thus overcoming barriers such as transportation and costs associated with exercise facilities. Tai chi may be tailored individually for elderly persons, so that only a few movements are taught and mastered before new movements are introduced. This gradual learning, with small attainable goals, promotes self-confidence and fosters long-term adherence to physical activity.

Tai Chi and Cardiorespiratory Function

An early study examining the cardiorespiratory responses of tai chi reported a more efficient use of ventilatory volume among long-term tai chi practitioners.³⁷ Among elderly populations practicing tai chi, significantly better cardiorespiratory function has been reported, with continued improvements documented after 2 years.^{38,39} Research among older adults regarded as long-term tai chi practitioners has demonstrated a significantly higher peak oxygen uptake during exercise than among their sedentary counterparts matched for gender, age, height, weight, and body mass index. There were no significant baseline differences in blood pressure or smoking status between the groups.^{40,41} Studies have shown tai chi to be just as effective as aerobic exercise in reducing blood pressure among older adults.^{42,43} Recent research found similar results among older adults regularly practicing tai chi, suggesting that tai chi may improve cardiovascular function.¹⁷ Tai chi was reported to be as effective as formal aerobic exercise for reducing blood pressure after myocardial infarction among patients participating in a cardiac rehabilitation program.²¹ Previous research has shown improvements in cardiorespiratory function among

coronary artery bypass surgery patients deemed to be at low risk during their participation in a tai chi exercise program.²⁰

Recently, tai chi chih was used among patients with heart failure.³¹ Initial support for this intervention among individuals with severely compromised energy reserves was positive, although the sample size was small. No adverse effects have been reported.

Tai Chi, Balance, Postural Stability, and Fall Prevention

Research among long-term tai chi practitioners has demonstrated greater flexibility and muscle strength and less body fat than exhibited by their sedentary counterparts matched for age, gender, and body size.^{40,41,44} Among older adults participating in a tai chi exercise program, significantly better balance, postural stability, arm movement control, and flexibility have been reported than among those in a control group matched for age and gender.^{17,30,45-49} However, Wolf et al⁵⁰ reported that tai chi among elders did not significantly improve postural stability over that of a balance-training group. Tai chi was estimated to reduce the risk of multiple falls among older persons by 47.5%,⁴³ and a recent economic analysis of tai chi implemented in a typical nursing home to prevent hip fractures demonstrated a significant annual cost savings of \$1274.43 per person.⁵¹ Among individuals with rheumatoid arthritis, no deterioration in joint tenderness, joint swelling, or handgrip strength was found after their participation in a tai chi exercise group.⁵² Findings from a pilot study among persons with chronic arthritis showed a significant reduction in pain for the tai chi group, as compared with the control group.⁵³ Significant improvements in walking speed and flexibility were reported for individuals with multiple sclerosis after a tai chi exercise program.⁵⁴

Tai Chi, Mood, Stress Reduction, and Well-Being

Previous research examining the effect of tai chi on physiologic and psychological changes associated with stress and mood disturbance reported improvements in mood and reductions in stress, tension, depression, anger, fatigue, confusion, and anxiety among both beginners and seasoned tai chi practitioners.⁵⁵ After exposure of tai chi practitioners to a stressful situation, tai chi was found to elicit a stress-reduction effect with an improvement in mood state.⁵⁶ Among older adults in the community, a sense of enhanced well-being, increased alertness, relaxation, better mental outlook, achievement, and greater confidence has been reported after completion of a tai chi exercise program.¹⁹ Healthy women participating in a tai chi exercise group reported an improvement in overall mood, with reductions in tension-anxiety, depres-

sion-dejection, anger-hostility and confusion-bewilderment.⁵⁷ Recent research has demonstrated reductions in anxiety among older adults⁴⁵ and improvement in health-related quality of life among persons with multiple sclerosis⁵⁴ and those with lower-extremity osteoarthritis.⁵⁸ Tai chi was used recently as an intervention among older adults to improve self-efficacy and exercise behavior, and positive results were reported.⁵⁹ Tai chi is thought to encourage exercise self-efficacy and to improve long-term adherence because of mind and body integration during this form of exercise.⁶⁰ Thus, psychological improvements are thought to coincide with physical improvements.⁶¹

DISCUSSION

Physiologic and psychological improvements after cardiac rehabilitation have been documented, and cardiac rehabilitation may be helpful in decreasing morbidity and mortality.^{10,11} Cardiac rehabilitation exercise training improves functioning of the cardiovascular system, with evidence of coronary heart disease risk factor reduction. Research evidence suggests that exercise is related to enhanced mood, with reductions in anxiety, stress, and mood disturbance. Findings have shown self-efficacy to be a significant predictor of exercise behavior. Tai chi has been reported to enhance self-efficacy, leading to exercise adherence.

Tai chi facilitates a lifestyle that practices health-related behavior among people of all ages. However, learning tai chi may initially be a daunting task because of a prior sedentary lifestyle, a lack of knowledge about exercise or potential health benefits, motivation to commence, finding an instructor, and the financial costs associated with learning tai chi. Information regarding potential health benefits and encouragement from others including healthcare practitioners, family, and friends may aid in developing a positive attitude toward tai chi exercise. Strategies need to be developed to overcome negative perceptions associated with exercise and tai chi such as having insufficient time, finding it too complicated to learn, and having no patience or interest to learn the movements.

Most research on tai chi as an intervention has focused mainly on the elderly population.^{17,30,40-42,44-47,53,58} In particular, improvements in flexibility, balance, control, muscular strength, and fall risk reduction have been documented. Research studies using tai chi as a low- to moderate-intensity exercise are limited among persons with heart disease,^{20,21,31} although the evidence suggests that it is safe, effective, and able to improve cardiovascular and respiratory function. However, the long-term safety and efficacy of tai chi as an exercise for persons with heart disease have not been established. Future research on using tai chi as an adjunct to other

secondary prevention measures is needed for a variety of cardiac conditions, including angina pectoris, myocardial infarction, coronary bypass surgery, intracoronary revascularization, valve replacement, and heart failure, to establish the effectiveness of this intervention for persons participating in cardiac rehabilitation exercise training. Limited research has found that individuals enrolled in a tai chi exercise program had a reduction in blood pressure,^{42,43} although further studies may want to examine how tai chi influences the atherosclerotic process. Finally, future research among persons with heart disease comparing the efficacy of a tai chi exercise intervention with traditional cardiac rehabilitation exercise training may be warranted. Additional forms of cardiac rehabilitation exercise training may aid with patient participation and program adherence, just as previous research found that exercise options other than the treadmill or cycle were desired.⁶²

Application to Practice

In developing countries, the implementation of cardiac rehabilitation exercise training programs using equipment-based exercise is likely to encounter financial difficulties. It is an unrealistic expectation for developing countries with large rural areas to have so many easily accessible facilities or to require patients to travel long distances to participate in them. Non-equipment-based programs using tai chi offers alternative strategies for promoting cardiovascular fitness, aiding cardiac risk factor reduction and leading to improvements in health and outcomes.

Tai chi is a suitable exercise for people of all ages, regardless of previous exercise experience or aerobic capacity. It is low- to moderate-intensity exercise, with work intensity not exceeding 50% of an individual's maximum oxygen uptake.³³ However, as with all cardiac rehabilitation exercise training programs, individuals should first be evaluated for exercise tolerance, dysrhythmias, ventricular function, and angina. Tai chi exercise then may be tailored individually to their exercise tolerance and aerobic capacity, which could include sitting versions of tai chi chih that have low energy requirements (1.5-2.6 METs).³⁵

Tai chi chih is a relatively simple form of tai chi to learn, and may be taught in 8 to 10 lessons, with the whole sequence requiring approximately 30 minutes to perform. However, individual progress needs to be monitored and evaluated on a regular basis among novice performers to ensure that no untoward effects from performing this exercise occur. Areas to be monitored include, but are not limited to, cardiovascular responses to exercise; cognitive and psychological responses, including depression, stress, and/or anxiety levels; and muscular strength, balance, flexibility, and control.

The slow and graceful movements of tai chi have several advantages over other forms of exercise, as it does not require any special clothing or equipment, making it a cost-effective and affordable form of exercise. Tai chi also may foster adherence because of its portability (it may be performed any time at any place), lower exercise intensity, and impact. Moreover, tai chi is an enjoyable form of exercise.

SUMMARY

The literature provides evidence of the potential effect that tai chi has on improving exercise capacity and self-efficacy for exercise while reducing anxiety, alleviating depression, and improving mood state. Tai chi has the potential to reduce expenditures associated with chronic disease management by facilitating a lifestyle that promotes wellness among people of all ages. The exercise intensity of tai chi varies among the different styles performed. Simplified forms of tai chi, such as tai chi chih, are characterized by lower intensity, fewer movements, and shorter duration. These simplified forms of tai chi are ideal for deconditioned persons, including those with heart disease and the elderly. Once the initial movements are learned and mastered, new movements can be added to increase the exercise intensity and duration of the tai chi exercise session, thus increasing the aerobic effect.

Tai chi usually is performed in a group setting, which also enhances exercise participation.²⁰ Moreover, persons who feel safe and confident in performing tai chi are more likely to continue over the long term, achieving the greatest benefits of cardiac rehabilitation. Tai chi is a self-paced, noncompetitive exercise that can be performed at any time or place without the need for large space requirements.^{17,20} It can be implemented easily in any community setting.

The creation of novel approaches to enhance the well-being of people with chronic disease or disabilities and needing long-term rehabilitation could include the use of tai chi exercise. Given the increased financial burden placed on the current healthcare systems, tai chi has the potential to be an affordable and cost-effective form of exercise. Tai chi may be an excellent complement to a traditionally supervised aerobic exercise program for secondary prevention. Future research studies examining the long-term safety and efficacy of tai chi and how it influences the atherosclerotic process are suggested.

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