



# A randomized controlled trial on the psychophysiological effects of physical exercise and Tai-chi in patients with chronic schizophrenia



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## ABSTRACT

The chronic and prevalent natures of schizophrenia result in long-term institutionalization for the patients. Conventional treatment of anti-psychotic medication on management of psychotic symptoms often brings on severe side effects and reduces patients' well-being. Tai-chi is a mind–body exercise that underscores motor coordination and relaxation. This 3-arm randomized controlled trial investigated the psychophysiological benefits of Tai-chi on 153 chronic schizophrenia patients, who were recruited from a mental health rehab complex and randomized into Tai-chi, exercise, or waitlist control groups. Both intervention groups received 12 weeks of specific intervention plus standard medication received by the controls. All participants completed psychiatric interviews, self-report questionnaires, performance tasks, and salivary cortisol measures at baseline, 3-month, and 6-month follow-up on psychotic symptoms, motor coordination, memory, daily living function, and stress. Multigroup latent growth modeling was used to evaluate the intervention effects on the outcomes. Compared to controls, the Tai-chi group showed significant decreases in motor deficits and increases in backward digit span and mean cortisol, while the exercise group displayed significant decreases in motor deficits, negative and depression symptoms and increases in forward digit span, daily living function, and mean cortisol. The two interventions did not show significantly different therapeutic effects, except for fewer symptom manifestations in the exercise group. These results suggest psychophysiological benefits for Tai-chi on chronic schizophrenia patients in terms of motor coordination and memory. Though both Tai-chi and exercise groups tended to manifest fewer symptoms than the control group, the exercise group showed better symptoms management than the Tai-chi group.

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## 1. Background

Schizophrenia affects approximately the lives of 24 million people worldwide. Despite a low incidence rate of 3 in 10,000 (Chen et al., 1998), the poor prognosis and chronicity render the illness rather prevalent (0.4–1%). Long-term care and illness management are crucial as psychotic symptoms persist throughout one's lifetime. While the symptoms can be managed with medication, the debilitating side-effects of treatment often considerably disrupt the physical and psychosocial well-being of the patients. Over the past decades, the primary focus of patient care and research prioritized illness management and self-care while patients' physical and psychological well-being was considered secondary. Effective coping with stressors is crucial in the symptoms management for schizophrenia as the illness is often psychogenic in

nature. Salivary cortisol is a neuroendocrine indicator of stress response regulated by the hypothalamic–pituitary–adrenal (HPA) axis (Gunnar and Quevedo, 2007). Patients with schizophrenia have shown abnormal HPA axis functioning in the form of altered cortisol levels (Bradley and Dinan, 2010; Mondelli et al., 2010), which has been associated with more severe negative symptoms and poorer quality of life (Brenner et al., 2011; Hempel et al., 2010).

Physical exercise, such as aerobic exercise and yoga, is considered an adjuvant treatment to medication for schizophrenia (Lin et al., 2011; Visceglia and Lewis, 2011). Levin and Gimino (1982) found that aerobic exercise reduced depression and anxiety symptoms in hospitalized individuals with schizophrenia compared with no-exercise control. Despite the well-established evidence for the benefits of physical activity (Koivukangas et al., 2009), motivation for participation is low, perhaps due to illness-induced limitations on physical exertion, balancing difficulty, motor control, and muscle dexterity (Fogarty and Happell, 2005). Tai-chi is a form of Chinese exercise that emphasizes balance, strength, and mental concentration. Since it is less physically

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demanding, it may be a possible alternative for patients with schizophrenia. Based on Eastern health philosophies stressing the mind-body inter-connections, it is a rare form of moderate exercise with a mental emphasis. It is cost-effective and sustainable for people under rehabilitation in that its movement sequences, once learnt, can be carried out by participants themselves without additional equipment.

Accumulating evidence suggests that Tai-chi exercise is conducive to the maintenance of physical and mental health across different chronic medical conditions, such as cancer and mental illness (Liu et al., 2015; Yang et al., 2015). The multifaceted benefits of Tai-chi were established by a recent review of 42 randomized control trials (Li et al., 2011). Tai-chi was found to improve coordination, balance, and flexibility (Hong et al., 2000; Li et al., 2011; Ng et al., 2012), immunity (Irwin et al., 2007), enhance overall functioning (Mustian et al., 2004), facilitate relaxation (Kutner et al., 1997), and HPA axis functioning (Jin, 1989) and mood disturbance and fatigue (Grodin et al., 2008).

For patients with schizophrenia, previous studies on Tai-chi suggest that the intervention is effective in improving the positive and negative psychiatric symptoms (Kwon and Kwag, 2011; Zhu et al., 2009). Nevertheless, little is known about the effectiveness of Tai-chi as a holistic intervention to improve the multidimensional manifestations of schizophrenia, particularly motor and cognitive deficits, stress levels, psychotic symptoms, and vocational-social functioning. Further research is needed to evaluate whether Tai-chi provides unique benefits over and above those associated with moderate aerobic exercise. Thus, it is the objective of this article to explore systematically the effectiveness of Tai-chi exercise on people with chronic schizophrenia. In view of the known stress-reducing benefits of physical exercise (Logghe et al., 2011), the present study aimed to elucidate the potential benefits of Tai-chi, such as attainment of mental tranquility and relaxation, which might not be achieved by exercise interventions alone.

## 2. Methods

### 2.1. Participants

The present study adopted a non-blind, 3-arm randomized controlled trial (RCT) with waitlist control design. Participants were patients with chronic schizophrenia residing in a mental health rehabilitation hostel in Hong Kong. The rehabilitation complex provided long-term care and halfway house services to the patients. The inclusion criteria of the study were fulfillment of DSM-IV TR criteria for schizophrenia, aged between 18 and 65 years, ability to understand and speak Cantonese, and no formal training in Tai-chi. The exclusion criteria included diagnosis of acute schizophrenia requiring hospitalization, presence of severe schizophrenic symptoms (e.g. persistent withdrawal) that would limit participation in class, a history of organic mental disorders (e.g. mental retardation or dementia), presence of physical disabilities and other illnesses that impair cognitive or visuomotor functioning. Ethical approval was obtained from the local institutional review board.

A total of 453 chronic schizophrenia patients were assessed for eligibility based on disease condition and 190 of them did not meet the inclusion criteria and were excluded. Among the 263 eligible participants, 110 of them could not participate in the planned group sessions because of other commitments such as home leaves and work placement in the hostel and were thus screened out. Research assistants obtained written informed consent from the 153 eligible and available participants at the residential hostel. They were randomized into one of the three treatment conditions: the Tai-chi, exercise, or waitlist control groups, on a 1:1:1 basis using simple randomization with no blocking. All participants were assessed at three time points: (i) baseline, (ii) 3-month follow-up (post-intervention), and (iii) 6-month follow-up (maintenance). Baseline data were collected one week before the start of the group programs. Fig. 1 depicts the flow chart of the study. A total of 8 participants dropped out of the study.

The attrition rate (5.2%) was comparable to that in prior community trials of Tai-chi interventions in elderly patients and exercise programs for patients with mental illnesses (Logghe et al., 2011). Reasons for drop-outs included a lack of time to join the group, returning to work, and a refusal to participate in the follow-up assessments.

### 2.2. Interventions

The Tai-chi intervention was based on the first segment of the Wu-style Cheng-form Tai-chi chuan, comprising 22 simple movements (Tsui, 2008). This form emphasizes attention and coordination and promotes concentration and focus during practice via learning of the names of each movement. Following the results from the pilot study, visual aids with descriptive diagrams of the movement forms were used to maximize learning and memory of the movements and to encourage practice. The intervention was conducted by mental health professionals who had received formal Tai-chi training at the professional Tsui Woon Kwong Tai-chi Institute.

To design a control exercise regime of comparable intensity, a pilot control study was conducted with four schizophrenic patients with past Tai-chi experience. The patients' heart rates were measured by a portable heart rate monitor during the practice of a full set of Tai-chi movements. Based on the data collected, a qualified fitness instructor devised a moderate aerobic exercise routine designed to achieve 50–60% of maximal oxygen consumption for the exercise group. The exercise intervention was led by mental health professionals and included a warm up, stretching and joint movements (15 min), walking (10 min), stepping (10 min), mild weight training (10 min), and cool down stretching (15 min). Both Tai-chi and exercise groups attended a 60-minute weekly class (with 20 participants) for 12 consecutive weeks and a 45-minute, twice-weekly practice sessions in-between the weekly sessions under the guidance of mental health professionals. Participants in the waitlist control group received regular medication and routine care during the study, and they were offered the Tai-chi or exercise class on a voluntary basis after the 3-month post-intervention follow-up assessment.

### 2.3. Measures

All assessments were conducted by trained researchers. Psychiatric symptoms were measured by the Positive and Negative Syndrome Scale (PANSS) (Kay et al., 1987). The PANSS is a 7-point psychiatric rating scale that assesses schizophrenic symptoms exhibited by the patient in the past week based on a semi-structured interview. A recent validation study supported a five-factor solution for the Chinese version of the PANSS (Jiang et al., 2013). The five factors are positive (4 items,  $\alpha = .84$ ), negative (5 items,  $\alpha = .83$ ), excitement (3 items,  $\alpha = .53$ ), depression (3 items,  $\alpha = .69$ ), and cognitive (2 items,  $\alpha = .79$ ). Motor and sequencing deficits were assessed by the motor coordination ( $\alpha = .80$ ) and the sequencing subscales ( $\alpha = .59$ ) of the Chinese Neurological Evaluation Scale (NES) (Buchanan and Heinrichs, 1989; Koivukangas et al., 2010). Participants' performance in the tasks was rated on a 3-point scale based on the number of mistakes. Participants' short-term memory and attention were evaluated by forward and backward digit spans of the Chinese Wechsler Adult Intelligence Scale (Wechsler, 2005).

Daily functioning was measured by the Chinese version of the Barthel's Activities of Daily Living (ADL) index (Mahoney and Barthel, 1965) and Lawton's Instrumental Activities of Daily Living (IADL) scale (Leung et al., 2011). The former evaluates basic self-care via ten tasks, such as feeding, toilet use, walking, and bladder continence. The latter covers 8 relatively complex domains in self-care, such as shopping, self-medication, and ability to handle finances. Since the residential hostel provided food preparation, housekeeping, and laundry services to all participants, these 3 items were excluded in the present study. The total score for the ADL ( $\alpha = .71$ ) and IADL ( $\alpha = .67$ ) range from

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