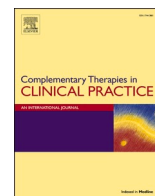




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## Traditional Chinese exercise potential role as prevention and adjuvant therapy in patients with COVID-19

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### ABSTRACT

The epidemic situation of COVID-19 is a great public health emergency worldwide characterized by fastest spreading, widest infection range and the mostly difficult to prevent and control in recent years. According to medical experience, traditional Chinese exercises (TCE) have been applied for COVID-19 prevention, adjuvant treatment or rehabilitation, and achieved some curative effects. They can enhance the body immunity, improve the function of organs, especially cardiopulmonary function, promote physical and mental rehabilitation by adjusting the body, regulating the breath, regulating the mind. This paper aims to investigate the potential value of TCE for health preservation in the prevention and adjuvant treatment for COVID-19 according to an overview of application and analysis of existing evidence. On this basis, this review proposed the TCE plan by visiting clinical and practice experts, so as to provide some references for the prevention and treatment of COVID-19 with TCE in the world.

### 1. Background

Corona Virus Disease 2019 is caused by the SARS-Cov-2 Virus. The epidemic situation of COVID-19 is a great public health emergency worldwide, characterized by the fastest spreading, widest infection range and the most difficult to prevent and control in recent years. Initially, fever, dry cough and weakness are the main clinical features of the novel coronavirus, and with the progress of the disease, the respiratory system, digestive system and circulatory system can be involved [1]. Severely ill patients may rapidly progress to respiratory distress syndrome, infectious shock, uncorrectable metabolic acidosis and coagulopathy, and multi-organ failure, eventually leading to death [2]. (see Table 1).

Recent studies have shown that early exercise and respiratory rehabilitation can improve respiratory function, relieve anxiety and enhance quality of life in older patients and those in the early stages of disease [3,4]. Cochrane has also published a series of rehabilitation reviews related to COVID-19, which suggest that rehabilitation interventions are beneficial to reduce the risk of disease for the people

quarantined at home and the recovery of inpatients with COVID-19 [5], especially the early respiratory rehabilitation intervention [6]; With the increasing demand for rehabilitation, more resources and effective rehabilitation recommendations need to be increased [7,8]. In the “The Guideline Of Chinese Medicine Rehabilitation For COVID-19 Convalescence (Pilot)” which issued by China National Administration of Traditional Chinese Medicine on 22 Feb 2020, Traditional Chinese Exercises (TCE), such as *Taiji*, *Baduanjin*, are recommended as adjuvant treatment. These photographs are impressive which healthcare workers and COVID-19 patients have practiced *Taiji* and *Baduanjin* together in Wuhan Leishenshan hospital, Huangshi Hospital of Traditional Chinese Medicine, Hubei 672 Traditional Chinese, and Western Medicine Orthopedic Hospital and multiple mobile cabin hospital. However, it is currently elusive that how to improve human immunity and decrease the risk of virus infection, how to regulate mind-body and improve therapeutic efficiency as adjuvant therapy, and how to facilitate recovery through practicing TCE. This paper reviews the existing literature on the function of TCE practice in the prevention, adjuvant treatment, and rehabilitation for COVID-19, and combines with

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COVID-19 clinical features to develop TCE implementation plan on the prevention and treatment of COVID-19.

## 2. Introduction of TCE

Traditional Chinese exercises called “*Daoyin*” exercise in ancient China were formed by the concept of viewing the situation as a whole, *Five-Zang* manifestation theory and meridian doctrine as theoretical guidance, and body movement as presentation. They are aimed to enhance fitness, prevent and treat diseases. The initial manifestations of TCE were divided into a dynamic “*Daoyin*” and a static “*Xingqi*”. “*Daoyin*” is characterized by motor and focus on body movement, and “*Xingqi*” is characterized by resting and focus on breath and mind regulation. With the continuous development of TCE, “*Daoyin*” and “*Xingqi*” are combined gradually, and generate the unique Traditional Chinese Exercises which cooperates and interacts with “motoring”, “breathing” and “thinking” of these three. It includes *Taiji*, *Wuqinxi* (Five-Animal Exercises), *Liuzijue* (qigong-6-character formulas), *Baduanjin* (Eight Section Brocade) and *Yijinjing*.

As one of the traditional Chinese martial arts, “*Taiji*” is a combination of the philosophy of “*I Ching/Yijing*”, the meridian doctrine of Traditional Chinese Medicine, the respiratory method of healing *Qigong*, and the body movement of martial arts. It requires the cooperation of “motoring”, “breathing” and “thinking” to keep the balance of the inner body and outer environment, prevent diseases and regulate emotion. *Wu Qin Xi* (Five-Animal Exercises) is a bionic health preservation exercise created by *Hua Tuo*, a famous doctor at the time of the Dong-Han Dynasty, according to the posture and life habits of tiger, deer, bear, ape, and bird. It has the functions of fitness-enhancing and spleen-fortifying. *Liuzijue* (qigong-6-character formulas), as one of the methods for guiding breath through vocalization of six words “Xu, He, Hu, Si, Chui, Xi” is a combination of *Zang-fu* function and body movement for a health cure. *Baduanjin* (Eight Section Brocade) integrates static-dynamic and interaction between body and mind. And it could regulate the function of the *Zang-fu* organs and the circulation of qi and blood, improve one’s immunity to prevent and cure diseases in long-term practice. The movements of *Yijinjing* are characterized by spreading, rotating and stretching. The function of regulating the *Zang-fu* and strengthening the body could be accomplished in the following various ways by joints activation and ligament stretching.

## 3. The possibility of COVID-19 prevention and treatment

### 3.1. Improving immunity to prevent virus infection

Improving immunity is critical to preventing infection of COVID-19. According to the “Novel Coronavirus Pneumonia Diagnosis and Treatment Plan (Provisional 7th Edition)”, the pathological characteristic of COVID-19 infector is a reduction in the number and function of immune cells such as CD4<sup>+</sup>CD8<sup>+</sup> T cells in lymphoid tissue [9]. Current research shows that it could improve both cellular and humoral immunity in the long-term practice of TCE. On the one hand, TCE can increase the CD4<sup>+</sup>/CD8<sup>+</sup> ratio to strengthen cellular immunity by decreasing the number of CD8<sup>+</sup> T lymphocytes in the peripheral blood. To a certain extent, it has the potential to promote immune regulation [10] and immune surveillance [11] by improving NK cell activity. On the other hand, TCE has been reported to increase immunoglobulin levels (either IgM, or IgG, or IgA) and enhance B lymphocytes function to directly strengthen humoral autoimmunity [12,13]. Thus, there is some existing evidence that TCE could improve both cellular and humoral immunity to prevent virus infection.

### 3.2. Improving viscera function to play various accessory roles in the treatment of COVID-19

Under the adjuvant treatment, TCM improves cardiac and other

viscera function and controls underlying conditions to exert a therapeutic and prophylactic effect in COVID-19. Firstly, the majority of COVID-19 patients presented with respiratory symptoms, including high fever and coughing, and abnormal indicators of pulmonary functions. TCE has a positive effect on improving respiratory symptoms, such as coughing, fever and sweating, throat swellings and phlegm [14]. It also has resulted in improvements in ventilatory efficiency by increasing *BODE Index*, *FEV1/FVC ratio* and 6-min walking test (6MWT) of COPD patient [15], and decrease in the measures of Peak Expiratory Flow Rates (PEFR) and Maximal voluntary ventilation (MVV) [16]. Secondly, different degrees of myocardial damage symptoms occur in the part of COVID-19 patients [17]. TCE could increase the compensatory force of the heart pump and myocardial contractility and improve cardiac function [18]. In addition, it can simultaneously decrease the B-type natriuretic peptide (BNP) level and regulate amino-terminal pro-brain natriuretic peptide (NT-proBNP) level of heart failure patient for improving circulation [19]. At present, TCE could be used as adjunctive therapy for hypoxemia treatment by improving saturated oxygen in arterial blood (SpO<sub>2</sub>). [20,21] Thirdly, “Diagnosis and Treatment Protocol for COVID-19 and other studies indicate that in addition to cardiopulmonary injury, the COVID-19 virus may lead to multiorgan disorders caused by severe infections and aggravate the underlying disease [22]. As a form of aerobic exercise, TCE may reduce erythrocyte sedimentation rate (ESR) and inhibit the secretion of C-reactive protein (CRP), Interleukin-6 (IL-6), Tumor necrosis factor-alpha (TNFα) to relieve inflammation of COVID-19 [23,24]. Long-term practice of TCE serves to be conducive to the liver and renal function recovery which is manifested with decrease serum gamma-glutamyl transpeptidase (GGT), alanine aminotransferase (ALT) and aspartate aminotransferase (AST) in patients with non-alcoholic fatty liver disease and improve 24-h urinary protein in patients with chronic kidney disease [25,26]. Moreover, TCE could be used as an adjunct therapy in the treatment of underlying disease by regulating blood pressure, lipid and glucose, such as the reduction in both systolic and diastolic blood pressure of hypertensive individuals, the adjustment in total serum cholesterol level and improvement fasting blood glucose of type 2 diabetes individuals [27–29].

### 3.3. Promoting rehabilitation and improving the quality of life

During the course of COVID-19 rehabilitation, TCE can play a role in promoting the absorption of lung lesions, relieving residual symptoms and improving emotion and the quality of life. Firstly, some of the COVID-19 patients remain lung lesions of varying degrees and symptoms of respiratory and gastrointestinal systems after hospital discharge due to poor organ functional recovery. Under the guidance of TCM theory, TCE could reconcile Qi and blood, smooth the meridians and regulate the functions of internal organs by nourishing the Qi originated from Dantian which locates on the lower abdomen, on the anterior midline, a distance of four fingers below the umbilicus [30]. It may also promote the formation of internal Zongqi which can enhance lung function and metabolism [30]. With respect to organ rehabilitation, TCE can promote lung recovery of patients [31,32] as well as improve diaphragm exercise capacity [33]. TCE can also ameliorate gastrointestinal symptoms such as diarrhea and vomiting by regulating the state of intestinal flora and increasing counts of bifidobacteria and lactobacilli [34]. Secondly, COVID-19 patients may suffer different levels of depression and anxiety symptoms, which significantly reduced their physical quality of life. The clinical trials show that TCE can relieve the negative emotions, such as anxiety, depression, anger and tension, and improve Spielberger State-Trait Anxiety Inventory (STAI) scores [35–38]. TCE can significantly improve the Pittsburgh Sleep Quality Index (PSQI) and physical discomfort with fatigue and pain, which is also conducive to improving the patients’ quality of sleep and life [39]. To sum up, TCE has substantial implications for both the physical and mental rehabilitation of COVID-19 patients after hospital discharge.

#### 4. The protocol of TCE for health preservation in the prevention and treatment for COVID-19

We have developed TCM practice programs for three different groups of population ( healthy people, mild and moderate cases, convalescence ), which are depending on clinical evidence and experts' consensus, combined with patients type and evolution law of disease in "Diagnosis and Treatment Protocol for COVID-19(Trial Version 7)", and according to the objective of TCE interventions to diverse populations. Among these, The principal purposes of TCE practice for three groups of the population are as follows: healthy for elevating the antiviral ability and body immunity; mild and moderate cases for improving viscera function and adjuvant treatment; convalescence for rehabilitation after illness and recovering physical function.

##### 4.1. TCE practice protocol in prevention and treatment for COVID-19

These are TCE practice protocols for diverse populations, and practice population can be flexible in adjustment of content, duration, intensity, and frequency, according to physical status (see Table 1).

##### 4.2. The basis for content, duration, intensity and frequency of TCE in the practice protocol

In terms of improving immunity for healthy people, the study has suggested that it is the optimum aerobic exercise of moderate intensity (the simple standard is that they can speak but not sing) 5 times per week for 30–60 min [40]. In the aspect of TCE content selection, some TCE experts believe that *Taiji* emphasizes physical and mental relaxation but *Yijinjing* and *Baduanjin* focus on the conversion between body contraction and mental relaxation, and they can choose several kinds of TCE on the basis of cooperation with each other.

Concerning pulmonary adjunctive treatment and rehabilitation, research shows TCE, such as *Taiji*, *Baduanjin*, *Liuzijue*, *Wuqinxi*, has a significant effect on the recovery of 6MWD, FEV1, Tiffenau index, Chronic Respiratory Disease Questionnaire score in patients with pulmonary diseases, and on the improvement of endurance [15,41,42]. In the aspects of content, duration, intensity and frequency selection of TCE, some pulmonary clinician and TCE experts suggest that the practice time and intensity for mild and moderate cases are significantly lower than that for a healthy population, but the practice frequency could be increased appropriately. And it is preferable in the content selection of *Liuzijue* and *Turtle Longevity Qigong* which are cardiopulmonary exercise dominated, or based on exercise of abdominal breathing. By reducing the exercise intensity, increasing the exercise time, frequency, and types appropriately, the body function of patients in the recovery phase of COVID-19 can be restored. Among them, mild and moderate cases will take *Taiji*, *Baduanjin*, *Yijinjing* as the main exercises, which could help facilitate a gradual and safe return to physical activity, and convalescence of severe and critical cases will practice *Taiji*, *Liuzijue*, *Turtle Longevity Qigong* and abdominal breathing as the main exercises which could be beneficial for cardiopulmonary rehabilitation and recovery of exercise capacity.

The unique advantages of TCE, such as *Taiji*, *Baduanjin*, *Liuzijue*, *Yijinjing*, have played an important role in response to the COVID-19 epidemic situation in China. In the present case, there is less directly medical evidence for TCE in the prevention and treatment of COVID-19. This review analyzed the points and feasibility of TCE in the prevention and treatment of COVID-19 through numerous related studies, combined clinicians and TCE experts' opinions, and then formulated the TCE practice protocol. It has a positive effect on prevention and treatment for COVID-19 worldwide by summarizing and promoting TCE. Although the effect that TCE exerted on COVID-19 is not yet able to comprehensively be summarized, TCE is still broadly concerned worldwide, and it can bring us more discoveries.

**Table 1**

TCE practice protocol in prevention and treatment for COVID-19.

	Healthy individuals	Mild and moderate cases	Convalescence cases
<b>Practice Purpose</b>	Elevating the antiviral ability and body immunity	Improving viscera function and adjuvant treatment	Rehabilitation after illness and recovering physical function
<b>TCE Content</b>	<i>Taiji</i> , <i>Yijinjing</i> , <i>Baduanjin</i> and many other Traditional Chinese Exercise for Health Preservation.	<i>Liuzijue</i> , <i>Turtle Longevity Qigong</i> , deep and slow abdominal breathing exercises ( It can be performed using different body position such as standing , sitting and lying. nasal inspiratory and mouth expiratory or vice versa ; smoothing and healing body and mind.	Convalescence of mild and moderate cases : <i>Taiji</i> , <i>Baduanjin</i> and <i>Yijinjing</i> ; Convalescence of severe and critical cases: <i>Tai Chi</i> , <i>Baduanjin</i> , <i>Liuzijue</i> , <i>Turtle Longevity Qigong</i> , deep and slow abdominal breathing exercises.
<b>Practice Time</b>	5–10 min to warm up, Body dynamic stretching, 30–60 min of Traditional Chinese exercises, 5–10 min static stretching.	Perform 12–15 min of exercises after a simple warm-up. The magnitudes of motion should be appropriate, and the frail individuals could complete the training by stratifying into three or four times.	5–10 min to warm up, Body dynamic stretching, About 60 min of Traditional Chinese exercise, 5–10 min static stretching, The magnitudes of motion should be appropriate, and the frail individuals could complete the training by stratifying into three or four times.
<b>Intensity</b>	Medium intensity	Low intensity	Intensity from low to medium, the practice intensity could gradually increase. according to the condition of self-recovery.
<b>Frequency</b>	3-5 times a week	7 times a week	7 times a week, the practice time or frequency could be adjusted depending on the actual situation.

#### Ethics approval and consent to participate

Not applicable.

#### Consent for publication

Not applicable.

#### Availability of data and materials

All data analyzed during this study are included in this published article and its supplementary information files.

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#### Declaration of competing interest

The authors declare that they have no competing interests.

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