

## Tai Chi to Preserve General Health of Elderly during the COVID-19 Pandemic

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### Abstract

SARS-CoV-2 virus is more severe in the elderly and contributes to most death cases. This is postulated due to the presence of multiple comorbidities and age-related immunological changes like immunosenescence and inflammaging. Immunosenescence causes impaired viral clearance, while inflammaging causes exaggerated response inappropriate to stimuli that triggers life-threatening cytokine storm. Hence, home-isolation prevents infection among the elderly and this limits their physical activity. Sedentary lifestyle eventually worsens pre-existing chronic disease and increases the risk of acquiring a new one. Tai Chi is one of the exercises recommended for the elderly during home-isolation. This literature review aims to provide information regarding the groups suggested for Tai Chi, its benefits, as an exercise to be practiced by elderly to maintain general health during COVID-19 and adverse effects. Tai Chi is for those aged 50 years and above or individuals with certain chronic, degenerative or psychological conditions. The systemic benefits

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are reduction in blood pressure, improves lipid profile, reduction in bone loss and musculoskeletal improvements; whereas neurologically, it reduces cortical shrinkage and improves depression, anxiety and insomnia. Moreover, it induces immune-regulation, which leads to enhancement of the immune system and inhibition of age-related chronic inflammatory condition, inflammaging. These may be protective against severe COVID-19 illness yet further studies are warranted. The adverse effect includes minor musculoskeletal pain and aches. In conclusion, Tai Chi is an ideal exercise for the elderly to maintain health during this challenging pandemic. However, the elderly need to be guided for the proper technique to perform this exercise at home.

**Keywords:** *Tai Chi, General Health, Elderly, COVID-19, Exercise.*

## 1. Introduction

In December 2019, a novel coronavirus, severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) began in China, resulting in a respiratory illness known as coronavirus disease 2019 (COVID-19) which spread worldwide. In China, this virus apparently infects mostly adults, with the average age of hospitalized patients being 49 to 56 years old (Chen et al., 2020; Zhu et al., 2020). While children account for only 1 to 5% of diagnosed cases and appear to have a mild course of the disease with an overall good prognosis (Ludvigsson, 2020). However, this evolving virus is difficult to predict and many studies are ongoing.

Sadly, among the elderly and those with multiple comorbidities, the infection is more severe. COVID-19 infection in these groups contributes to most of the death cases. For instance, in China, about 80% of the death cases are among those aged 60 years and older (Meftahl et al., 2020). While in Italy, the median age of death is about 78.5 years (Kunz, 2020; Palmieri et al, 2020). This is believed to be mainly due to the age-related systemic physiological changes, which lead to the presence of immunological changes and multiple comorbidities (Meftahl et al., 2020). Due to aging, the elderly have immunosenescence and inflammaging whereby there is an exaggerated response that is inappropriate to a stimulus like COVID-19 infection. Moreover, due to the high infectivity rate of COVID-19 among the elderly, they are advised to stay at home instead of leaving their houses to prevent infection.

Therefore, home-isolation seems to be the best prevention method for the elderly at this time of the pandemic. By home-isolation, this age group may not be exposed to the virus of COVID-19 infection. However, this will lead to a vicious cycle, whereby it will cause inactivity among the elderly, and consequently a sedentary lifestyle as they are confined to their home. A sedentary lifestyle will further increase the risk of getting chronic diseases like diabetes mellitus, hyperlipidemia, and hypertension. Finally, this will lead to difficulty in controlling chronic diseases and worsening comorbidities (Rezende et al, 2014). In turn, they are more vulnerable to infection and if these elderly acquire COVID-19, they are at an increased risk of suffering from the complications of the infection (CDC, 2021c, 2021b).

It is commonly known that a healthy lifestyle which includes exercise and meditation for relaxation, helps to prevent diseases, enhances immune function, and improves overall health and well-being (Bentlage et al., 2020; Birdee et al., 2013). Thus, during this period of quarantine, there may be a restriction on proper place and equipment to perform an exercise. Even an active elderly may become demotivated because of these barriers. Therefore, Tai Chi is suggested for the elderly as it

is a mild form of exercise that is easy to perform on their own at home (Bentlage et al., 2020). Besides, Tai Chi has a lower risk of fall and injury. However, knowledge of proper technique for the optimal outcome is also important, thus elderly can watch Tai Chi videos that are widely available in social media while doing the exercise. This will increase their physical and psychological strength, helping them to surge their functional independence; hence preventing the development and progression of medical conditions that increase their comorbidities. Basically, Tai Chi prevents possible chronic disease exacerbation that is due to the lack of physical movement, which is contributed by the aging process (Birdee et al., 2013; Lauche et al., 2016).

Tai Chi originated from China and has been practiced by the elderly for centuries. It is a martial art that was also designed for self-defence (Birdee et al., 2013). Interestingly, it started growing among the Western population in the last 40 years. This is because, in the West, Tai Chi is thought to give a longevity effect on its practitioners (Guo et al., 2014; Lan et al., 2013). It is a lower intensity exercise, which has a low impact as it is performed in semi-squat posture. There are no risky physical movements like jumping which makes it suitable and safe for the elderly. However, Tai Chi demands neuromuscular coordination, despite the slow muscle contraction. In addition, it also provides a relaxation effect and is known as mind-body movement therapy, as the whole body will be in coordination with the brain during the exercise (West, 2010).

However, not all exercises are safe for the elderly. In recent literature, exercises that are presumed suitable for the elderly are those that include resistance, strength and balancing. Some examples are light aerobics, Pilates, Yoga, Tai Chi and Qi Gong (Hartmann-Boyce et al., 2020; Ng et al., 2019). Among these exercises, Tai Chi was chosen for this review specifically because it is one of the most established exercises that involves the mind and body that synchronizes to improve balance, promote stability, decrease falls and improve psychological well-being and immune system (Marks, 2020). This is particularly important at this time of COVID-19, to help the elderly to feel more relaxed. There are various health benefits from Tai Chi in achieving optimal health especially in the elderly. This literature review aims to distinguish the suitability, benefits and adverse effects of Tai Chi in the elderly age group, rendering it as a mild home-based exercise that they can practise during the COVID-19 Pandemic.

## **2. Methodology**

The review of the literature was based on electronic databases: PubMed, Google Scholar, EZproxy, UptoDate and web resources by using combinations of keywords such as 'elderly', 'tai chi', 'exercise', 'health' and 'COVID-19'. Several books, journal articles and reports were analysed. The key points and important facts were extracted as references in order to provide information from reliable sources.

## **3. Results & Discussion**

### ***SARS- CoV-2 Pathophysiology of Infection***

SARS-CoV-2 is a novel virus, originating from a zoonotic infection. It is the seventh coronavirus infecting humans and spreads through direct contact, indirect transmission through aerosols, or droplets. The SARS-CoV is an earlier virus of the same beta coronavirus class that caused an outbreak in the year 2003, thus many studies for SARS-CoV-2 refer to the predecessor virus, the SARS-CoV (Singh et al., 2020).

The pathophysiology of infection starts when the SARS-CoV-2 virus enters the nasopharyngeal tract and attaches to cells by binding its spike (S) protein specifically to the targeted receptors, angiotensin-converting enzyme 2 (ACE-2) receptor. The receptors present in the endothelial and smooth muscle cells of almost all organs but mostly found in lungs and intestines (Payne, 2017; Yuki et al, 2020). After the binding, the S protein will be activated in two ways during the attachment. That is through the cleavage process by a protease enzyme called furin and activation by another enzyme known as type II Transmembrane Serine Protease (TMPRSS2). The activation of S protein will facilitate the virus to enter into host cells via fusion or endoplasmic uptake (Astuti & Ysrafil, 2020; Kumar et al., 2020). Then, in order to copy viral genomes and translate them into proteins, the host cells' ribosomes will be invaded. Once the proteins have matured and packed to form new virions, it will be released from host cells to continue infecting other cells.

In addition, SARS-CoV-2 is known to be a very contagious virus, compared to other beta coronaviruses. This is maybe because it has a stronger and well-stabilized attachment, as the S protein has 12 extra nucleotides. The virus also has a receptor-binding motif (RBM) which forms a larger binding interface and more contacts with its receptor, thus stronger attachment (Kumar et al., 2020). Moreover, the furin that assists in the activation of S protein is found abundantly in the body (Walls et al., 2020). This may cause infections of other various organs too, eventually leading to organ failure. Thus, the elderly are at a higher risk of more severe diseases as many have underlying chronic diseases and comorbidities that can cause the infection to be worse, eventually cause life.

#### ***COVID-19 Illness Progression and Elderly***

The COVID-19 disease progression can be divided into three stages whereby the first stage takes place within the two days of infection, while the infected person has no symptoms. However, the virus can be identified through the nasal swab. This is because the virus replicates in the epithelial cells of the nasal cavity. This also causes the virus to be transmitted to others. In the second stage, within five days after exposure until the fourteenth day, about 80% of infected individuals start having symptoms like fever, cough and sore throat. But, some may remain asymptomatic and this can be dangerous to the elderly as they are easily infected by these asymptomatic people (Mason, 2020). In the third stage, approximately 20% of infected patients, mostly elderly, can advance to a more severe critical stage that includes periods of hypoxia, pulmonary infiltrates, and progression to respiratory distress (World Health Organization (WHO), 2020). This is because the virus has spread to the alveoli and infected type-II pneumocytes. As a result, there can be diffuse alveolar damage that is worse in the elderly when a large number of replicated virus lead the infected pneumocytes to undergo apoptosis. This leads to bilateral pulmonary diffuse alveolar damage that may progress to acute respiratory distress syndrome (ARDS) (Jin et al., 2020; Xu et al., 2020). Subsequently, the uncontrolled viral infection can cause a life-threatening cytokine storm when there is a surge of systemic cytokines and chemokines in the serum (Giamarellos-Bourboulis et al., 2020; Jin et al., 2020). This severe inflammation results in further endothelial damage and activation of the coagulation cascade. As a result, disseminated intravascular coagulation and consumption of coagulation factors will lead to multi-organ failure and eventually death (Li et al., 2020). This pathophysiology can be worse in the elderly as they have chronic diseases and multiple comorbidities which may be uncontrolled and weakened age-related immune responses.

### ***COVID-19 Infection in Elderly and Effect of Weakened Immune Response***

The elderly particularly those with chronic diseases and comorbidities have an increased risk for infection (Bentlage et al., 2020). Moreover, as mentioned above, the elderly are prone to progress to a severe form of COVID-19 as a result of a cytokine storm that can cause death (Zhang et al., 2020). This is because of the combination of immunosenescence and chronic inflammatory conditions due to aging, known as inflammaging (Cunha et al., 2020).

As for immunosenescence, there is a decreased number and function of white cells like neutrophils and phagocytic cells, increased pro-inflammatory cytokines and decreased anti-inflammatory cytokines that results in inflammaging. This poor intrinsic immune response causes the absence of fever despite infection. In the early stage of infection, some elderly may also have an atypical presentation of viral infection like a low-grade fever, fatigue, unstable mobility, diarrhea, loss of appetite, and delirium (Guillen et al., 2020; Rui et al., 2020). Hence, this causes a delay in diagnosis and delayed management, eventually leading to intubation.

Progressively in the lung, the macrophages keep producing interleukin-6 (IL-6) (Canan et al., 2014), the activations of CD4 and CD8 T cells are inhibited and the integrity of the air-blood barrier in the alveoli is also impaired (Velazquez-Salinas et al., 2019). Also, immunosenescence causes reduced naïve T cells and a reduced number of regulatory T cells (Fessler et al., 2013). All this can lead to a relative immune-paralysis that will impair the clearance of SARS-Cov-2 from the lung (Giamarellos-Bourboulis et al., 2020). Thus, this fails in viral elimination due to impaired cytotoxic cell activation and antibody production (Thevarajan et al., 2020).

Other than due to immunosenescence, inflammaging of the elderly immune system is caused by many other factors. But the most harmful effect is, there is an exaggerated response that is inappropriate to stimuli (Canan et al., 2014) and the immune response will transform into a life-threatening cytokine storm (Meftahl et al., 2020). This is even worse when the SARS-CoV-2 virus itself causes an abnormal immune response where the pro-inflammatory cytokines and chemokines are hypersecreted leading to hyperinflammation and causing life-threatening conditions (Chen et al., 2020). Despite this, the SARS-CoV-2 virus itself may also infect T cells (Wang et al., 2020) and T cells become significantly decreased in infected patients further weakening the immune response (Zheng et al., 2020).

### ***Elderly and Exercise during COVID-19***

It is clear that the elderly have a higher risk of infectivity rate for COVID-19 and the risk of developing severe illness. Hence, they are advised to stay at home. But this leads to a progressive cycle as in Figure 1. At home, the elderly develop a sedentary lifestyle as they are unable to do exercise, which in the long run can cause an increased risk of chronic diseases, difficulty to control chronic diseases and a further increase in comorbidities. Moreover, exercise is also needed for their well-being, to prevent frailty, imbalance, and risk of falls. Not only that, exercise among the elderly would help to boost their cardiovascular, endocrine, metabolic and psychological health (Guest & Apgar, 2002).

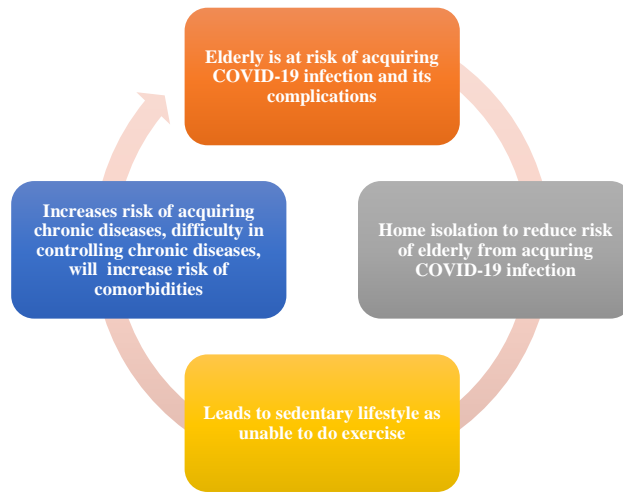


Figure 1: Progressive cycle of home isolation impact, the risk of COVID-19 infection and complications.

However, not all exercises are safe for the elderly. In recent literature, exercises that are presumed suitable for the elderly are those that include resistance, strength and balancing (Hartmann-Boyce et al., 2020). Some examples are light aerobics, Pilates, Yoga, Tai Chi and Qi Gong. Tai Chi was chosen for this review specifically because it is one of the most established exercises. This is because Tai Chi involves the mind and body that synchronize to improve balance, promote stability, decrease falls and improve psychological well-being (Marks, 2020). Originating in China, it is also used during self-defence, religious rituals, and as a form of relaxation. Among the elderly community, depression is among the common psychiatric conditions encountered. It can be contributed by many biopsychosocial factors especially due to a decline in physical functions, which leads to increased dependence on others, and low self-esteem, and lack of interpersonal relations, which is prominent during the time of home isolation (Boss & Seegmiller, 1981). Ample evidence has proven that adjunct physical activity especially Tai Chi may help in improving depression because it is a mind-body exercise (Cunha et al., 2020). It also has positive effects on anxiety and insomnia (Cunha et al., 2020; Wang et al., 2014). This is particularly important during this time of pandemic, to help the elderly feel more relaxed. Besides that, Tai Chi is a type of exercise that is feasible to be practiced indoors among the elderly, requiring almost zero props (Marks, 2020).

### ***Tai Chi is a Recommended Exercise among the Elderly during COVID-19***

The Centre for Disease Control and Prevention (CDC) has provided a guideline on exercise recommendations for healthy older adults. The recommendations are as below (CDC, 2021a);

- At least 150 minutes a week of moderate-intensity activity such as brisk walking
- At least 2 days a week of activities that strengthen muscles
- Activities to improve balance such as standing on one foot

According to the American College of Sports Medicine (ACSM), exercise intensity is classified as

in Table 1 below (American College of Sports Medicine, 1998).

Table 1: Classification of exercise intensity

Intensity	VO <sub>2</sub> R*(HRR**)	HR <sub>max</sub> ***	Time requirement
Low	40-49%	55-64%	>30min at least 3/week
Moderate	50-85%	65-76	>20mins
High	86-93%	77-93	>15mins

\* Percentage of maximum oxygen consumption

\*\*Maximum heart rate reserve

\*\*\*Percentage of maximum heart rate

Table 2: Maximum heart rate according to age

Ages	Beats per minute (bpm)
55 years	107.25-125.4
60 years	104-121.6
65 years	100.75-117.8
70 years	97.5-114

Tai Chi is performed in a semi-squat posture, which places a significant load on the lower extremities and exercising a large muscle group of the thigh. According to studies, there are various intensities of Tai Chi and they actually differ according to the styles, posture and speed. The slower the motion, the greater the load exerted; while the lower the posture, the greater strength is needed (Lan et al., 2008).

Among these styles, Yang, the classic style shows to be more intense compared to the simplified style. The mean heart rate that can be achieved with the former is up to 130 bpm in the 50 to 65 years old, and about 120 bpm in 66 to 80 years old (Lan et al., 1996). In comparison to the simplified Tai Chi, the mean heart rate achieved was only 104 bpm (Gong et al., 1981). Another study showed, 55.1±3.1% of HRR in male elderly (65-80 years old) and 50.3± 2.9% of HRR in female elderly. Meanwhile, the mean heart rate was 120±10 bpm in men and 115±12 bpm in women (Lan et al., 2004). Hence, these findings prove that Tai Chi is a mild to moderate-intensity exercise and it fulfils the criteria of exercises that help to develop and maintain cardiorespiratory fitness by ACSM (American College of Sports Medicine, 1998).

From the literature, the benefit of exercise is dose-dependent (American College of Sports Medicine, 1998). Low-intensity exercise is shown to provide a reduction in the risk for obesity and weight control, in certain chronic diseases such as coronary heart disease, hypertension, and in degenerative diseases including osteoporosis and improves metabolic fitness (American College of Sports Medicine, 1983, 1993, 1994, 1995). Metabolic fitness is the state of metabolic systems and variables predictive of the risk of diabetes and cardiovascular disease which can be positively modified by increasing physical activity or performing endurance exercise regularly without the requirement of a training-related increase in maximum oxygen consumption (Despres & Al, 1990).

Additionally, moderate to high-intensity exercise provides more benefits as mentioned previously, with further improvement in the maximum oxygen consumption, thus maximizing cardiorespiratory function. However, for those with chronic conditions like most elderly who are unfit to perform high intensity exercise, they should be physically active as much as they can. Some physical activity is better than none at all (2018 Physical Activity Guidelines Advisory Committee Scientific Report, 2018). Studies show that even shifting from a sedentary lifestyle to minimal physical activity already provides significant health benefits (American College of Sports Medicine, 1998). They can still practice Tai Chi by changing to a higher squat posture and shorten the training duration to reduce the intensity, especially considering that many elderly persons have osteoarthritis, and may not be able to do the true squatting posture.

### ***Role of Tai Chi as Primary and Secondary Prevention***

Tai Chi is generally a safe mild exercise that can be practiced by anyone regardless of age and fitness condition if it is done accordingly. It may be a method of primary prevention of diseases, as well as secondary prevention in adjunct with other measures like a healthy diet (Klein et al., 2019). Besides, it is also suggested as an adjunctive or supportive treatment and rehabilitation for certain diseases due to its proven efficacy and potentially positive effects (Taylor-Piliae & Haskell, 2007; Taylor-Piliae et al., 2010). Among those of which Tai Chi is encouraged, are in:

- People aged 50 years and above (Huang et al., 2016; Wang et al., 2020).
- Patients with chronic diseases such as hypertension (Ludvigsson, 2020), dyslipidaemia (Kunz, 2020), diabetes (Palmieri et al., 2020), coronary artery disease (Meftahl et al., 2020) and heart failure (Gu et al., 2017; Taylor-Piliae & Finley, 2020).
- Patients recovering from stroke (Lyu et al., 2018; Lyu et al., 2020) and chronic obstructive pulmonary disease (COPD) (Guo et al., 2020).
- Patients with degenerative diseases such as osteoarthritis (Hu et al., 2020; Zhang Y et al., 2017), osteoporosis (Zhang et al., 2019) and Parkinson disease (Klein et al., 2019).
- Patients with psychological conditions such as depression, anxiety (Cheng et al., n.d.; Lyu et al., 2020; Wayne et al., 2018), stress (Marks, 2020) and insomnia (Irwin et al., 2015).

However, the exact frequency and durations of intervention required to achieve the benefits are undetermined as there are wide variations between studies, and may differ according to the primary aim. Despite that, since it is a mild exercise, the authors suggest a minimum of 60 mins session for 5 times per week, for at least 12 weeks. We recommend the Yang style as it is being used in majority of the studies and it has been proven as moderate-intensity exercise (Lan et al., 2004; Lan et al., 2008).

### ***Health Benefits of Tai Chi among the Elderly***

In a survey conducted in the United States, most Tai Chi practitioners noted that they have reduced levels of stress (83%) and improved overall well-being and health (74%) (Guillen et al., 2020). This is likely because, from studies, Tai Chi is noted to have a positive impact not only in physical conditions but also in psychology, cognitive and immunology. The benefits of Tai Chi on the various systems in the body are described below.



### **1. Cardiovascular System**

Hypertension is a chronic disease that leads to cardiovascular diseases like atherosclerosis and stroke. By doing Tai Chi, the possibilities of developing heart attacks can be reduced by 21%, and strokes by 37%. One of the reasons is due to the effect of Tai Chi in reducing blood pressure (Dong et al., 2020). There can be an average reduction of 12 to 13 mmHg in systolic blood pressure (SBP) within 4 years of practice (Lee et al., 2010).

In another study, Tai Chi has been proven almost as effective as any other aerobic exercise in decreasing systolic and diastolic blood pressures. These are seen in healthy elderly with high normal blood pressure, in those with hypertension and patients who are recovering from acute myocardial infarction (Dong et al., 2020). Besides, patients with dyslipidemia also benefited from Tai Chi as it shows positive effects in reducing cholesterol, low-density lipoprotein (LDL), triglyceride (TG) and in increasing high-density lipoprotein (HDL) (Li et al., 2020; Wang et al., 2020; Xu et al., 2020).

High blood pressure, LDL, TG and cholesterol are among the modifiable risk factors of stroke. The reduction of these components has been demonstrated to reduce the chance of non-fatal stroke occurrence in healthy adults or patients with chronic diseases (Zheng et al., 2015). The changes can be seen especially when it is combined with other conventional treatments. On average, Tai Chi needs to be practiced at least 180 minutes weekly for 12 weeks (Romy et al., 2017; Pan et al., 2016).

In addition, Tai Chi can be used as a rehabilitation activity for cardiovascular patients (Yang et al., 2017). A study proved Tai Chi can be safely performed in stroke survivors within at least 3 months post-stroke period. They showed a reduced risk of death, improved functional disability, cognitive impairment and physical performance including balance, gait, speed and lower body strength (Lyu et al., 2020).

### **2. Musculoskeletal System**

Bone mass starts to decrease as people age. This is due to a relative increase in bone resorption over bone formation. In women, the process gradually starts as early as age 40 and abrupt loss occurs after menopause where the rate is faster than men. This causes osteoporosis to be more prominent in women, especially in the first 10 years of menopause, which is the fastest bone loss phase. Osteoporosis leads to a higher risk of fractures (Finkelstein et al., 2008). Studies showed that Tai Chi potentially has a positive effect in slowing the rate of bone loss in weight-bearing bones such as the lumbar spine, proximal femur and distal tibia (Zhang et al., 2019).

Muscle mass and strength decline with age due to loss of cells and atrophy is known as sarcopenia. It is one of the major factors of instability in the elderly that increases incidents of fall particularly when descending stairs (Hong et al., 2000; Sloane et al., 2019). Studies showed that elderly Tai Chi practitioners have better postural stability and balance (Huang, 2018). They can walk faster and have larger steps compared to non-practitioners of their age. This is probably because most Tai Chi steps are performed while maintaining a large step position and emphasizes lowering the centre of gravity (Huang, 2018). These train balance and strengthen lower limb muscles particularly the hip adductor and abductor (Li & Law, 2018).

Degenerative joint disease, known as osteoarthritis, is also common among the elderly. It can affect almost any joints, but most common in the weight-bearing joints. The pain and stiffness experienced would lead to slow gait and instability, which affects their daily life function. This may result in not

only physical distress but mental distress as well. Tai Chi is potentially beneficial in reducing pain, alleviating stiffness and physical function improvement in them (Hu et al., 2020; Zhang et al., 2017).

### **3. Neurological System**

Due to aging, our brain will undergo several neuroanatomical changes which include (Fjell & Walhovd, 2010):

- Cortical and subcortical shrinkage and expansion of the ventricular system.
- Grey matter reduction due to shrinkage of neurons, reduced number of synapses and length of myelinated axons.
- Reduction in specific cognitive abilities such as executive functions, memory and speed.

The anatomical changes can be observed within as short as one year period. There is a lack of pharmaceutical treatment that works in slowing down the age-related cognitive decline process. However, practicing regular exercises can be taken as an alternative measure as it has been proven to slow down the process (Zheng et al., 2015).

Tai Chi shows quite promising effects in the improvement of cognitive function in both cognitively healthy and impaired elderly. Studies showed it is as effective as other commonly suggested exercises such as aerobic and cognitive training (Yang et al., 2020). Moreover, it helps in reducing the relative risk of dementia by 28% among long-term (more than 5 years) Tai Chi practitioners (Wayne et al., 2014). In studies comparing those who practiced other aerobic exercises for 12 weeks to a year, with Tai Chi practitioners of the same period, revealed to have at least the same, or a greater total brain volume and better global cognitive function including executive function, attention, learning and memory (Fjell & Walhovd, 2010).

Tai Chi proves many prominent benefits when being compared to sedentary elderly (Pan et al., 2018; Wayne, Walsh, et al., 2014).

- The practitioners have thicker cortex in the left and right hemispheres.
- The practitioners have a more active brain. Among the active areas identified include the area between the medial prefrontal cortex and the medial temporal lobe, and between the bilateral hippocampus and medial prefrontal cortex, which represent an improvement in memory function.
- The practitioners become more alert and relaxed.
- In cognitively impaired elderly, there was a marked decline in rates of progression to dementia.

There are a few explanation on how Tai Chi affects the general well-being:

- It is considered an aerobic exercise because it has an intensity similar to brisk walking, which has been shown to have positive effects on cognitive function due to neurophysiological changes and better brain plasticity and function.
- Learning new skills and movement patterns will assist the patient to improve their memory and improve their learning process.
- Steps in Tai Chi involve the process of shifting and multitasking trained its practitioner's working memory, divided attention, cognitive flexibility and overall executive function.
- Meditative and relaxation components of Tai Chi helps in reducing anxiety and depression, which may affect cortisol and other stress-related pathways of cognitive decline.
- Greater time spent in leisure activities and social support has been associated with improved cognitive function.

#### **4. Psychology**

Depression, anxiety and insomnia are among the common psychiatric conditions encountered in the geriatric community. It can be contributed by many biopsychosocial factors especially due to a decline in physical functions which leads to increased dependence on others and low self-esteem, and lack of interpersonal relations (Boss & Seegmiller, 1981; Vink et al, 2008). Evidence proves that adjunct physical activity may help in improving depression, anxiety and insomnia especially Tai Chi because it is a mind-body exercise (F. Wang et al., 2014).

In most studies done in the elderly with and without diseases, there is an improvement of overall quality of life (Wang et al., 2020), depression, anxiety (Lyu et al., 2020; Zhang et al., 2019) and insomnia (Irwin et al., 2015; Lia et al., 2020) along with physical improvement. A study suggested that there is a low vagal activity in a depressed individual, which causes them to have flat facial expressions and limited vocal intonation. Therefore, Tai Chi, which is known to increase vagal activity, can counteract depression (Field et al., 2012).

#### **5. Immune System**

A systematic review showed that Tai Chi has a positive impact on immune system functioning and inflammatory responses (Oh et al., 2020). To achieve this, a minimum of 4 weeks of practicing Tai Chi is required to enhance their immune system and regulate biomarkers associated with inflammation. While more than 12 weeks are required to regulate the immune response by altering gene expression. There is a significant small rise in the levels of innate and adaptive immune cells. Enhancing the efficacy of the adaptive immune response may result in more effective pathogen clearance, appropriate generation of immunity upon vaccination and inhibiting inflammaging (Cunha et al., 2020).

While C - reactive protein (CRP) is generally reduced following the intervention, the cell-mediated inflammatory cytokines such as IL-6 and tumor necrosis factor- $\alpha$  (TNF- $\alpha$ ) undergoes both upregulation and downregulation, which also results in generally reduced inflammation (Oh et al., 2020). It was concluded that the influence of cytokines on the immune system occurs as a parallel process and that changes in one specific cytokine can be balanced by others within the cytokine system, leading to a modulation of the immune response (Ben-Sasson et al., 2009; Musolino et al., 2017).

These findings are consistent with the results of studies that examined exercise (Leandroa et al., 2020) and mind-body therapies induced immunoregulation (Gong et al., 1981; Lan et al., 2004). It suggested that regular moderate exercise by the elderly and those with chronic diseases (Simpso et al., 2020) helps to reduce pro-inflammatory cytokines (IL-6, TNF- $\alpha$ , and IL-1 $\beta$ ), increase natural killer (NK) cell and CD8 T cell cytotoxic activity, and enhance neutrophil function and B lymphocyte proliferation (Bigley et al., 2015; Peake et al., 2015; Sellami et al., 2018; Senna et al., 2015).

Whether or not individuals accustomed to practicing moderate-intensity exercise experience less serious complications associated with COVID-19 need further investigation. Yet, there is evidence of lower rates of acute respiratory infections incidence among those who exercise regularly and decreased mortality from pneumonia and influenza (Laddu, Lavie, Phillips, & Arenaa, 2020), (Simpson & Katsanis, 2020).

*Adverse Effects of Tai Chi*



Figure 2: Benefits of Tai Chi to the whole body

This literature review mainly focuses on studies of Tai Chi in the elderly that are healthy and with illness. However, no serious adverse effects were reported. Among complaints commonly received were minor musculoskeletal pain and aches, knee and joint pain, ankle sprain and low back pain, which may affect their quality of life (Wayne et al., 2014). It is most likely due to improper technique especially during squatting position (Wang et al., 2009). Thus, this incurs a high mechanical load to the knee and worsens pain especially in those with osteoarthritis. However, if the proper technique is applied, Tai Chi should not cause excessive stress to the knee joints even in a patient with knee arthritis (Li & Law, 2018; Li et al., 2018).

**4. Conclusion**

In conclusion, Tai Chi is generally suitable for everyone regardless of age and fitness level. However, as it is a low-impact exercise with mild to moderate intensity, the elderly can benefit from it more, as they may be unfit to perform other exercises with higher impact and intensity. Moreover, it is safe and can be done at home. Furthermore, it provides positive effects to the whole body, which helps to slow down aging-related symptoms and benefits in improving comorbidities. Nevertheless, Tai Chi requires training by a well-trained practitioner. For this, technology may play a role in educating these elderly via the internet, exercise videos, or media broadcasts. However, not many elderly are familiarized with the advent of technology. Thus, this may hinder them from accessing the Tai Chi programs, either for pre-recorded or live sessions. Therefore, this issue must be addressed appropriately and the elderly must be encouraged to practise a healthy lifestyle to achieve a good quality of life despite being confined to their homes at this time of daunting COVID-19. More rigorous studies are needed regarding the relationship between the elderly, Tai Chi and COVID-19.

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