The Positive Role of Tai Chi in Responding to the COVID-19 Pandemic

Suodi Xu 1, Julien S. Baker 2,∗ and Feng Ren 3,∗

Abstract: The ongoing coronavirus 2019 (COVID-19) pandemic has posed a significant threat to both people’s physical and mental health. Physical inactivity, sedentary behavior, and negative emotions among the general population have been significantly increased because of COVID-19 home confinement. These are major risk factors associated with higher incidences of morbidity and mortality. Therefore, effective exercise management should be proposed as a prevention strategy to improve both physical and mental health while diminishing the effects of COVID-19. Tai Chi as a low-to-moderate aerobic exercise combines physical and mental training and plays a positive impact on human health. Here we aim to outline the effects of Tai Chi on the immune system, inflammatory responses, pulmonary function, and emotional control. The benefits of Tai Chi practice for individuals coping with COVID-19 are stated here which include immune system promotion, inflammation response reduction, rehabilitation in respiratory diseases, and emotional improvement. This statement has been supported by available clinical, physiological, and biological research. As a result, we hope to introduce Tai Chi as an effective exercise intervention for people coping with COVID-19 and as a beneficial exercise for maintaining an active lifestyle during a pandemic.

Keywords: COVID-19; pandemic; Tai Chi; exercise intervention

1. Introduction

Due to the consistently growing number of confirmed cases during the ongoing pandemic, the World Health Organization (WHO) appealed to all member states to implement effective measurements to curb human-to-human transmission. In response, the global public health departments of governments and health authorities have imposed extensive measures trying to mitigate and counteract the spread of COVID-19. These measures have included nationwide lockdowns, home confinement, social distancing, and self-isolation [1]. An inevitable consequence of these regulations was to restrict social activities in relation to access to public areas, gyms, parks, sports grounds, outdoor playing areas and schools. In addition, non-essential services were also closed to slow down the spread of the disease [2]. However, these quarantine strategies have negatively affected the health of the general population and have resulted in a reduction of physical activity (PA) and contributed to a sedentary lifestyle. Indeed, current reports show that people of various ages have faced difficulties maintaining at least similar levels of PA during home confinement [3–6].

In a recent international cross-disciplinary online survey about the changes in PA levels related to “before” and “during” confinement conditions, responders from Asia, Africa, Europe, and others indicated that the quantity of PA significantly reduced during home confinement. Specifically, the time performing vigorous intensity PA decreased by 33.1% minutes/day, moderate intensity decreased by 33.4% minutes/day, walking decreased by 34% minutes/day and combined activity decreased by 33.5% minutes/day [7]. As
a result, daily sedentary time increased from 5 to 8 h per day due to reduced PA [7]. Importantly, both PA deficiency and sedentary behavior are associated with poor disease-related outcomes, such as an increase in the risk of the metabolic syndrome, type 2 diabetes, cardio-respiratory diseases, and some cancers [8–12].

Additionally, non-engagement in PA (failure to meet WHO PA recommendations) has been considered as an important risk factor for depressive symptoms developed during the confinement period. As a result, anxiety, frustration, depression, sleep disorders, and domestic violence have become quite common during home confinement with helpline numbers being overloaded [13,14]. In the international cross-disciplinary online survey conducted by Ammar et al., it was found that the COVID-19 home confinement period induced an adverse effect on mental health with a greater proportion of respondents suffering from psychosocial stress and emotional disorders. Previously, during the outbreak of “severe acute respiratory syndrome” (SARS), emotional and psychological issues in quarantined individuals have been a concern. It has been revealed that the individuals who experienced self-isolation suffered from more anxiety and tension [15,16]. Generally, lack of PA and mental health disorders are among the major risk factors associated with the incidence of morbidity and mortality [17,18]. As a result, effective home-based exercise programs should be proposed to improve people’s physiological health, mental health, and quality of life during home confinement. Here, we would recommend Tai Chi as a potential exercise intervention to improve people’s healthy lifestyle during a pandemic. Tai Chi is one of the Chinese martial arts consisting of light-to-moderate aerobic exercise combining both physical and mental training [19]. In fact, Tai Chi has been suggested as a feasible program for promoting active lifestyles during pandemics previously [20]. Here we will discuss the benefits of Tai Chi in coping with the ongoing pandemic in terms of immune system, inflammatory responses, lung function, and mental health.

2. The Benefits of Tai Chi on Human Health

The mindfulness and flexibility movements of Tai Chi which integrates multiple features has become a popular exercise around the world—the key features of Tai Chi are presented in Figure 1 [19]. Researchers indicate the significant value of Tai Chi in promoting physical health and benefits the practitioners with various positive health outcomes including muscular strength, aerobic capacity, balance and motor control, prevention of falls, mental health, sleep disorders, fatigue, body mass index, blood pressure, heart rate, etc. (Figure 1) [21]. Tai Chi is already prescribed in therapeutic programs for patients with neurological diseases (Parkinson’s disease, traumatic brain injury, multiple sclerosis), rheumatological disease (rheumatoid arthritis, ankylosing, spondylitis, fibromyalgia), orthopedic disease (osteoarthritis, osteoporosis, low-back pain, musculoskeletal disorder), cardiovascular disease (acute myocardial infarction, coronary artery bypass grafting, congestive heart failure), certain cancers, as well as a pulmonary disease [22].
Immune system function and inflammatory biomarker responses can be modulated by Tai Chi practice. Regarding the immune system, Tai Chi can increase the levels of immune cells in both innate immune systems and adaptive immune systems. Liu et al. observed a Tai Chi training group with 30 middle-aged participants who practiced Tai Chi for 6 months, four times a week, for 60 min. They found a significant increase in the percentage of natural killer (NK) and NKT cells compared with a control group. There was also T cell improvement, resulting in a higher level of Th1 immune responses and therefore potentially increased anti-viral function in humans [23]. In addition, a meta-analysis review of 19 studies based on the effects of Tai Chi and qigong (TQ) training on immune responses found similar results, concluding that TQ presented a significant small effect in enhancing the immune cell levels as well as inflammatory processes [24]. The positive effects of Tai Chi on immune response have also been confirmed in antibody levels following vaccination. Yang et al. suggested that the traditional TQ training could increase the antibody response [25].

Regarding the impacts of Tai Chi interventions on inflammation response, the levels of C-reactive protein reduced following Tai Chi training, which is a common diagnostic maker used to estimate systemic inflammation [26]. Additionally, the level of cell-mediated inflammatory cytokines (IL6, TNF-α) were generally reduced in a Tai Chi intervention group compared to the control group [27–29]. Indeed, cellular interactions in the inflam-
matory mediators, innate immune system, and adaptive immune system induce various aspects of acute and chronic inflammation in many organ diseases [30].

Clinically, COVID-19 is characterized by an overexuberant inflammatory response—it is a necessary response of the immune system to infection. The system then activates a coagulation reaction resulting in excessive production of proinflammatory cytokines (IL-6, IL-1β, and TNF-α) causing multiorgan injury, leading to acute respiratory distress syndrome [31,32]. The levels of inflammatory cytokines (IL6, TNF-α) can be reduced during Tai Chi practice which has been demonstrated in many randomized controlled trials. Based on these findings, Tai Chi can be recommended as an appropriate exercise intervention to reduce inflammation response, improve the immune system, and resist viral infections. In a recent clinical case report outlining the case of a patient diagnosed with mild symptoms of COVID-19, the doctor advised the patient to practice Tai Chi as a rehabilitation therapy when the patient was in recovery [33]. However, in future studies, a large randomized controlled trial is needed to confirm the prevention and improvement effects of Tai Chi on COVID-19 in humans.

4. Application of Tai Chi to Rehabilitation in Pulmonary Function

Tai Chi training as a pulmonary rehabilitation program has shown the positive effects on patients with chronic obstructive pulmonary disease (COPD) [34–39]. COPD is a disease characterized by restricted airflow due to abnormal airways and/or alveolar, accompanied by chronic symptoms such as dyspnea, cough, and sputum production [34]. Currently, Tai Chi practice has been considered as an effective exercise intervention to improve lung function in patients with COPD around the world [35,36]. Breathing techniques are very important during Tai Chi exercise which coordinates balance and strength training. The style of mind-body breathing as a component of Tai Chi provides lung function improvement for the COPD population. Lung capacity could be enhanced by this kind of breathing strategy which combines slow and deep breathing to encourage a complete exhalation [37–39]. Additionally, the strength of the respiratory muscles could also be increased using mind-body breathing [37].

Additionally, a Cochrane review has shown a positive impact of Tai Chi training on pulmonary function in people with COPD compared to conventional treatment and outlined four collected studies with 570 subjects presenting an improvement of FFV1 (forced expiratory flow volume in one second) and FVC (forced vital capacity) in post-program data [40]. Researchers have investigated the effects of long-term home-based Liuzijue exercise on COPD patients. Liuzijue is a low-moderate exercise similar to Tai Chi which has more focus on abdominal breathing and pursed lip breathing. Following 6 months of Liuzijue intervention, pulmonary function (FEV1/pred, FEV1/FVC) significantly improved in training individuals when compared with a control group [41]. It was suggested that a combination of Liuzijue exercise and clinical guidance can be used as a feasible and effective method to improve lung function, exercise capacity, as well as the quality of life in elderly patients with COPD.

5. Effects of Tai Chi Intervention on Negative Emotions (Anxiety and Depression)

Tai Chi emphasizes body-mental training that coordinates body-based exercise and mind-based practice. Body-based exercise focuses on body control with a state of musculoskeletal relaxation, whereas mind-based practice emphasizes the mental control of concentration in a mindfulness way [42–44]. Most studies have shown a preventive effect of Tai Chi training on reducing negative emotions, such as depression, anxiety, and sadness in many clinical studies [45–47]. Kimberly and colleagues conducted a 10-week pilot study in which they recruited 24 patients with a mean age of 52 years with varying levels of anxiety, as measured by the Hamilton Anxiety psychiatric rating scale. The authors were surprised to find that participants’ emotion improved dramatically, and anxiety reduced by 84% after attending a 10-week program of Tai Chi classes [48]. This strongly indicates that Tai Chi could be used as an effective method for reducing anxiety. Additionally, the
influence of Tai Chi on negative mental conditions in non-clinical populations by using meta-analysis has been investigated by Zhang et al. [49] Fourteen experimental studies were evaluated, and the results showed that the negative emotions in both young and old adults could be significantly improved by practicing Tai Chi. The authors suggested that Tai Chi can be used as an effective complementary non-pharmacological resource in coping with anxiety and depression. Researchers have also explored the motivations of Tai Chi training among 35 survivors who were infected with SARS-CoV-1 during the 2003 outbreak in Hong Kong; the study showed that almost all of the subjects obtained relief from their emotional suffering of psychological sequelae through Tai Chi training [50].

The positive effect of Tai Chi on improving negative emotions could be explained from several aspects. Firstly, the mindfulness function of Tai Chi, with an emphasis on attention control and self-awareness to improve meditative levels during Tai Chi training, may contribute to depression and anxiety reduction [51–53]. Secondly, the abdominal breathing function associated with Tai Chi practice may have an impact on heart rate variability. This can be improved by increasing breathing amplitude in combination with abdominal breathing patterns, which are used as a psychophysiological marker of the brain’s capacity to regulate emotional responses [54–56]. Thirdly, Tai Chi has a role in exercise-induced brain-derived neurotrophic factor. Tai Chi, as an aerobic exercise program of light-to-moderate intensity can increase the production of insulin-like growth factor and brain-derived neurotrophic factor which are neurobiological markers related to emotional regulation [57–60]. In general, the effects of Tai Chi on emotional improvement has been confirmed by some researchers, and it could be an effective method to improve mental health in both young and older adults during home confinement.

6. Conclusions

The available clinical and biological research supports that Tai Chi can be used as an effective exercise intervention to improve both physical and psychological health. Some of the benefits of Tai Chi practice for individuals coping with COVID-19 are outlined here. Benefits include immune system promotion, inflammation response reduction, rehabilitation in pulmonary function, and emotional improvement. These positive effects of Tai Chi on human health can be recommended as alternatives to counteract the negative effect of physical inactivity, sedentary behavior, and mental disorders on the general population during the confinement period. Furthermore, Tai Chi may be useful in achieving prevention, to treat the condition, and provide rehabilitation following COVID-19 infection. Additionally, Tai Chi is easy to practice and is safe to perform at home, in isolation, or in groups. It is suitable for the elderly, individuals with emotional disorders, and chronically ill populations. Future research is required to confirm the effectiveness of Tai Chi during the current pandemic and to provide more valid and reliable data on this topic.

Author Contributions: Conceptualization, S.X.; methodology, J.S.B. and F.R.; writing—original draft preparation, S.X.; writing—review and editing, J.S.B. All authors have read and agreed to the published version of the manuscript.

Funding: This research received no external funding.

Institutional Review Board Statement: Not applicable.

Informed Consent Statement: Not applicable.

Conflicts of Interest: The authors declare no conflict of interest.

References
1. Jiang, X.; Niu, Y.; Li, X.; Li, L.; Cai, W.; Chen, Y.; Wang, E. Is a 14-day quarantine period optimal for effectively controlling coronavirus disease 2019 (COVID-19)? MedRxiv 2020. [CrossRef]

2. Yılmazkaya, E.; Esentürk, O.K. Promoting physical activity for children with autism spectrum disorders during Coronavirus outbreak: Benefits, strategies, and examples. Int. J. Dev. Disabil. 2020. [CrossRef]
3. Ammar, A.; Brach, M.; Trabelsi, K.; Chtourou, H.; Boukhris, O.; Masmoudi, L.; Batatia, H. Effects of home confinement on mental health and lifestyle behaviours during the COVID-19 outbreak: Insights from the ECLB-COVID19 multicentre study. *Biol. Sport.* 2021, 38, 9–21. [CrossRef] [PubMed]

4. Bartling, E.; Ammar, A.; Trabelsi, K.; Chtourou, H.; Boukhris, O.; Masmoudi, L.; Hoekelmann, A. Depression, anxiety and stress during COVID-19: Associations with changes in physical activity, sleep, tobacco and alcohol use in Australian adults. *Int. J. Environ. Res. Public Health* 2020, 17, 4065. [CrossRef]

5. Qin, F.; Song, Y.; Nassis, G.P.; Zhao, L.; Cui, S.; Lai, L.; Zhao, J. Prevalence of insufficient physical activity, sedentary screen time and emotional well-being during the early days of the 2019 novel coronavirus (COVID-19) outbreak in China: A national cross-sectional study. *Preprints* 2020, 17, 5170. [CrossRef]

6. Stanton, R.; To, Q.G.; Khalesi, S.; Williams, S.L.; Alley, S.J.; Thwaite, T.L.; Vandelanotte, C. Depression, anxiety and stress during COVID-19: Associations with changes in physical activity, sleep, tobacco and alcohol use in Australian adults. *Int. J. Environ. Res. Public Health* 2020, 17, 4065. [CrossRef]

7. Ammar, A.; Trabelsi, K.; Brach, M.; Chtourou, H.; Boukhris, O.; Masmoudi, L.; Batatia, H. Effects of home confinement on mental health and lifestyle behaviours during the COVID-19 outbreak: Insights from the ECLB-COVID19 multicentre study. *Biol. Sport.* 2021, 38, 9–21. [CrossRef] [PubMed]

8. Buman, M.P.; Winkler, E.A.; Kurka, J.M.; Hekler, E.B.; Baldwin, C.M.; Owen, N.; Gardiner, P.A. Reallocation of time to sleep, sedentary behaviors, or active behaviors: Associations with cardiovascular disease risk biomarkers, NHANES 2005–2006. *Am. J. Epidemiol.* 2014, 179, 323–334. [CrossRef]

9. Chau, J.Y.; Grunseit, A.; Midthjell, K.; Holmen, J.; Holmen, T.L.; Bauman, A.E.; Van der Ploeg, H.P. Sedentary behaviour and risk of death from all-causes and cardiometabolic diseases in adults: Evidence from the HUNT3 population cohort. *Br. J. Sports Med.* 2015, 49, 737–742. [CrossRef]

10. Koster, A.; Caserotti, P.; Patel, K.V.; Matthews, C.E.; Berrigan, D.; Van Domelen, D.R.; Harris, T.B. Association of sedentary time with mortality independent of moderate to vigorous physical activity. *PLoS ONE* 2012, 7, e37696. [CrossRef] [PubMed]

11. Thorp, A.A.; Owen, N.; Neuhaus, M.; Dunstan, D.W. Sedentary behaviors and subsequent health outcomes in adults: A systematic review of longitudinal studies, 1996–2011. *Am. J. Prev. Med.* 2011, 41, 207–215. [CrossRef] [PubMed]

12. Wilmot, E.G.; Edwardsen, C.L.; Achana, F.A.; Davies, M.J.; Gorely, T.; Gray, L.J.; Biddle, S.J. Sedentary time in adults and the association with diabetes, cardiovascular disease and death: Systematic review and meta-analysis. *Diabetologia* 2012, 55, 2895–2905. [CrossRef]

13. Galea, S.; Merchant, R.M.; Lurie, N. The mental health consequences of COVID-19 and physical distancing: The need for prevention and early intervention. *JAMA Intern. Med.* 2020, 180, 817–818. [CrossRef]

14. Qiu, J.; Shen, B.; Zhao, M.; Wang, Z.; Xie, B.; Xu, Y. A nationwide survey of psychological distress among Chinese people in the COVID-19 epidemic: Implications and policy recommendations. *Gen. Psychiatry* 2020, 33, e100213. [CrossRef] [PubMed]

15. Hawryluck, L.; Gold, W.L.; Robinson, S.; Pogorski, S.; Galea, S.; Styra, R. SARS control and psychological effects of quarantine, Toronto, Canada. *Emerg. Infect. Dis.* 2004, 10, 120–1212. [CrossRef]

16. Reynolds, D.L.; Garay, J.R.; Deamond, S.L.; Moran, M.K.; Gold, W.; Styra, R. Understanding, compliance and psychological impact of the SARS quarantine experience. *Epidemiol. Infect.* 2008, 136, 997–1007. [CrossRef] [PubMed]

17. Bentlage, E.; Ammar, A.; How, D.; Ahmed, M.; Trabelsi, K.; Chtourou, H.; Brach, M. Practical recommendations for maintaining active lifestyle during the COVID-19 pandemic: A systematic literature review. *Int. J. Environ. Res. Public Health* 2020, 17, 6265. [CrossRef]

18. Wang, M.; Baker, J.S.; Quan, W.; Shen, S.; Fekete, G.; Gu, Y. A preventive role of exercise across the coronavirus 2 (SARS-CoV-2) pandemic. *Front. Physiol.* 2020, 11, 572718. [CrossRef]

19. Wayne, P.M.; Fuerst, M. The Harvard Medical School Guide to Tai Chi: 12 Weeks to a Healthy Body, Strong Heart, and Sharp Mind; Shambhala Publications: Boulder, CO, USA, 2013.

20. Polero, P.; Rebollo-Seco, C.; Adsuara, J.C.; Pérez-Gómez, J.; Rojo-Ramos, J.; Manzano-Redondo, F.; Carlos-Vivas, J. Physical activity recommendations during COVID-19: Narrative review. *Int. J. Environ. Res. Public Health* 2021, 18, 65. [CrossRef]

21. Easwaran, K.; Gopalasingam, Y.; Green, D.D.; Lach, V.; Melnyk, J.A.; Wan, C.; Bartlett, D.J. Effectiveness of Tai Chi for health promotion for adults with health conditions: A scoping review of meta-analyses. *Disabil. Rehabil.* 2020, 1–12. [CrossRef]

22. Lan, C.; Chen, S.Y.; Lai, J.S.; Wong, A.M.K. Tai Chi Chuan in medicine and health promotion. *Evid-Based Complalt.* 2013, 2013, 502131. [CrossRef]

23. Liu, J.; Chen, P.; Wang, R.; Yuan, Y.; Li, C. Effect of Tai Chi exercise on immune function in middle-aged and elderly women. *J. Sports Med. Doping Stud.* 2012, 2, 2161-0673. [CrossRef]

24. Oh, B.; Bae, K.; Lamoury, G.; Eade, T.; Boyle, F.; Corless, B.; Back, M. The effects of tai chi and qigong on immune responses: A systematic review and meta-analysis. *Medicina* 2020, 7, 39. [CrossRef]

25. Yang, Y.; Verkuilen, J.; Rosengren, K.S.; Mariani, R.A.; Reed, M.; Grubisich, S.A.; Woods, J.A. Effects of a Taiji and Qigong intervention on the antibody response to influenza vaccine in older adults. *Am. J. Chin. Med.* 2007, 35, 597–607. [CrossRef] [PubMed]

26. Oh, B.; Butow, P.N.; Mullan, B.A.; Clarke, S.J.; Beale, P.J.; Pavlakis, N.; Vardy, J. Effect of medical Qigong on cognitive function, quality of life, and a biomarker of inflammation in cancer patients: A randomized controlled trial. *Support Care Cancer* 2012, 20, 1235–1242. [CrossRef]
27. Campo, R.A.; Light, K.C.; O’Connor, K.; Nakamura, Y.; Lipschitz, D.; LaStayo, P.C.; Kinney, A.Y. Blood pressure, salivary cortisol, and inflammatory cytokine outcomes in senior female cancer survivors enrolled in a tai chi chih randomized controlled trial. J. Cancer Surviv. 2015, 9, 115–125. [CrossRef]

28. Irwin, M.R.; Olmstead, R.; Breen, E.C.; Wittarama, T.; Carrillo, C.; Sadeghi, N.; Cole, S. Cognitive behavioral therapy and tai chi reverse cellular and genomic markers of inflammation in late-life insomnia: A randomized controlled trial. Biol. Psychiatry 2015, 78, 721–729. [CrossRef] [PubMed]

29. Robins, J.L.; Elswick Jr, R.K.; Sturgill, J.; McCain, N.L. The effects of tai chi on cardiovascular risk in women. Am. J. Health Promot. 2016, 30, 613–622. [CrossRef]

30. Libby, P. Inflammatory mechanisms: The molecular basis of inflammation and disease. Natr. Rev. 2007, 65, S140–S146. [CrossRef]

31. Jose, R.J.; Manuel, A. COVID-19 cytokine storm: The interplay between inflammation and coagulation. Lancet Respir. Med. 2020, 8, 46–47. [CrossRef]

32. Stebbing, J.; Phelan, A.; Griffin, I.; Tucker, C.; Oechsle, O.; Smith, D.; Richardson, P. COVID-19: Combining antiviral and anti-inflammatory treatments. Lancet Infect. Dis. 2020, 20, 400–402. [CrossRef]

33. Zhang, L.; Li, C.; Zhou, Y.; Wang, B.; Zhang, J. Persistent viral shedding lasting over 60 days in a mild COVID-19 patient with ongoing positive SARS-CoV-2. Quant. Imaging Med. Surg. 2020, 10, 1141. [CrossRef]

34. Ratarasarn, K.; Kundu, A. Yoga and Tai Chi: A mind–body approach in managing respiratory symptoms in obstructive lung diseases. Curr. Opin. Pulm. Med. 2020, 26, 186–192. [CrossRef] [PubMed]

35. Leung, R.W.; McKeough, Z.J.; Alison, J.A. Tai Chi as a form of exercise training in people with chronic obstructive pulmonary disease. Expert Rev. Respir. Med. 2013, 7, 587–592. [CrossRef] [PubMed]

36. Moy, M.L.; Wayne, P.M.; Litrownik, D.; Beach, D.; Klings, E.S.; Davis, R.B.; Yeh, G.Y. Long-term Exercise After Pulmonary Rehabilitation (LEAP): Design and rationale of a randomized controlled trial of Tai Chi. Contemp. Clin. Trials. 2015, 45, 458–467. [CrossRef]

37. Jerath, R.; Edry, J.W.; Barnes, V.A.; Jerath, V. Physiology of long pranayamic breathing: Neural respiratory elements may provide a mechanism that explains how slow deep breathing shifts the autonomic nervous system. Med. Hypotheses 2006, 67, 566–571. [CrossRef] [PubMed]

38. Pal, G.K.; Velkumary, S. Effect of short-term practice of breathing exercises on autonomic functions in normal human volunteers. Indian J. Med. Res. 2004, 120, 115.

39. Peng, C.K.; Mietus, J.E.; Liu, Y.; Khalsa, G.; Douglas, P.S.; Benson, H.; Goldberger, A.L. Exaggerated heart rate oscillations during ongoing positive SARS-CoV-2. Quant. Imaging Med. Surg. 2020, 10, 1141. [CrossRef]

40. Ngai, S.P.; Jones, A.Y.; San Tam, W.W. Tai Chi for chronic obstructive pulmonary disease (COPD). Cochrane Database Syst. Rev. 2016, 6, 1–74. [CrossRef]

41. Li, P.; Liu, J.; Lu, Y.; Liu, X.; Wang, Z.; Wu, W. Effects of long-term home-based Liuzijue exercise combined with clinical guidance in elderly patients with chronic obstructive pulmonary disease. Clin. Interv. Aging. 2018, 13, 1391. [CrossRef]

42. Lan, C.; Chen, S.Y.; Lai, J.S. Relative exercise intensity of Tai Chi Chuan is similar in different ages and gender. Am. J. Chinese Med. 2004, 32, 151–160. [CrossRef]

43. Lu, X.; Hui-Chan, C.W.; Tsang, W.W. Tai Chi, arterial compliance, and muscle strength in older adults. Eur. J. Prev. Cardiol. 2013, 20, 613–619. [CrossRef] [PubMed]

44. Wang, C.; Bannuru, R.; Ramel, J.; Kupelnick, B.; Scott, T.; Schmid, C.H. Tai Chi on psychological well-being: Systematic review and meta-analysis. BMC Public Health. 2010, 10, 1–16. [CrossRef]

45. Wang, C.; Schmid, C.H.; Fielding, R.A.; Harvey, W.F.; Reid, K.F.; Price, L.L.; McAlindon, T. Effect of tai chi versus aerobic exercise for fibromyalgia: Comparative effectiveness randomized controlled trial. BJM 2018, 360, k851. [CrossRef]

46. Zhang, X.; Ni, X.; Chen, P. Study about the effects of different fitness sports on cognitive function and emotion of the aged. Cell Biochem. Biophys. 2014, 70, 1591–1596. [CrossRef] [PubMed]

47. Zheng, S.; Kim, C.; Lal, S.; Meier, P.; Sibbritt, D.; Zaslavsky, C. The Effects of Twelve Weeks of Tai Chi Practice on Anxiety in Stressed But Healthy People Compared to Exercise and Wait-List Groups–A Randomized Controlled Trial. J. Clin. Psychol. 2018, 74, 83–92. [CrossRef] [PubMed]

48. Hoffmann-Smith, K.A.; Ma, A.; Yeh, C.T.; DeGuire, N.L.; Smith, J.P. The effect of tai chi in reducing anxiety in an ambulatory population. J. Complement. Integr. Med. 2009, 6, 1–14. [CrossRef]

49. Zhang, S.; Zou, L.; Chen, L.Z.; Yao, Y.; Loprinzii, P.D.; Siu, P.M.; Wei, G.X. The Effect of Tai Chi Chuan on negative emotions in non-clinical populations: A meta-analysis and systematic review. Int. J. Environ. Res. Public Health 2019, 16, 3033. [CrossRef] [PubMed]

50. Siu, J.Y.M. Coping with future epidemics: Tai chi practice as an overarching strategy used by survivors of severe acute respiratory syndrome (SARS) in post-SARS Hong Kong. Health Expect. 2016, 19, 762–772. [CrossRef]

51. Goyal, M.; Singh, S.; Sibinga, E.M.; Gould, N.F.; Rowland-Seymour, A.; Sharma, R.; Haythornthwaite, J.A. Meditation programs for psychological stress and well-being: A systematic review and meta-analysis. JAMA Intern. Med. 2014, 174, 357–368. [CrossRef]

52. Stonerock, G.L.; Hoffman, B.M.; Smith, P.J.; Blumenthal, J.A. Exercise as treatment for anxiety: Systematic review and analysis. Ann. Behav. Med. 2015, 49, 542–556. [CrossRef]
53. Zou, L.; Yeung, A.; Quan, X.; Hui, S.S.C.; Hu, X.; Chan, J.S.; Wang, H. Mindfulness-based Baduanjin exercise for depression and anxiety in people with physical or mental illnesses: A systematic review and meta-analysis. *Int. J. Environ. Res. Public Health* 2018, 15, 321. [CrossRef]

54. Appelhans, B.M.; Luecken, L.J. Heart rate variability as an index of regulated emotional responding. *Rev. Gen. Psychol.* 2006, 10, 229–240. [CrossRef]

55. Mather, M.; Thayer, J.F. How heart rate variability affects emotion regulation brain networks. *Curr. Opin. Behav. Sci.* 2018, 19, 98–104. [CrossRef]

56. Wei, G.X.; Li, Y.F.; Yue, X.L.; Ma, X.; Chang, Y.K.; Yi, L.Y.; Zuo, X.N. Tai Chi Chuan modulates heart rate variability during abdominal breathing in elderly adults. *PsyCh J.* 2016, 5, 69–77. [CrossRef]

57. Chen, S.; Jiang, H.; Liu, Y.; Hou, Z.; Yue, Y.; Zhang, Y.; Yuan, Y. Combined serum levels of multiple proteins in tPA-BDNF pathway may aid the diagnosis of five mental disorders. *Sci. Rep.* 2017, 7, 1–9. [CrossRef] [PubMed]

58. Hosang, G.M.; Shiles, C.; Tansey, K.E.; McGuffin, P.; Uher, R. Interaction between stress and the BDNF Val66Met polymorphism in depression: A systematic review and meta-analysis. *BMC Med.* 2014, 12, 1–11. [CrossRef] [PubMed]

59. Sungkarat, S.; Boripuntakul, S.; Kumfu, S.; Lord, S.R.; Chattipakorn, N. Tai Chi improves cognition and plasma BDNF in older adults with mild cognitive impairment: A randomized controlled trial. *Neurorehabilit. Neural Repair.* 2018, 32, 142–149. [CrossRef]

60. Xianjian, C.; Datao, X. Effects of Tai Chi Chuan on the Physical and Mental Health of the Elderly: A Systematic Review. *Phys. Act. Health* 2021, 5, 21–27. [CrossRef]