UNIVERSITY OF CALIFORNIA SAN DIEGO

Randomized Controlled Trial: Examining the Effects of Body and Mind Exercise Tai-Chi on Depressive Mood Symptoms, Psychological Resilience, and C-Reactive Protein Levels in Older Adults with Hypertension

A thesis submitted in partial satisfaction of the requirements for the Master

of

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by

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The thesis of Rita Hedo is approved, and it is acceptable in quality and form for publication on microfilm and electronically:

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Chapter 2, in full, is original work of Hong lab that include unpublished material that is currently being prepared for publications. Drs. Hong and Redwine are the principal investigators and Ms. Hedo is the author of the thesis/manuscript and co-authored with Dr. Hong, Dr. Redwine, Dr. Kohn, Dr. Troyer, Dr. Pung, Ms. Wilson, and Ms. Gavrilla. Hedo, Rita Y.; Redwine, Laura.; Kohn, Jordan; Troyer, Emily; Pung, Meredith; Pruitt, Chris; Wilson, Kathleen; Ang, Gavrila; Hong, Suzi. “Randomized Controlled Trial: Examining the Effects of Body and Mind Exercise Tai Chi on Depressive Mood symptoms, Psychological Resilience, and C-Reactive Protein Levels in Older Adults with Hypertension.”

ABSTRACT OF THE THESIS

Effects of Tai Chi practice on Depressive Mood Symptoms, Psychological Resilience, and C-Reactive Protein Levels in Older Adults with Hypertension

by

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Non-pharmacological approaches such as behavioral interventions are shown to reduce depression symptoms in older adults. Interventions that boost mental health could be an effective therapy to protect against or reduce depressive symptoms and inflammation factors in older adults. Studies showed that mind-body behavioral intervention like Tai-Chi (TC) may act as a therapy to reduce psychological stress and modulate the inflammation process and immune system where it can produce anti-inflammatory effects. The objective of this study is to examine the effects of a TC intervention versus a Healthy-Aging Education (HAE) classes in hypertensive

older adults on depressive symptoms, resilience, and inflammation. Older adults (72.62 ± 7.09 years) were cluster-randomized to a 12-week TC intervention (N=102) or HAE classes (N=85). Baseline (V1) and post-intervention (V3) assessments included Beck Depression Inventory (BDI-II), Connor-Davidson Resilience Scale (CD-RISC), and inflammation level C-reactive protein (CRP). Linear mixed effects regression models were performed to examine if there was significant difference between the intervention group and comparison group. Post-hoc analysis was used to examine if TC and HAE classes had an independent effect on BDI-II, CD-RISC, and CRP levels from V1 to V3. The models were adjusted for age, sex, and class attendance. BDI-II scores decreased post-TC significantly (V1=7.41 ± 0.72; V3= 5.87 ± 0.86; Wald_F=11.794; p=0.001) and post- HAE classes (V1=6.73 ± 0.71; V3= 5.45 ± 0.64; Wald_F= 8.08; p=0.005). CD-RISC scores improved significantly post-TC intervention (V1=31.3 ± 6.25; V3= 33.5 ± 5.2; Wald_F= 14.691; P<0.001) and post HAE classes (V1= 32.20 ±5.99; V3= 33.10 ± 6.31; Wald_F=8.151; p=0.004). Plasma CRP levels remained unchanged post-TC intervention (V1= 5.40 ± 0.78; V3= 5.36 ± 0.90; Wald_F=0.072; p= 0.789), and post HAE (V1= 6.65 ± 0.90, V3= 6.12 ± 0.95; Wald_F=0.844; p=0.359).Therefore, when each group was examined independently, there was visit-by-visit group interaction at V3 in relation to V1 for BDI-II and CD-RISC, but not for CRP levels. However, when both groups were examined simultaneously, there were no significant interaction effect between the TC intervention and HAE comparison group from V1 to V3 for depressive mood symptoms (t= - 0.333; p=0.740), resilience (t= 0.585; p=0.559), and CRP levels (t= -0.573; p=0.637). It is possible that the 12-weeks of TC was not sufficient to observe significant improvement in the depressive mood symptoms, resilience, and CRP levels among the hypertensive older adults. Thus, future studies are needed to test this hypothesis.

Chapter 1: Background

Significant increase of aged population:

Due to effective public health measures and interventions, the world experienced a transition from a high fertility and mortality rate to a decreased fertility and delayed mortality. As a result of a decrease in fertility rates, the demographic transition in age distribution is predicted to shift to have more older adults than young adults in the next three decades. [1] The number of people aged ≥65 years is predicted to double from 703 million people in 2019 to 1.5 billion in 2050. The proportion is projected to increase to 16% by 2050 where there will be one in six people with an age of 65 or above worldwide. [2] In the United States, over 46 million people are older adults aged ≥65 years, and this number is expected to reach 98 million by 2060. [3] The reason behind this increase is the increase in life expectancy where people are expected to live longer for an average of additional 17 years. Besides the demographic transition in age, over time, an epidemiological transition was also observed where the cause of morbidity and mortality shifted from infectious diseases to chronic and degenerative diseases. [4] Therefore, epidemiological and demographical transitions together produce a new challenge to the public health.

Public health significance of hypertension and related conditions among aged population:

The prevalence of hypertension is greater among older adults, where 70% of elderly aged ≥65 years have high blood pressure which places elderly population at risk of experiencing psychological distress, dementia, falls, hip fractures, physical disability, and cardiovascular diseases (CVD).[5,6] One of the biological characteristics of aging, which is chronic low-grade inflammation and elevated cellular oxidative stress, is considered a contributor to age-related diseases, and studies have shown that they are associated with hypertension. [6]

Furthermore, according to the American Psychological Association, one of the critical health issues among older adults is depression. Depression is a common mood disorder that impacts the overall quality of life of older adults, as well as physical decline.[7] The prevalence of depression among older adults with hypertension is 8.4% which is considerably greater than the prevalence of depression among younger hypertensive adults which is 4.5%. [8]

Public Health Implementation:

While aging is a natural biological process, there are ways to mitigate aging-related health declines among older adults and avoid illnesses. As a response to the aforementioned issues older adults face, global health organizations developed comprehensive actionable plans to address healthy aging among the elderly as a public health priority. For example, the United Nations and the World Health Organization objectives include an emphasis on achieving healthy lives and promotion of well-being among older adults as a focus for research to improve health statistics in their 2030 Agenda for Sustainable Development Goals and Global Strategy and Action Plan on Ageing and Health, respectively.[2,4]

Behavioral and lifestyle interventions are one of the most common strategies used as a compliment to medical treatments, suggested to improve the mental and physical health of older adults.[9] For instance, previous studies illustrated the role of physical activities in improving the quality of life among older adults; however, given that older adults have restrictions or challenges to practice vigorous or strenuous physical activities, Tai Chi (TC) exercise is suggested as a mild therapeutic activity in the literature for this population as a potential non-pharmacological treatment for depression. TC is an internal martial art that has been practiced not only for defense training but also as mind-body exercise to promote health and wellness in traditional Chinese medicine for the past three hundred years. TC consists of a sequence of light,

gentle, slow, and focused mediative movements and stretches along with deep breathing that relax the mind and body. [10,11] Thus, TC is believed to regulate older adults' body, mind, and breath. [12,13] TC research has grown in the past four decades, and the findings indicate TC may be beneficial as a treatment for several clinical indications. [10] The literature has accumulated evidence with systematic reviews that show TC benefits for older adults include, a decreased risk of falls, and improved balance, osteoarthritis pain, Parkinson disease symptoms, and chronic obstructive pulmonary disease. In addition, it improved stroke rehabilitation in elderly with coronary artery diseases, [15-19] and improved cognitive capacity in older adults with dementia. [20,21] TC practice is not only proven to benefit the physical health but also for psychological health and well-being. Evidence shows that TC is associated with improvement in the severity of depression and mood disturbance. [14] However, we cannot make solid conclusions that TC can be used as a treatment for chronic conditions in older adults due to lack of a sufficient number of quantitative research studies and methodological limitations such as variation in study designs and control group selections.[16] Therefore, this research has been conducted to add to the literature the effect of TC intervention vs. Healthy-Aging Education classes (HAE) on physical and psychological well-being in hypertensive older adults. HAE group was used in this study as a comparison group or a standard of care to examine if TC was more effective at improving the outcomes.

References

1. Kinsella K, Velkoff VA. An Aging World: International Population Reports. Census . https://www.census.gov/prod/2001pubs/p95-01-1.pdf. Published November 2001. Accessed August 1, 2021.

2. World Population Ageing 2019. United Nations. https://www.un.org/en/development/desa/population/publications/pdf/ageing/WorldPopulationAgeing2019-Highlights.pdf. Published October 10, 2019. Accessed August 1, 2021.

3. Ageing and health. World Health Organization. https://www.who.int/news-room/fact-sheets/detail/ageing-and-health. Accessed August 1, 2021.

4. Public health and aging: Trends in aging --- United States and worldwide. Centers for Disease Control and Prevention. https://www.cdc.gov/mmwr/preview/mmwrhtml/mm5206a2.htm. Published February 14,2003. Accessed August 1, 2021.

5. Kokubo Y, Matsumoto C. Hypertension Is a Risk Factor for Several Types of Heart Disease: Review of Prospective Studies. *Adv Exp Med Biol*. 2017;956:419-426. doi:10.1007/5584_2016_99

6. Buford TW. Hypertension and aging. Ageing Research Reviews. https://www.sciencedirect.com/science/article/pii/S1568163716300071?casa_token=uJQcFWdrVJ0AAAAA%3AXk8JsWu4RWgROAP7ZwrFeX5ugSwo-N2-WIXSH-PEyUZFs4r-qWgTJB4r94swd0Um8pjp42keCiE. Published February 1, 2016. Accessed August 1, 2021.

7. Aging and depression. American Psychological Association. https://www.apa.org/topics/aging-end-life/depression. Accessed August 1, 2021.

8. Boima V, Tetteh J, Yorke E, et al. Older adults with hypertension have increased risk of depression compared to their YOUNGER counterparts: Evidence from the World Health Organization study of GLOBAL ageing and adult Health Wave 2 in Ghana. Journal of AffectiveDisorders. https://www.sciencedirect.com/science/article/pii/S016503272032629X. Published August 22, 2020. Accessed August 1, 2021.

9. Anderson NB. Behavioral health interventions: What works and why? Critical Perspectives on Racial and Ethnic Differences in Health in Late Life. https://www.ncbi.nlm.nih.gov/books/NBK25527/. Published January 1, 1970. Accessed August 1, 2021.

10. Hempel S, Taylor SL, Solloway MR, Miake-Lye IM, Beroes JM, Shanman R, et al *Evidence map of tai chi.* Los Angeles, CA*:* Evidence-based Synthesis Program Center*;* 2014.

11. Wayne PM, Kaptchuk TJ. Challenges inherent to t'ai chi research: part I--t'ai chi as a complex multicomponent intervention. *J Altern Complement Med*. 2008;14(1):95-102. doi:10.1089/acm.2007.7170a
12. Larkey L, Jahnke R, Etnier J, Gonzalez J. Meditative movement as a category of exercise: Implications for research. *Journal of Physical Activity & Health.* 2009;6:230–238.

13. Jahnke R. *The Healing Promise of Qi: Creating Extraordinary Wellness through Qigong and Tai Chi.* Chicago, Il: Contemporary Books; 2002.

14. Li F, Harmer P, Fisher KJ, et al. Tai chi and fall reductions in older adults: A randomized controlled trial. *J Gerontol A Biol Sci Med Sci.* 2005;60A:187–194.

15. Hart J, Kanner H, Gilboa-Mayo R, Haroeh-Peer O, Rozenthul-Sorokin N, Eldar R. Tai chi chuan practice in community-dwelling persons after stroke. *International Journal of Rehabilitation Research.* 2004;27:303–4.

16. Hass CJ, Gregor RJ, Waddell DE, et al. The influence of tai chi training on the center of pressure trajectory during gait initiation in older adults. *Arch Phys Med Rehabil.* 2004;85:1593–1598.

17. World Health Organization. *Active ageing: A policy framework.* 2002.

18. Irwin MR, Pike JL, Cole JC, Oxman MN. Effects of a behavioral intervention, tai chi chih, on varicella-zoster virus specific immunity and health functioning in older adults. *Psychosomatic Medicine.* 2003;65:824–30.

19. Lee LYK, Lee DTF, Woo J. Effect of tai chi on state self-esteem and health-related quality of life in older Chinese residential care home residents. *Journal of Clinical Nursing.* 2007;16:15802.

20. Gatts SK, Woollacott MH. Neural mechanisms underlying balance improvement with short term tai chi training. *Aging-Clinical & Experimental Research.* 2006;18:719.

21. Gemmell C, Leathem JM. A study investigating the effects of tai chi chuan: Individuals with traumatic brain injury compared to controls. *Brain Injury.* 2006;20:151–156.

Chapter 2: Manuscript

Introduction

The prevalence of clinically depressed patients is eight to 16% among older adults.[1] Depression disproportionally puts older adults at risk of cognitive and physical decline.[2] It increases the risk of cognitive impairment, disability, mortality, and negatively affect the quality of life in older adults.[1] Epidemiological studies found that older adults with hypertension (HTN) have twice the prevalence of depression compared to younger adults.[3] A systematic review and meta-analysis showed that one-third of patients with hypertension have depressive mood symptoms.[4] In addition, older adults with HTN are more likely to develop depression.[5-9] Patients living with HTN and depression have a greater risk of mortality compared to patients living without comorbidity.[10,11]

As older adults age, they become susceptible to inflammation, namely 'inflammageing'. The term inflammageing is described in the literature as an elevation in blood inflammatory markers that increases susceptibility to chronic morbidity, disability, and death.[27] The high levels of systematic inflammation are identified by elevated levels of blood inflammatory markers such as interleukin (IL-6) and C-reactive protein (CRP). As a result, older adults with prolonged inflammation may lead to depression if they are genetically vulnerable by presence of single nucleotide polymorphism in cytokine genes, lack of social support, adverse life events, suffer from central obesity, increased gut permeability, or chronic infection.[27,28] Clinical trials indicate that inflammageing is a risk factor for CVD and the association is predicted to be causal.[27]

In addition, previous studies show an association between depression and inflammation.[12] In patients with cardiovascular diseases, depression is shown to be associated

with elevated inflammatory markers.[13,14] Patients who developed acute depression were shown to have higher concentration of circulating C-reactive protein (CRP) and inflammatory cytokines interleukin 6 (IL-6) at baseline than patients who did not develop depression.[16-19] This suggests that inflammation might be the cause rather than the consequences of depression.[20-23] Studies also suggest that patients with depression who fail to respond to antidepressant may have increased inflammation.[14] A relationship was found between failed antidepressant treatment trials and inflammation biomarkers where CRP elevated levels have been associated with depression and HTN. [14] It is documented that one in four patients with depression exhibit CRP levels of greater than 3 mg/L. [24] Thus, older adults with HTN who have elevated depressive symptoms may be at greater risk of inflammatory diseases such as cognitive disfunction and cardiovascular diseases.

Since exposure to psychological stress may activate the inflammatory response, positive psychological traits such as resilience may act as a protective factor against the effects of psychological stressful events on inflammatory responses. Resilience is defined by the American Psychological Association as the capacity to adapt well to life challenges and adversity. Therefore, one's resilience may confer protection against depressive symptoms experienced by elderly individuals. Also, resilience may reduce inflammation through reducing the impact of psychological stress and in turn, decrease depressive mood symptoms. [24] Non-pharmacological approaches such as behavioral interventions are shown to reduce depression symptoms in older adults. [25-26] Interventions that boost resilience may be effective therapies to protect against or reduce depressive mood symptoms and inflammation factors in older adults. Studies showed that mind-body behavioral interventions like TC may act as a therapy to reduce psychological stress and modulate the inflammation process and immune system to produce anti-inflammatory

effects. This modulation could decrease depressive mood symptoms by regulating emotions and modifying the autonomic nervous system. [29,30] However, more quantitative research is needed to draw a definite conclusion that TC reduces depressive mood symptoms, and improves resilience, and inflammation. Therefore, the objective of this study was to determine whether depressive mood symptoms decreased among participants post-TC practice and HAE classes compared to their levels at baseline, and whether the magnitude of change differed between the two groups. Healthy-Aging Education (HAE) group was used in this study as a comparison group or a standard of care to examine if TC was more effective at improving the outcomes.

Methods

Study Design and Procedures

This study is a secondary analysis of a two-armed randomized controlled trial and with a cluster randomization design. Groups from the same geographical region were randomized to either receive TC intervention or HAE classes. A computer-generated randomization algorithm assigned community sites (e.g., senior centers), to host the TC intervention or Healthy Aging Education (HAE) classes. Participants were recruited to attend the intervention and HAE classes, and they were not told which group they would be assigned to until their baseline assessment visit. Participants were blinded to the hypothesis and the recruiter was blinded to participants' group assignment. The parent study was conducted to examine the effects of TC intervention compared to the HAE control/comparison condition on hemodynamic, autonomic regulation, vascular function, inflammatory factors, and psychological functioning among older adults. The TC group was assigned to a 12-week, one-hour, twice weekly instructor-led TC classes. The control group was assigned to 12-weeks, two-hours weekly, HAE classes where healthy aging-related topics, videos, and lectures were presented and discussed in a group setting. TC sessions

were provided by a trained TC instructor, and HAE classes were delivered by a trained research associate utilizing lectures from the University of California San Diego (UCSD) Stein Institute for Clinical Research on Aging. Baseline data were obtained from the participants before the start of the TC intervention and HAE classes (coded as visit 1), evaluated in the middle of TC intervention and HAE classes (visit 2) and post-intervention (visit 3), then followed-up every three months after the intervention visits 4, 5, 6 respectively. Visit 1 corresponds with the baseline assessments while Visit 3 corresponds with the post-TC intervention and HAE classes assessments. This study focuses on examining the change pre- and post-TC intervention, and the HAE group was used in the analysis as a comparison group. The follow-up measurements that are about three-months apart are included in the graphs for just to give an overview trend across the visits. Furthermore, participants were financially compensated up to $250 for the entire study. All participants provided written informed consent understanding and agreeing to participate in our study based on documents approved by the University of California, San Diego Institutional Review Board.

Sample-Size and Power Calculation

Previous TC studies reported a wide range of effect size of 0.79 to 6.0 for TC class impact on lowering blood pressure. A sample size of 85 was determined as needed in each arm for 80% power (alpha 0.05) with 20% dropout rate, using a cluster randomization design, 12 participants were included in each cluster. 187 completed the baseline visit where the intervention arm had 102 participants and the control arm had 85 participants.

Study Setting and Sample

Participants were recruited between January 2016 and March 2021 from San Diego, California local communities. Our study sample was recruited from a variety of zip codes to have

a diverse population from different ethnic backgrounds and socioeconomic status. Recruitment method was based on posting flyers at local libraries and posting electronic versions on the Nextdoor website, a social media website largely utilized by older adults. TC intervention and HAE classes were delivered at the community recreation centers and residential independent living facilities of San Diego. TC was taught by a TC instructor and HAE classes were delivered by a health educator. Study inclusion criteria included: 1) older adults who are between age of 60 to 90 years with systolic blood pressure of 135 to 160 and/or diastolic blood pressure of 90 to 100; 2) Participant's ability to perform mild to moderate exercise; 3) Participant's ability to give written informed consent; 4) Participant's ability to commit to the study and comply with the protocol. Study exclusion criteria included: 1) Participants currently engaging in a regular moderate to vigorous physical activity, yoga, or mediation programs; 2) Participants who performed TC in the previous year; 3) Participants who had recent stroke or cerebral neurological impairment; 4) Participants who were using mood stabilizers or antipsychotics at the start of the study; 5) Participants who were taking steroids medication or any medication that affects immune status at the start of the study; 6) Participants who were diagnosed with bipolar, schizophrenia, or other neurological disorders; 8) Participants who were identified as suicidal; 9) Participants who were unable to give a written informed consent in English. Participants who agreed to be randomized to either TC or HAE classes were further screened to determine their eligibility and randomly assigned to either TC or HAE classes. All the testing took place at UCSD Medical Center.

Outcome Measures

Beck Depression Inventory-II (BDI-II): a 21-item self-report multiple choice inventory was used to measure clinical depressive mood symptoms among study participants. BDI-II is

widely used clinically to detect the severity of depression. Patients who score 0-13 are considered to have minimal depressive symptoms, a score of 14-19 is considered mild, a score of 20-28 is considered moderate, and a score of 29-63 is considered severe. This measure is considered a reliable and valid measure to capture depressive mood symptoms for older adults.[7]

Connor Davidson Resilience Scale (CD-RISC): a 10-item self-report was used to measure participants' resilience ability to thrive in the face of adversity and bounce back from it. Adversity can be a traumatic events or experiences. In other words, it is participants' ability to cope with stress and unpleasant events. Reliability and validity of this scale is well documented for older adults. [8] Each item is rated on a five-point Likert scale (0-4) where a score of zero represents not at all, and a score of four represents almost all the time. For each of the 10-items, a score was given from 0-4 per item; the score was calculated by taking the sum of each response of the 10-items. The higher the score the greater the resilience. [8]

Inflammation: To determine the level of inflammation, a non-fasting blood-draw was obtained from the participants in the morning (8 – 10 AM) to examine CRP levels; CRP has been used widely as a standard and reliable measure of low-grad inflammation worldwide. [15] The samples were assayed using reagents by a lab technician who was blinded to participant identifiers.

Statistical Analysis

Descriptive statistics were used to compare the demographic characteristics of our study sample based on the intervention and comparison groups randomization. BDI-II score of 13 was used as a cut-off point to classify the study participants into two groups; patients with minimal depressive symptoms (BDI-II score <13) and patients with mild, moderate, severe symptoms (BDI-II score $\geq$13), to describe and compare age, gender, SBP, and BMI based on depressive

mood to characterize older adults in relation to depressive mood symptoms. Independ samples t-test was used to test the statistical significance differences in the mean values of BDI-II, CD-RISC, and CRP.

To examine the intervention effects (V1 to V3) between the TC intervention and HAE comparison group, linear mixed-effects effects models were primarily used to determine if the mean score changed from pre-to-post TC intervention for BDI-II scores, CD-RISC scores, and CRP levels. Models were adjusted for age, gender, and class attendance. Attendance was calculated counting the proportion of everyone's visits throughout the six visits. Visit was modeled as a categorical variable and visit-by-group interaction was included in all the mixed effects models. Moreover, post-hoc analysis was performed to assess visit-to-visit differences within TC group and HAE comparison group. Log-transformation was used for BDI-II, CD-RISC, and CRP variables to reduce skewness in the data and ensure that the data is approximately normally distributed. Furthermore, Box-Cox transformation was also used for CD-RISC variable with lambda of 2.4 considered as the optimal value to reduce skewness in the data. Analysis was completed using R programming (version 3.6.3).

Results

The CONSORT diagram describes the recruitment and retention process (*figure 1*). Initially, 597 individuals responded to study recruitment, and they were assessed for eligibility. 406 individuals were excluded from the study while 191 met the study eligibility criteria. There were 4 participants who could or did not continue after the baseline study visit. Therefore, 187 participants were randomized to TC (N=102) and HAE (N=85) at baseline (visit 1), and 168 participants were followed-up after the intervention (visit 3). Nineteen participants were lost to follow-up or missed the post-intervention visit due to illness.

Table 1 provides the demographic characteristics of the study participants. The mean age of older adults was 72.62 ± 7.09 years. Seventy-two percent of the sample size were female and approximately 28% were males. *Table 2* shows the sociodemographic characteristics and outcome measures of this study. Twenty-seven percent of males reported minimal depressive mood symptoms and 37% reported mild, moderate, or severe depressive mood symptoms. Age was a significant factor where people who were younger had greater depressive mood symptoms compared to the older patients in this study sample with a p-value of 0.004 (t-statistic 3.030). Those with higher depression scores had lower resilience scores on the CD-RISC than those with lower depression scores (p-value <0.001, t-statistic 5.850) at baseline. Moreover, 77% of study sample reported a mean score of 4.92. Clinically, this score is classified as having minimal depressive mood symptoms, while 23% of the sample reported having mild-moderate depressive mood symptoms. Moreover, CRP levels at baseline among this study population indicated a high level of inflammation that was greater than 3mg/L. The mean level of CRP for patients with minimum depressive mood symptoms (BDI-II score <13) was 6.14 ± 7.82 and for people with mild depressive mood symptoms (BDI-II score >= 13) 5.96 ± 6.54. However, CRP-RD did not show statistical significance at baseline between the two BDI groups (P-value 0.904, t-statistic 0.121).

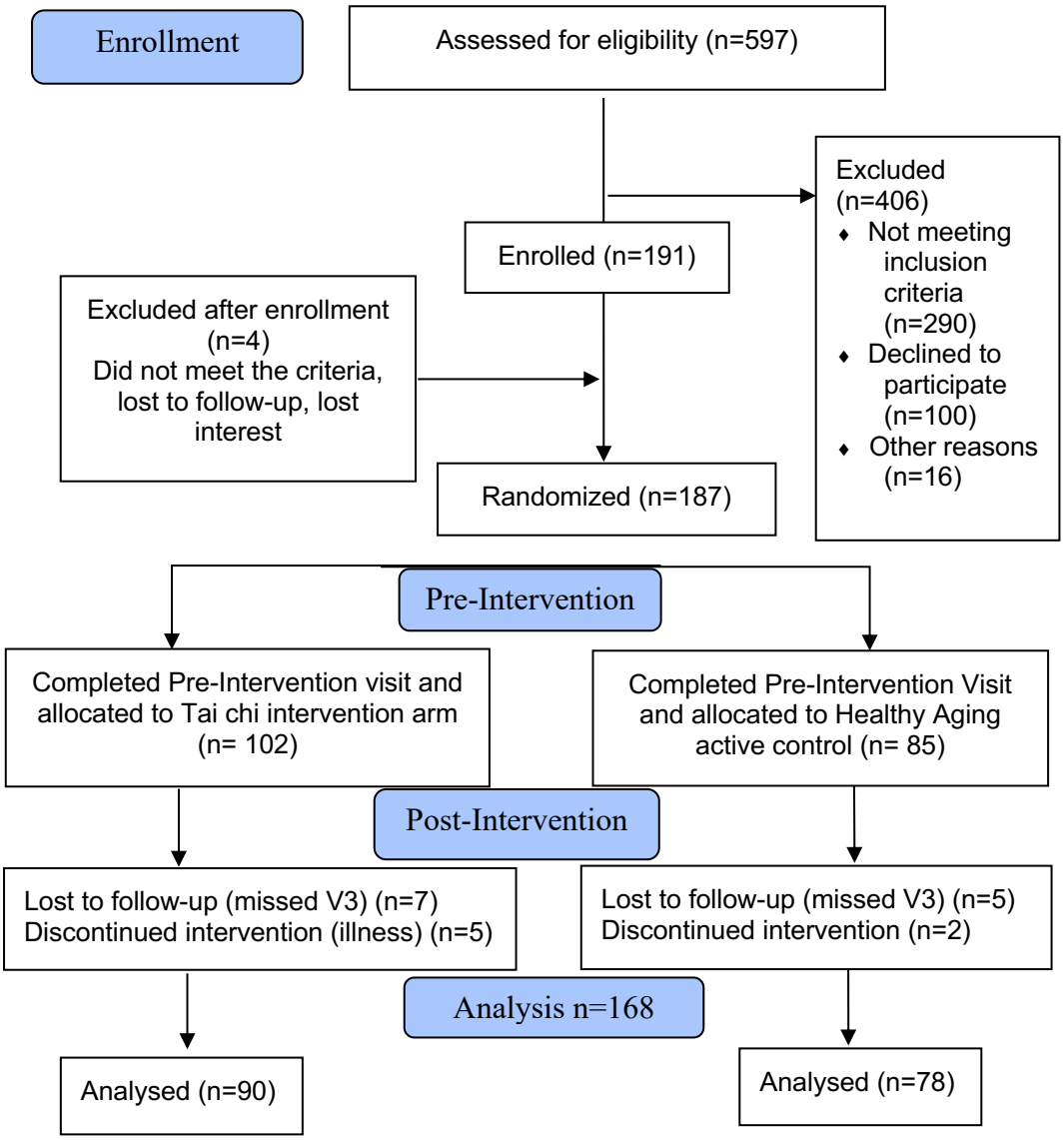

Figure 1: CONSORT Diagram

Table 1: Demographic characteristics of study participants at baseline (N=187)

Variables	Mean (SD)	HAE	TC	t-statistics/x-squared	P-Value
Age in years	72.62 (7.09)	73.21 (7.80)	72.16 (7.93)	0.91	0.363
Male %	27.66%	30.95%	25.49%	0.438	0.508
Systolic BP	136.36 (19.14)	136.83 (21.04)	136.09 (17.73)	0.236	0.814
CD-RISC	31.77 (6.12)	32.19 (5.99)	31.33 (6.25)	0.921	0.358
CRP-RD mg/l	6.01 (7.54)	6.65 (7.98)	5.40 (7.09)	1.047	0.297
BMI kg/m^2	29.39 (6.40)	28.84(6.05)	29.86 (6.76)	-1.04	0.299

Table 2: Sociodemographic characteristics and outcome measures of study participants at baseline (N=187)

Variables	Mean (SD)	BDI-II <13 (SD)	BDI >=13 (SD)	t-statistics/x-squared	P-Value
Age in years	72.62 (7.09)	73.07 (7.41)	68.54 (7.09)	3.030	0.0044*
Male %	27.66 %	27.59%	37.04%	0.929	0.446
Systolic BP	136.36 (19.14)	135.57 (18.58)	140.35 (22.83)	-0.950	0.35
CD-RISC	31.77 (6.12)	32.76 (5.79)	26.44 (5.03)	5.850	< 0.001**
CRP-RD mg/l	6.01 (7.54)	6.14 (7.82)	5.96 (6.54)	0.121	0.9042
BMI kg/m^2	29.39 (6.40)	29.31 (6.40)	30.41(6.56)	-0.801	0.428

Outcome measures:

Table 3 shows the mean scores of BDI-II, CRP, and CD-RISC among the study participants during from pre-to-post intervention in the TC and HAE groups. TC group participants reported a decrease in depressive mood symptoms from pre-to post-intervention (7.41 ± 0.72 to 5.87 ± 0.86); in addition, there was a decrease in the HAE comparison group (6.73 ± 0.71 to 5.45 ± 0.64). TC group participants also reported an increase in CD-RISC scores from pre- to post-intervention (31.3 ± 6.25 to 33.5 ± 5.26). HAE group pre to post also increased (32.20 ±5.99 to 33.10 ± 6.31). However, the mean level of CRP remained the same from pre-to post in the intervention (5.40 ± 0.78 to 5.36 ± 0.90); the same trend is observed for the HAE comparison group (6.65 ± 0.90 to 6.12 ± 0.95).

Table 3: Mean changes in the score of primary and secondary outcomes

	BDI-II Mean (SD)		CD-RISC Mean (SD)		CRP Level Mean (SD)	
Visits	TC	HAE	TC	HAE	TC	HAE
Visit 1	7.41 (0.72)	6.73 (0.71)	31.3 (6.25)	32.2 (5.99)	5.40 (0.78)	6.65 (0.90)
Visit 3	5.87 (0.86)	5.45 (0.64)	33.5 (5.26)	33.1 (6.31)	5.36 (0.90)	6.12 (0.95)

Primary outcome: depressive mood symptoms

Figure 2 illustrate the mean change in depressive mood symptoms from pre-to-post TC intervention in comparison to the HAE group. *Table 4* shows the effects of TC intervention and the comparison group HAE from visit 1 to visit 3. The mean score of depressive mood symptoms among the TC intervention group, after the intervention (visit 3), improved significantly (Wald_F= 11.794, p=0.001). In addition, the mean score of depressive mood symptoms improved significantly among the HAE group (Wald_F=8.08; p=0.005). Therefore, TC and HAE groups showed significant improvement in depressive mood symptoms from pre-to-post intervention and HAE classes when examined independently. However, when we compared the TC intervention group to the HAE group using the linear mixed effect model, we observed no significant interaction effect between the two groups from pre-to-post when the mean score of BDI-II of both groups were compared together (*table 5*). There was no significant change in the mean score of BDI-II between the TC intervention group and HAE comparison group (t= -0.333; p=0.740).

Table 4: Visit-by-visit mean change between two groups for depressive mood symptoms

	Estimate	Std. Error	df	Wald_F	Pr(>|W|)
visit3 vs. visit1 (ref) for TC	-0.298	0.087	542.237	11.794	0.001
visit3 vs. visit1 (ref) for HAE	-0.257	0.090	538.36	8.080	0.005

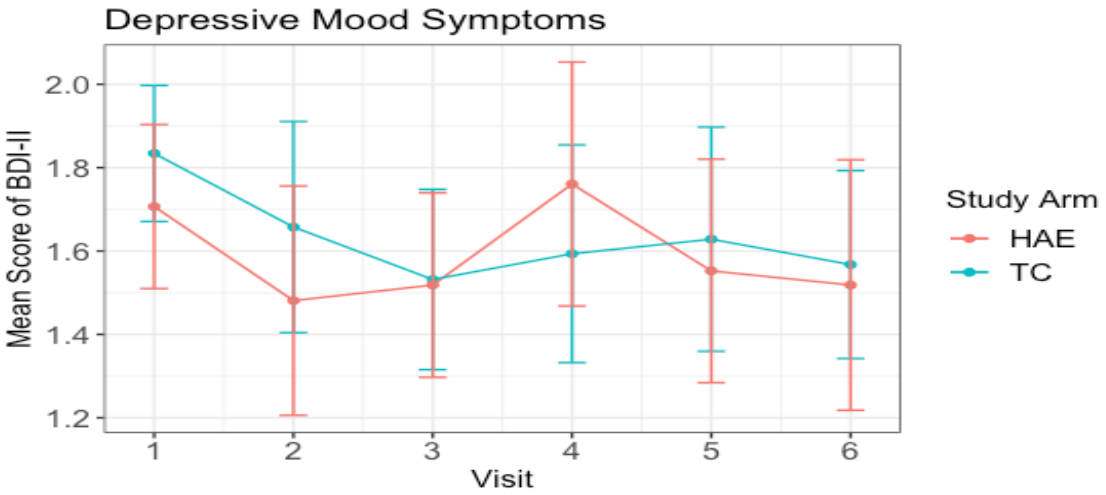

Figure 2: Log-transformation mean changes in depressive mood symptoms (I bar indicate 95% confidence intervals)

Table 5: Linear mixed effects model comparing means between the two groups for depressive mood symptoms

N= 168	Estimate	Std. Error	df	t-statistics	Pr(>|t|)
(Intercept)	1.404	0.672	165.507	2.09	0.038
study_arm1 (reference)	0.115	0.151	246.166	0.764	0.445
HAE: visit3	-0.257	0.09	538.36	-2.843	0.005
Class Attendance	-0.369	0.219	200.509	-1.685	0.094
Age	0.009	0.009	161.975	1.106	0.271
Gender	-0.064	0.145	160.337	-0.440	0.660
TC: visit3	**-0.042**	**0.125**	**542.237**	**-0.333**	**0.740**

Secondary outcomes: psychological resilience

Figure 3 illustrates the log transformation mean change in psychological resilience from pre-to-post TC intervention in comparison to the HAE group. *Table 6* shows the effects of TC intervention and HAE by visit. *Table 6* shows that the mean score of psychological resilience improved significantly for the group who received the TC intervention, after the intervention (visit 3), (Wald_F= 14.691, $p<0.001$), and significant improvement in the comparison group HAE (Wald_F= 8.151, $p=0.004$). Thus, when we examined both groups independently, there was a significant improvement in the psychological resilience from visit 1 to visit 3 in both

groups. When we compared the TC intervention group to the HAE group using the linear mixed effect model, we observed no significant interaction effect between the two groups from pre-to-post when the mean score of CD-RISC of both groups compared together (*table 7*). There was no significant change in the mean score of CD-RISC between the TC and HAE groups (t= 0.585; p=0.559).

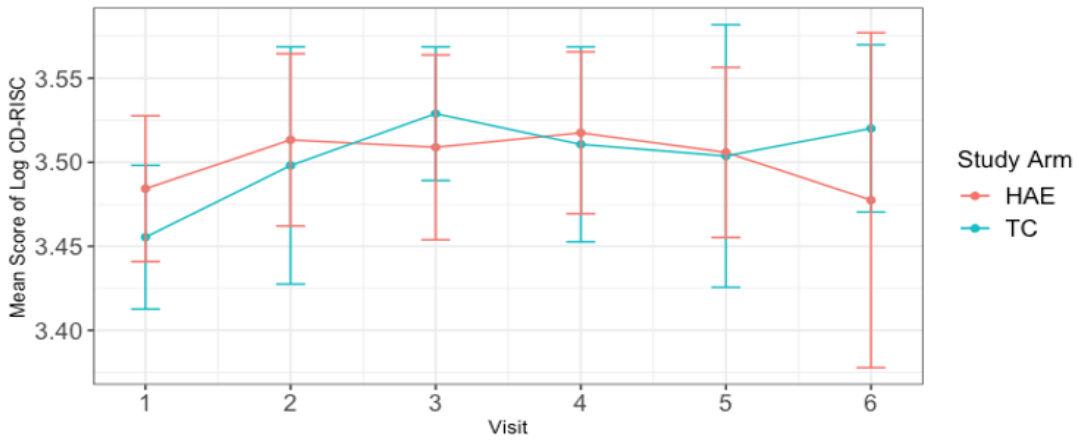

Figure 3: Log transformation mean changes in psychological resilience (I bar indicate 95% confidence intervals)

Table 6: Visit-by-visit mean change between two groups for psychological resilience

	Estimate	Std.err	df	Wald_F	Pr(>|W|)
visit3 vs. visit1 (ref) for TC	244.135	63.695	536.613	14.691	< 0.001
visit3 vs. visit1 (ref) for HAE	190.365	66.676	532.529	8.151	0.004

Table 7: Linear mixed effects model comparing means between the two groups for psychological resilience

	Estimate	Std. Error	df	t-statistics	Pr(>|t|)
(Intercept)	1710.636	528.384	163.834	3.237	0.001
study_arm1	-75.234	120.15	229.432	-0.626	0.532
HAE: visit3	190.365	66.676	532.529	2.855	0.004
Class Attendance	370.42	178.39	194.113	2.076	0.039
Age	-2.681	7.061	160.736	-0.38	0.705
Gender	30.617	117.768	161.447	0.26	0.795
TC: visit3	**53.77**	**91.935**	**536.613**	**0.585**	**0.559**

Furthermore, *Figure 4* illustrate the mean change in CRP levels from pre-to-post TC intervention in comparison to the HAE group. *Table 8* shows the effects of TC intervention and the comparison group HAE from visit 1 to visit 3. The mean score of CRP levels among the TC intervention group, after the intervention (visit 3), did not improve significantly (Wald_F= 0.072, p=0.789) as well as among the HAE comparison group (Wald_F=0.844; p=0.359). Thus, TC and HAE groups showed no significant improvement in inflammatory marker CRP from pre-to-post intervention and HAE classes when examined independently. Even when we compared the TC intervention group to the HAE group using the linear mixed effect model, we observed no significant interaction effect between the two groups from pre-to-post when the mean score of CRP levels in both groups were compared together (*table 9*). There was no significant change in the mean score of CRP levels between the TC intervention group and HAE comparison group (t= - 0.473; p=0.637).

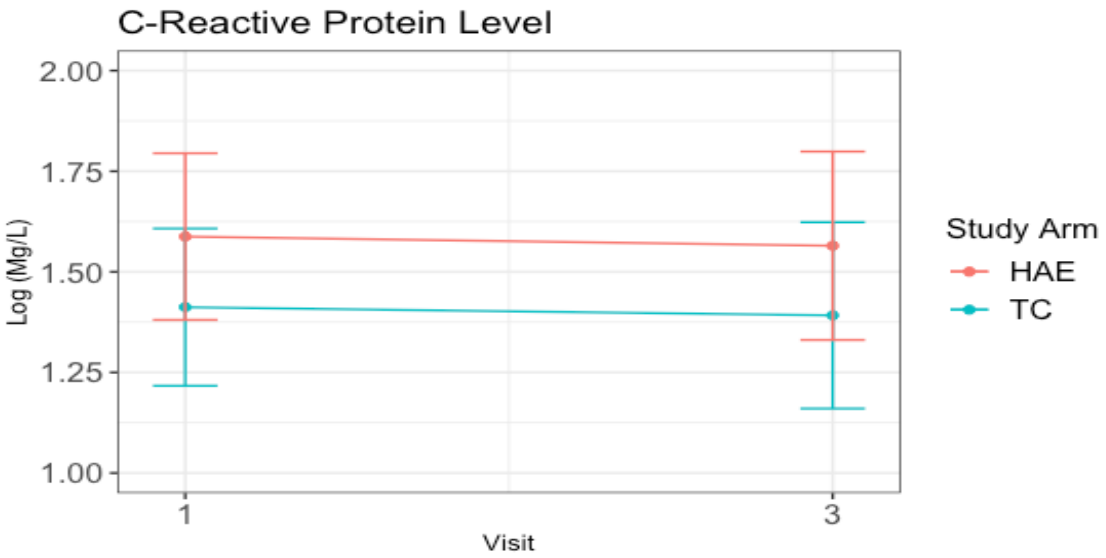

Figure 4: Log-transformation mean changes in CRP Level (I bar indicate 95% confidence intervals)

Table 8: Visit-by-visit mean change between two groups for CRP levels

	Estimate	Std. Error	df	Wald_F	Pr(>|W|)
visit3 vs. visit1 (ref) for HAE	0.020	0.022	530.742	0.844	0.359
visit3 vs. visit1 (ref) for TC	0.011	0.040	537.882	0.072	0.789

Table 9: Linear mixed effects model comparing means between the two groups for CRP levels

	Estimate	Std. Error	df	t-statistics	Pr(>|t|)
(Intercept)	0.924	0.71	156.357	1.302	0.195
study_arm1	-0.178	0.148	193.511	-1.2	0.231
HAE: visit3	0.003	0.095	124.638	0.032	0.974
Class Attendance	0.103	0.225	176.919	0.459	0.647
age	0.002	0.009	154.524	0.188	0.851
gender	0.279	0.148	154.192	1.88	0.062
TC: visit 3	**-0.062**	**0.13**	**125.476**	**-0.473**	**0.637**

Discussion

Both TC intervention group and HAE comparison group showed significant improvements in depression symptoms and psychological resilience scores pre-to post-

intervention when examined independently. However, the effects of TC and HAE groups did not differ from each other on depression symptoms, resilience, and CRP when compared. Moreover, plasma CRP levels did not change pre-to-post TC intervention or HAE classes.

While it is not entirely clear why the effects of the TC intervention did not differ from those of the HAE on depressive mood symptoms and resilience, there are several possibilities. It is possible that the depressive symptom reducing and resilience promoting effects of TC practice could be mainly due to general improvements in emotional health from participating in a group-based health class that are not specific to TC. It is also, possible that the 12-weeks of TC is not sufficient to observe such 'TC-specific' benefits above and beyond general improvements from participating in a group health class that is also achieved by HAE. Future studies could therefore, employ a longer duration of TC practice and/or addition of a wait-list control condition to further clarify the contributing factors. There was one study showed that multiple mild-moderate exercises of TC for 16-weeks could help reduce depressive mood symptoms in heart failure patients.[32] Lack of differences between groups could also be related to social cohesion in a group setting where study participants in both TC and HAE collaborated with one another to preform class activities. This finding aligns with previous studies that showed social cohesion activities among older adults improved their mental health overall. [34-37]

Absence of changes in plasma CRP levels pre to post TC intervention or HAE classes agrees with a previous study that reported that short-term TC practice (< 6 months) did not result in significant effects especially on the biological level whereas significant improvements are observed likely after a longer-term such as 12 months of practice. [30,31] Thus, the duration and frequency of TC play a major factor in altering the inflammatory markers.

Strengths and limitations

This study had methodological limitations; this study was a secondary analysis of hypertensive study patients with minimum to mild depressive mood symptoms, which may have reduced the interventions' efficacy, compared with if participants had higher depression scores. Thus, the findings from this study may not be applicable to clinically depressed patients. In addition, gender distribution of males and females was not even, as a greater portion of the study participants were women, but this may be more reflective of the gender distribution of the general elderly population. Despite these limitations, the randomized and controlled design of this study is considered as one of the strengths of this study since it was a community-dwelling randomized control trial, and it included the geriatric population with diverse backgrounds.

Future directions

Longer-duration randomized control trails may be required to inform clinical decisions, as these kinds of studies take time to observe improvements. Thus, to advance this knowledge, future studies should examine the intensity and frequency of TC classes on depression, resilience, and inflammation for both men and women with larger sample size to draw a solid conclusion.

Conflict of Interest

The authors declare that they have no conflicts of interest.

Authors Contribution

Drs. Hong and Redwine designed the study and guided the author throughout the study. Dr. Tu and Mr. Wu guided the author through the statistical analysis and interpretation. Hedo drafted the manuscript. The co-authors managed and coordinated the study.

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References

1. Blazer DG. Depression in late life: review and commentary. *J Gerontol A Biol Sci Med Sci*. 2003;58(3):249-265. doi:10.1093/gerona/58.3.m249.

2. Xue J, Chen S, Bogner HR, Tang W, Li L, Conwell Y. The prevalence of depressive symptoms among older patients with hypertension in rural China. *Int J Geriatr Psychiatry*. 2017;32(12):1411-1417. doi:10.1002/gps.4628.

3. Boima V, Tetteh J, Yorke E, et al. Older adults with hypertension have increased risk of depression compared to their younger counterparts: Evidence from the World Health Organization study of Global Ageing and Adult Health Wave 2 in Ghana. https://www.sciencedirect.com/science/article/pii/S016503272032629X. Published August 22, 2020. Accessed December 19, 2020.

4. Li Z, Li Y, Chen L, Chen P, Hu Y. Prevalence of Depression in Patients With Hypertension: A Systematic Review and Meta-Analysis [published correction appears in Medicine (Baltimore). 2018 Jun;97(22):e11059]. *Medicine (Baltimore)*. 2015;94(31):e1317. doi:10.1097/MD.0000000000001317.

5. Davidson K, Jonas BS, Dixon KE, Markovitz JH. Do depression symptoms predict early hypertension incidence in young adults in the CARDIA study? Coronary Artery Risk Development in Young Adults. Arch Intern Med. 2000 May 22;160(10):1495-500. doi: 10.1001/archinte.160.10.1495. PMID: 10826464.

6. Jonas BS, Franks P, Ingram DD. Are symptoms of anxiety and depression risk factors for hypertension? Longitudinal evidence from the National Health and Nutrition Examination Survey I Epidemiologic Follow-up Study. *Arch Fam Med*. 1997;6(1):43-49. doi:10.1001/archfami.6.1.43.

7. Markovitz JH, Matthews KA, Kannel WB, Cobb JL, D'Agostino RB. Psychological predictors of hypertension in the Framingham Study. Is there tension in hypertension?. *JAMA*. 1993;270(20):2439-2443.

8. Meurs M, Groenewold NA, Roest AM, et al. The associations of depression and hypertension with brain volumes: Independent or interactive?. *Neuroimage Clin*. 2015;8:79-86. Published 2015 Mar 28. doi:10.1016/j.nicl.2015.03.020.

9. Ong KL, Cheung BM, Man YB, Lau CP, Lam KS. Prevalence, awareness, treatment, and control of hypertension among United States adults 1999-2004. *Hypertension*. 2007;49(1):69-75. doi:10.1161/01.HYP.0000252676.46043.18

10. Hajjar I, Kotchen JM, Kotchen TA. Hypertension: trends in prevalence, incidence, and control. *Annu Rev Public Health*. 2006;27:465-490.doi:10.1146/annurev.publhealth.27.021405.102132.

11. Kayano H, Koba S, Matsui T, et al. Impact of depression on masked hypertension and variability in home blood pressure in treated hypertensive patients. *Hypertens Res*. 2015;38(11):751-757. doi:10.1038/hr.2015.75.

12. Goldsmith DR, Rapaport MH, Miller BJ. A meta-analysis of blood cytokine network alterations in psychiatric patients: comparisons between schizophrenia, bipolar disorder and depression. *Mol Psychiatry*. 2016;21(12):1696-1709. doi:10.1038/mp.2016.3.

13. Ridker PM. Clinical application of C-reactive protein for cardiovascular disease detection and prevention. *Circulation*. 2003;107(3):363-369. doi:10.1161/01.cir.0000053730.47739.3c.

14. Haroon E, Daguanno AW, Woolwine BJ, et al. Antidepressant treatment resistance is associated with increased inflammatory markers in patients with major depressive disorder. *Psychoneuroendocrinology*. 2018;95:43-49. doi:10.1016/j.psyneuen.2018.05.026.

15. Fernandes BS, Steiner J, Bernstein HG, et al. C-reactive protein is increased in schizophrenia but is not altered by antipsychotics: meta-analysis and implications. *Mol Psychiatry*. 2016;21(4):554-564. doi:10.1038/mp.2015.87.

16. Howren MB, Lamkin DM, Suls J. Associations of depression with C-reactive protein, IL-1, and IL-6: a meta-analysis. *Psychosom Med*. 2009;71(2):171-186. doi:10.1097/PSY.0b013e3181907c1b.

17. Dowlati Y, Herrmann N, Swardfager W, et al. A meta-analysis of cytokines in major depression. *Biol Psychiatry*. 2010;67(5):446-457. doi:10.1016/j.biopsych.2009.09.033.

18. Haapakoski R, Mathieu J, Ebmeier KP, Alenius H, Kivimäki M. Cumulative meta-analysis of interleukins 6 and 1β, tumour necrosis factor α and C-reactive protein in patients with major depressive disorder. *Brain Behav Immun*. 2015;49:206-215. doi:10.1016/j.bbi.2015.06.001.

19. Goldsmith DR, Rapaport MH, Miller BJ. A meta-analysis of blood cytokine network alterations in psychiatric patients: comparisons between schizophrenia, bipolar disorder and depression. *Mol Psychiatry*. 2016;21(12):1696-1709. doi:10.1038/mp.2016.3.

20. Gimeno D, Kivimäki M, Brunner EJ, et al. Associations of C-reactive protein and interleukin-6 with cognitive symptoms of depression: 12-year follow-up of the Whitehall II study. *Psychol Med*. 2009;39(3):413-423. doi:10.1017/S0033291708003723.

21. Wium-Andersen MK, Ørsted DD, Nielsen SF, Nordestgaard BG. Elevated C-reactive protein levels, psychological distress, and depression in 73, 131 individuals. *JAMA Psychiatry*. 2013;70(2):176-184. doi:10.1001/2013.jamapsychiatry.102.

22. Khandaker GM, Pearson RM, Zammit S, Lewis G, Jones PB. Association of serum interleukin 6 and C-reactive protein in childhood with depression and psychosis in young adult life: a population-based longitudinal study. *JAMA Psychiatry*. 2014;71(10):1121-1128. doi:10.1001/jamapsychiatry.2014.1332.

23. Zalli A, Jovanova O, Hoogendijk WJ, Tiemeier H, Carvalho LA. Low-grade inflammation predicts persistence of depressive symptoms. *Psychopharmacology (Berl)*. 2016;233(9):1669-1678. doi:10.1007/s00213-015-3919-9.

24. Osimo EF, Baxter LJ, Lewis G, Jones PB, Khandaker GM. Prevalence of low-grade inflammation in depression: a systematic review and meta-analysis of CRP levels. *Psychol Med*. 2019;49(12):1958-1970. doi:10.1017/S0033291719001454.

25. Holvast F, Massoudi B, Oude Voshaar RC, Verhaak PFM. Non-pharmacological treatment for depressed older patients in primary care: A systematic review and meta-analysis. *PLoS One*. 2017;12(9):e0184666. Published 2017 Sep 22. doi:10.1371/journal.pone.0184666.

26. Apóstolo J, Bobrowicz-Campos E, Rodrigues M, Castro I, Cardoso D. The effectiveness of non-pharmacological interventions in older adults with depressive disorders: A systematic review. *Int J Nurs Stud*. 2016;58:59-70. doi:10.1016/j.ijnurstu.2016.02.006.

27. Dantzer R, Cohen S, Russo SJ, Dinan TG. Resilience and immunity. *Brain Behav Immun*. 2018;74:28-42. doi:10.1016/j.bbi.2018.08.010.

28. Ferrucci L, Fabbri E. Inflammageing: chronic inflammation in ageing, cardiovascular disease, and frailty. *Nat Rev Cardiol*. 2018;15(9):505-522. doi:10.1038/s41569-018-0064-2.

29. Miller AH, Raison CL. The role of inflammation in depression: from evolutionary imperative to modern treatment target. *Nat Rev Immunol*. 2016;16(1):22-34. doi:10.1038/nri.2015.5.

30. Bower JE, Irwin MR. Mind-body therapies and control of inflammatory biology: a descriptive review. *Brain Behav Immun* (2016) 51:1–11. doi: 10.1016/j.bbi.2015.06.012.

31. Morgan N, Irwin MR, Chung M, Wang C. The effects of mind-body therapies on the immune system: meta-analysis. *PLoS One* (2014) 9(7):e100903. doi: 10.1371/journal.pone.0100903.

32. Redwine LS, Wilson K, Pung MA, et al. A Randomized Study Examining the Effects of Mild-to-Moderate Group Exercises on Cardiovascular, Physical, and Psychological Well-being in Patients With Heart Failure. *J Cardiopulm Rehabil Prev*. 2019;39(6):403-408. doi:10.1097/HCR.0000000000000430.

33. Song QH, Xu RM, Shen GQ, et al. Influence of Tai Chi exercise cycle on the senile respiratory and cardiovascular circulatory function. *Int J Clin Exp Med*. 2014;7(3):770-774. Published 2014 Mar 15.

34. Olamijuwon EO, Odimegwu CO, De Wet N. Social cohesion and self-rated health among adults in South Africa: The moderating role of race. *Health Place*. 2018;51:89-96. doi:10.1016/j.healthplace.2018.02.010.

35. Cramm JM, Nieboer AP. Relationships between frailty, neighborhood security, social cohesion and sense of belonging among community-dwelling older people. *Geriatr Gerontol Int*. 2013;13(3):759-763. doi:10.1111/j.1447-0594.2012.00967.

36. Kim ES, Kawachi I. Perceived Neighborhood Social Cohesion and Preventive Healthcare Use. *Am J Prev Med*. 2017;53(2):e35-e40. doi:10.1016/j.amepre.2017.01.007.

37. Hajdeja Iglič, Jesper Rözer, Beate G.M. Volker. (2021) Economic crisis and social capital in European societies: the role of politics in understanding short-term changes in social capital. *European Societies* 23:2, pages 195-231.

Chapter 3: Conclusion

In conclusion, as the burden of mental and physical illnesses is increasing among our rapid aging population, there is evidence to suggest that TC practice decreases the burden of depressive mood symptoms and improve resilience. However, there is no clear standards on the frequency and duration of the exercise that would be recommended to see an improvement in the level of CRP, resilience, and depressive mood symptoms.

Many studies observed that TC practice have positive effects in improving depressive mood symptoms. Therefore, we suggest that TC can be advised to older adults, as it is proven to be safe and effective exercise that leads to psychological benefits. Given the fact that an instructor-guided TC practice is costly [1], and access to it frequently might be challenging for older adults with low socioeconomic status, making such healthy lifestyle and non-pharmacological interventions accessible to older adults through funded community programs, peer-led group exercises or coverage through their health insurance would be impactful for public health.

References

1. Jahnke R, Larkey L, Rogers C, Etnier J, Lin F. A comprehensive review of health benefits of qigong and tai chi. *Am J Health Promot*. 2010;24(6):e1-e25. doi:10.4278/ajhp.081013-LIT-248.