GDANSK UNIVERSITY
OF PHYSICAL EDUCATION AND SPORT

Keqiang Li

The effects of Baduanjin Exercise as a single intervention and combined with Er-Xian Decoction on physical and mental health

supervisor:
dr hab. Mariusz Lipowski, prof. AWFiS
assistant supervisor:
dr Tamara Walczak-Kozłowska

Gdańsk 2023

Akademia Wychowania Fizycznego i Sportu
im. Jędrzeja Śniadeckiego w Gdańsku

Keqiang Li

Wpływ ćwiczeń Baduaniin jako pojedynczej interwencji i w połączeniu z wywarami Er-Xian na zdrowie fizyczne i psychiczne

promotor:
dr hab. Mariusz Lipowski, prof. AWFiS
promotor pomocniczy:
dr Tamara Walczak-Kozłowska

Gdańsk 2023

TABLE OF CONTENT

Letter of thanks

First, I would like to thank my supervisor, professor dr hab. Mariusz Lipowski & dr Tamara Walczak-Kozłowska for enabling my scientific development, motivation and invaluable help. Especially I learned a lot from them about how to treat my family and my academic attitude.

Secondly, I would like to thank my beloved parents for their great faith, love and support.

Finally, I would also like to thank the family, friends and all those who contributed to the creation of this work.

I dedicate the work to Mom

LIST OF WORKS CONSTITUTING A DOCTORAL DISSERTATION

The presented doctoral dissertation entitled: "*The effects of Baduanjin Exercise as a single intervention and combined with Er-Xian Decoction on physical and mental health*", consists of a series of three papers published in foreign journals with a total Impact Factor (IF) score of 5.134 and they are all listed on the Ministry of Education and Science (MEiN):

Paper 1:
Li, K., Walczak-Kozłowska, T., Lipowski, M., Li, J., Krokosz, D., Su, Y., Yu, H., & Fan, H. (2022). The effect of the Baduanjin exercise on COVID-19-related anxiety, psychological well-being and lower back pain of college students during the pandemic. *BMC Sports Science, Medicine and Rehabilitation, 14*(1), 102.
https://doi.org/10.1186/s13102-022-00493-3 (IF = 2.367)

Paper 2:
Li, K., Yu, H., Kortas, J. A., Lin, X., Lipowski, M. (2022). The effect of 12 weeks of Baduanjin exercise on cognitive function, lower limb balance and quality of life of the elderly with mild cognitive impairment: a randomized controlled trial. *Gazzetta Medica Italiana – Archivio per le Scienze Mediche,181*, 811-823.
https://doi.org/10.23736/S0393-3660.22.04802-1 (IF = 0.117)

Paper 3:
Li, K., Yu, H., Lin, X., Su, Y., Gao, L., Song, M., Fan, H., Krokosz, D., Yang, H., & Lipowski, M. (2022). The Effects of Er Xian Decoction Combined with Baduanjin Exercise on Bone Mineral Density, Lower Limb Balance Function, and Mental Health in Women with Postmenopausal Osteoporosis: A Randomized Controlled Trial. *Evidence-Based Complementary and Alternative Medicine, 2022*, 8602753.
https://doi.org/10.1155/2022/8602753 (IF = 2.650)

INTRODUCTION

People's lifestyles have changed dramatically with the COVID-19 epidemic. It has greatly influenced their physical and mental health. A sedentary lifestyle and a lack of physical activity are common problems in people of all ages globally. These conditions slow down physiological processes and disturb metabolism, leading to the development of chronic and geriatric diseases and even premature death (Ozemek et al., 2019). In sedentary behavior, the neck, lumbar spine, and other body parts stay inactive for a long time. Students typically spend many hours seated on non-ergonomic chairs and assuming incorrect postures to carry out their curricular activities, leading to a general musculoskeletal overload (Caromano et al., 2015), especially at the neck and low back (Vujcic et al., 2018). Haroon et al. (Haroon et al., 2018) reported university students using laptops for more than 3 hours per day as a risk factor for neck pain. This leads to an abnormal body position, causing pain in the waist, abdomen, and back, in addition to decreased muscle strength. Relevant research also shows that chronic pain increases patient-perceived stress (Ehlert et al., 2001; Jankord & Herman, 2008). Growing evidence suggests that the COVID-19 pandemic is contributing to an increased incidence of mental health problems, anxiety, and depression (Faisal et al., 2021; Hyland et al., 2020; Kathirvel, 2020; Wu et al., 2021).

A lack of physical activity is one of the main causes of geriatric diseases, especially for menopausal women. During menopause, due to declining ovarian function, women secrete little estrogen, and the level of bone metabolism decreases. Studies have shown that exercise can promote a slight increase in estrogen concentration (Saintier et al., 2006). Therefore, estrogen plays a very important role in the mechanism of female bone metabolism. Estrogen inhibits the secretion of thyroid hormone, which reduces bone absorption, promotes the secretion of calcitonin, and reduces bone resorption. Estrogen receptors secrete factors that can effectively improve the proliferation of osteoblasts and promote bone-transforming growth factor β. In contrast, a lack of physical activity has adverse effects on estrogen. It can cause a range of adverse effects, such as hot flashes, depression, difficulty sleeping, and bone and heart health problems (Stojanovska et al., 2014).

A lack of exercise also adversely affects the cognitive function of people with mild cognitive impairment (MCI). Several studies have suggested that MCI is a mental disease with mild symptoms. It is characterized by depression, irritability, apathy, anxiety, agitation, and sleep problems (Feldman et al., 2004; Martin & Velayudhan, 2020). The pathologic and molecular substrate of people diagnosed with MCI is not well-established. Neuronal degeneration initiated at different levels of the central nervous system may drive cognitive decline as a final common pathway at this stage of the dementing disease process (Mufson et al., 2012). Despite no apparent disease in the limb function of the elderly with MCI, cognitive function is impaired or memory is reduced to varying degrees. Acute exercise can induce changes in Plasma brain-derived neurotrophic factor (pBDNF) concentration, and significant associations have been observed between acute exercise and cognitive memory (Piepmeier & Etnier, 2015).

The existing data show that sports and physical activity are effective regulators of chronic and geriatric diseases, improve physiological functions affected by chronic diseases and geriatric diseases (Pedersen & Saltin, 2015), and prevent mental health and cognitive dysfunction. Therefore, exercise interventions and therapies can improve these to some extent.

The effectiveness of Baduanjin as an exercise intervention has been recognized in many international studies (Wang et al., 2021). As a traditional Chinese mind–body aerobic exercise, Qigong is based on Taoist philosophy and traditional Chinese medicine theories (Jones, 2001). Qigong is a combination of postures, meditation, and movements designed to improve holistic health and facilitate mind–body integration (Jones, 2001; McCaffrey & Fowler, 2003). It consists of eight independent, simple, subtle, and smooth movements (Ekman, 2003). Although the potential effectiveness of each movement may be different, the overall Baduanjin exercise has been demonstrated to have positive effects on the body and mind (P., 2003). Baduanjin exercise can enhance Qi function through the whole exercise of body posture, movement, breathing, and meditation–that is, drawing on natural forces to optimize and balance energy within, through the purposeful coordination of body, breath, and mind (Koh, 1982). With the combination of self-awareness, self-correction of the posture and movement of the body, the flow of breath, and stilling of the mind, Baduanjin exercise is thought to comprise a state that activates the natural self-regulation capacity, stimulating the balanced release of endogenous neurohormones and a wide array of natural health recovery mechanisms (Jahnke et al., 2010).

Osteoporosis is a systemic, multifactorial disease that causes morbidity and mortality in the elderly and is increasing in prevalence worldwide (Reginster & Burlet, 2006). Western medicine is still the primary treatment for women with postmenopausal osteoporosis (PMOP). However, the long-term use of Western medicine still cannot completely cure the disease. Moreover, most Western drugs are expensive, have adverse effects, and damage the patient’s body. Examples of such medications include bisphosphonates, tibolone, calcitonin, and parathyroid hormone (PTH) therapy (Barrionuevo et al., 2019; Delmas, 2002; Eastell et al., 2019).

Er Xian decoction (EXD) is a multi-herb formula composed of six herbs: Rhizome curculiginis, Herba epimedium, Radix morinda officinalis, Rhizome anemarrhenae, Cortex phellodendron, and Radix angelica sinensis. As a traditional Chinese medicine, it has several biological and pharmacological effects (Sze et al., 2009). It has long been used to treat osteoporosis, perimenopausal syndrome, and age-related diseases in elderly patients (Liu et al., 2005; Shen et al., 1995; Wang et al., 1998). Many animal studies and clinical experiments have shown that traditional Chinese medicine has a significant effect in the prevention and treatment of PMOP, with fewer adverse effects on the body in comparison to chemically synthesized medicines (Mukwaya et al., 2014).

This thesis is based on a series of three studies with different participant groups: (1) examining the influence of Baduanjin exercise on college students' low back pain, COVID-19-related anxiety, and mental health during the pandemic; (2) improving cognitive function and physical health with a Baduanjin exercise intervention in the elderly with MCI; (3) using Chinese herbal medicine (EXD) combined with Baduanjin exercise to improve the symptoms of menopausal women. These studies also aimed to further support the effectiveness and safety of Baduanjin exercise in clinical trials.

The final goal of this thesis is to evaluate the value and function of Baduanjin as a traditional exercise in China. It also aims to explore the effects of Baduanjin exercise as a single intervention and in combination with medicine on the physiological function, psychological state, and cognitive function of different age groups. It aims to further verify the safety, effectiveness, and scientificity of the single and combined interventions. There is currently no literature on related research. This is a very valuable and innovative topic.

RESEARCH ISSUES

1. Research objectives

The final goal of this thesis is to evaluate the value and function of Baduanjin as a traditional exercise in China. It also aims to explore the effects of Baduanjin exercise as a single intervention and in combination with medicine on the physiological function, psychological state, and cognitive function of different age groups. It aims to further verify the safety, effectiveness, and scientificity of the single and combined interventions.

2. The research questions and hypotheses

Question 1:

What impact did the Baduanjin exercise intervention have on college students' physical and mental health during the COVID-19 pandemic?

Hypothesis 1:

Baduanjin exercise can improve the physical and mental health of college students during the COVID-19 pandemic.

Question 2:

What is the effect of Baduanjin on the cognitive function, lower limb balance function, and quality of life of the elderly with MCI?

Hypothesis 2:

Baduanjin exercise can improve the cognitive function, lower limb balance function, and quality of life of the elderly with MCI.

Question 3:

Can the combination of EXD and Baduanjin exercise work more effectively than the single intervention (Baduanjin exercise alone or Er Xian decoction alone) in treating the BMD, lower limb balance function, and mental health of PMOP patients?

Hypothesis 3:

The combination of EXD and Baduanjin exercises has a more effective therapeutic effect on BMD, lower limb balance function and mental health of patients with PMOP compared to using these methods independently.

Test procedure

1. Tested persons

Characteristic information of participants in the experiment:

Paper 1:

A total of 400 participants who were college students met the eligibility criteria; 13 dropped out after the first screening for personal reasons unrelated to the study: 5 had a scheduling conflict, 6 did not give a reason, and 2 could not perform the exercises. Finally, 387 participants were randomly allocated in a 1:1 ratio to a 12-week Baduanjin exercise group (BEG, $n = 195$) or a 12-week control group (CG, $n = 192$). The average age of college students participating in this experiment was 24 ± 3 years.

Paper 2:

According to the inclusion criteria and exclusion criteria, 76 participants with MCI completed the questionnaire survey of this study. After the screening, 6 participants were excluded with no reason provided, 7 were excluded due to plan conflicts, and 3 were excluded because their physical conditions were unsuitable. Finally, a total of 60 participants qualified for the study. They were randomly allocated in a 1:1 ratio to a 12-week Baduanjin exercise group and a 12-week leisure walking group, with 30 cases in each group. The average age of participants in this experiment was 61 ± 2 years.

Paper 3:

A total of 57 participants (mean age 57 ± 2 years) with PMOP were allocated to three groups. Seven participants dropped out after the first screening for personal reasons unrelated to the study: 2 had a scheduling conflict, 2 did not give a reason, and 3 could not perform the exercises. The remaining 50 eligible participants were enrolled and randomly assigned to the BE group ($n = 18$), EXD group ($n = 15$), or combined BE + EXD group ($n = 17$). All participants completed their intervention.

2. Research methods and materials

2. 1. Measurement of waist pain

Nordic Musculoskeletal Questionnaire

The Nordic Musculoskeletal Questionnaire (NMQ) was applied to measure musculoskeletal pain (de Barros & Alexandre, 2003; Mendonca et al., 2018; Pinheiro et al., 2002). The internal consistency of the NMQ in our study was α = 0.93.

2. 2. Measurement and evaluation of bone density

Bone mineral density

A dual-energy X-ray absorptiometry (DEXA) scan is a valid and reliable tool for measuring BMD (lumbar spine [LS] and femoral neck [FN]; Prodigy-GE Healthcare, Chicago, IL, USA) (Smith-Ryan et al., 2017). During a DEXA scan, participants lay supine on an open X-ray table. The participants were asked to remain still during the scan as the large scanning arm passed over their bodies. We also calculated the Z-score, which compares the obtained bone density to the age-matched normal average bone and is often helpful in cases of severe osteoporosis (Blake & Fogelman, 2007; Kanis, 1994).

2. 3. Test methods for evaluating balance ability

Berg Balance Scale

The Berg Balance Scale (BBS) includes 14 items: standing up from a sitting position; standing without support; sitting position without a backrest but landing with both feet or putting them on a stool; sitting down from a standing position; transferring; closing eyes without support; standing with both feet together without support; upper limbs stretching and moving forward in standing position; picking up articles from the ground in a standing position; turning to look back in a standing position; turning 360 degrees; putting one foot on a step or stool in standing position without support; standing without support with one foot in front. The higher the score, the better the balance (Berg et al., 1992). The Cronbach's α value of this test is 0.828.

Timed Up and Go test

In the Timed Up and Go (TUG) test, the participant wears their usual shoes and sits on a chair (the height of the chair is around 45 cm), leaning against the chair's back with their hands at their sides. After hearing the instruction to start, the participant immediately gets up from the chair and walks forward for 3 meters with their usual gait, turning around after passing a marker. They then walk back to the chair and turn to sit down, ending with leaning back on the chair. No help can be given during the test (Podsiadlo & Richardson, 1991). The time is recorded (in seconds) with a stopwatch. The shorter the test time, the better the balance ability. The Cronbach's α value of this test is 0.794.

10-meter walking test

The 10-meter walking test (10MWT) evaluates walking ability on a 14-meter straight line marked at 2 m and 12 m. Participants must walk along the line, starting from 2 m and finishing at 12 m. The time and steps taken for walking between 2 m and 12 m are recorded. The shorter the walking time, the better the balance (Bushnell et al., 2015). The Cronbach's α value of this test is 0.775.

One-leg standing test

A one-leg standing test (OLST) was used to assess static balance. The participants were asked to close their eyes, stand on their preferred leg, lift the other leg to an approximately 90° angle at the knee, keep their arms by their sides, and maintain balance without using any assistive device. The test was completed when the stance foot shifted or when the lifted foot was replaced on the ground (whichever occurred first). The longer they stood on one leg, the better the balance (Michikawa et al., 2009). The Cronbach's α value of this test was 0.815.

2. 4. Measurement methods for mental health

The Coronavirus Anxiety Scale

The Coronavirus Anxiety Scale (CAS) was developed by Sherman A. Lee (Lee, 2020). It consists of five items developed based on the psychological descriptions of fear and anxiety symptoms (American Psychiatric Association, 2013; Barlow, 1991; Cosmides & Tooby, 2000; P., 2003). The internal consistency of the CAS in our study was α = 0.793.

Psychological Well-Being Scale

This questionnaire was originally designed and proposed by Ryff (Ryff & Keyes, 1995), but we used the version developed by Ryff and Almeida (Delaney, 2014). The Psychological Well-Being Scale (PWBS) is a measurement tool with a multi-dimensional structure and six subscales that are the principal elements of psychological well-being. These subscales are autonomy, personal growth, environmental mastery, purpose in life, positive relations with others, and self-acceptance. The internal consistency of the PWBS (total scale) in our study was α = 0.784.

Self-Anxiety Scale

The Self-Anxiety Scale (SAS) is used to evaluate subjective feelings of anxiety in patients and can be used as a self-assessment tool for the clinical understanding of anxiety symptoms (Zung, 1971). It consists of 20 items. The critical standard of anxiety assessment in China is 50 points. The lower the score, the less psychological anxiety. The Cronbach's α value of this measure is 0.835.

Self-Rating Depression Scale

The Self-Rating Depression Scale (SDS) is a short-term self-rating scale compiled by Zung in 1965 (Zung, 1965). It is easy to implement and can effectively reflect the symptoms of depression, together with their severity and changes. The scale consists of 20 declarative sentences and corresponding question items. The lower the score, the lower the level of depression. The Cronbach's α value of this test was 0.851.

2. 5. Methods for evaluating cognitive function

Montreal Cognitive Assessment

The Montreal Cognitive Assessment (MoCA) is mainly used to screen the elderly who complain of memory loss where the Mini Mental State Examination (MMSE) score is still in the normal range, with high sensitivity and good reliability and validity. The MoCA includes seven dimensions: visual space and executive function, naming, attention, language, abstraction, delayed recall, and orientation. This gives a total score out of 30 points (Folstein et al., 1975), and the higher the score, the better the cognitive function. The Cronbach's α value of this scale was 0.826.

Mini Mental State Examination

The MMSE was used to evaluate the cognitive status of participants before and after the intervention. This is a simple tool for the classification of cognitive impairment in the elderly. The higher the score, the better the cognitive function (Nasreddine et al., 2005). Combined with the education level and cognitive score, cognitive status was comprehensively evaluated. In so doing, the evaluation criteria for cognitive impairment in the elderly were acquired. The Cronbach's α value of this scale was 0.862.

2. 6. Assessment of quality of life

Quality of life assessment

The 12-Item Short Form Survey (SF-12) questionnaire was designed and put forward by Ware and Sherbourne (Ware & Sherbourne, 1992). This paper uses the American version developed by Gandek, Ware, Aaronson, et al. (Gandek et al., 1998). The scores obtained by the participants were totaled. The higher the score, the better the physical condition of the participants. The Cronbach's α value of this scale was 0.847.

MAIN RESULTS AND CONCLUSIONS FROM INDIVIDUAL PAPERS

Paper 1:

The effect of the Baduanjin exercise on COVID-19-related anxiety, psychological well-being and lower back pain of college students during the pandemic (2022)

The outcomes for the Baduanjin group differed significantly from the control group. Baduanjin exercises were very beneficial to participants' mental health and physiological functions. The intervention effect on the Baduanjin exercise group was remarkably better than that of the control group ($p < 0.05$). COVID-19-related anxiety scores of the Baduanjin group reduced progressively from 5.22 ± 0.45 to 5.07 ± 0.27 ($p < 0.05$). which means that Baduanjin exercise can effectively improve COVID-19-related anxiety The total PWBS score increased significantly from 70.11 ± 8.65 to 84.12 ± 7.38 ($p < 0.05$), which indicates that the psychological well-being of participants in the Baduanjin group is significantly higher than that of the control group. And the prevalence of low back pain decreased significantly from 22.45 ± 1.67 to 18.35 ± 1.05 ($p < 0.05$) among the Baduanjin group of college students. It shows that Baduanjin exercise can effectively relieve the symptoms of low back pain and reduce the prevalence of low back pain.

Paper 2:

The effect of 12 weeks of Baduanjin exercise on cognitive function, lower limb balance and quality of life of the elderly with mild cognitive impairment: a randomized controlled trial (2022)

In comparison to the leisure walking group, participants in the Baduanjin group had a significant improvement in cognitive function (MMSE: from 21.83 ± 2.22 to 27.4 ± 2.07, $p < 0.05$; MoCA: from 19.96 ± 1.92 to 24.48 ± 2.33, $p < 0.05$). The Baduanjin exercise group showed significant improvement in lower limb balance function (BBS: from 47.68 ± 1.95 to 52.38 ± 2.19, $p < 0.05$; TUG: from 9.63 ± 0.15to 8.64 ± 0.21, $p < 0.05$); 10 MWT: from 0.93 ± 0.02to 1.27 ± 0.2, $p < 0.05$). The Baduanjin exercise group had a great effect on the quality of life than the leisure walking group (PCS: from 47.88 ± 2.27 to 53.79 ± 1.95], $p < 0.05$; MCS: from 57.33 ± 1.84 to 62.55 ± 2.02, $p < 0.05$). In addition, after the Baduanjin exercise intervention, a significant positive correlation existed between lower limb balance (BBS) and the improvement of cognitive function (MMSE; $r = 0.32$, $p < 0.05$). A significant positive correlation was also found between lower limb balance (10 MWT) and the improvement in cognitive function (MMSE; $r = 0.36$, $p < 0.05$). The change in quality of life (MCS) was positively correlated with cognitive function (MoCA) improvement ($r = 0.59$, $p < 0.01$).

Paper 3:

The Effects of Er Xian Decoction Combined with Baduanjin Exercise on Bone Mineral Density, Lower Limb Balance Function, and Mental Health in Women with Postmenopausal Osteoporosis: A Randomized Controlled Trial (2022)

In comparison to the Er Xian decoction (EXD) and Baduanjin exercise (BE) groups, the EXD + BE group showed the strongest effects on Bone mineral density BMD (LS: from 0.75 ± 0.01 to 0.98 ± 0.01, $p < 0.05$; FN: from 0.73 ± 0.01 to 0.97 ± 0.01, $p < 0.01$). Lower limb balance function improved (OLST: from 3.88 ± 0.22 to 7.3 ± 0.19, $p < 0.01$; BBS: from 39.31 ± 1.26 to 45.23 ± 1.02, $p < 0.01$; TUG: from 7.23 ± 0.14 to 6.54 ± 0.19, $p < 0.01$), and mental health scores decreased (SDS: from 50.71 ± 2.04 to 46.06 ± 2.26, $p < 0.01$; SAS: 53.37 ± 1.83 to 46.02 ± 1.23, $p < 0.001$). In the EXD + BE group, a correlation was found between BMD and lower limb balance (BBS: $r = 0.35$, $p < 0.05$; TUG: $r = -0.52$, $p < 0.01$). The change in mental health (SAS score) was correlated with BMD (FN) improvement ($r = -0.57$, $p < 0.01$).

DISCUSSION AND GENERAL CONCLUSIONS

The purpose of this study was to explore and verify whether Baduanjin exercise is a harmless non-pharmaceutical intervention with minimal adverse effects. Baduanjin exercise can be used for treating musculoskeletal physiological health, cognitive function, and mental health problems caused by the COVID-19 epidemic and geriatric diseases. Through this research using Chinese herbal medicine combined with Baduanjin exercise, we further support the effectiveness and safety of Baduanjin exercise as an adjuvant therapy in clinical trials. The participants had no adverse reactions during the intervention, and all were satisfied with the intervention program.

A series of three articles have been published to show the main findings.

Paper 1: The effect of Baduanjin exercise on COVID-19-related anxiety, psychological well-being, and lower back pain of college students during the pandemic (2021).

Paper 2: The effect of Baduanjin exercise on cognitive function, lower limb balance, and quality of life of the elderly with mild cognitive impairment: A randomized controlled trial (2022).

Paper 3: The effects of Er Xian decoction combined with Baduanjin exercise on bone mineral density, lower limb balance function, and mental health in women with postmenopausal osteoporosis: A randomized controlled trial (2022).

In terms of its effect as an exercise intervention, Baduanjin has been recognized in international studies (Kuorinka et al., 1987). Similar to the well-recognized traditional Tai Ji, Baduanjin Qigong is characterized by slow and relaxing movements. In addition, Baduanjin exercise has been recognized as an effective way of alleviating lower back pain (even as a chronic condition) caused by lumbar disc herniation (Xu et al., 2018; Yuan et al., 2020). It improves the strength and flexibility of the neck, shoulders, and back. In addition, the latest studies have found that in China, Baduanjin has been used as an essential adjuvant therapy and postoperative rehabilitation component in COVID-19 (Ma et al., 2020; Rong et al., 2021; X. B. Zhang et al., 2021). Baduanjin can promote lower limb function, especially lower limb balance and muscle strength development, and quality of life to a certain extent (Fan Weiying, 2021; Jiang Yunzhi, 2021; Meng, 2018). Thus, it helps reduce the occurrence and development of diseases related to these parts of the body (Gao et al., 2018; Teut et al., 2016). The positive effect of Baduanjin exercise on mental health has been previously observed in cohorts of college students, as well as middle-aged and older people (Chen et al., 2017; Ding & Wang, 2014; Peng et al., 2015).

In paper 1, one of the most remarkable findings was that the effect of the Baduanjin intervention on COVID-19-related anxiety was significant. This result is consistent with other studies (Paggi et al., 2016; Wheaton et al., 2012; X.-B. Zhang et al., 2021; Zou et al., 2018) showing that Baduanjin exercise has a significant effect on alleviating anxiety symptoms. For example, Zhang et al. proposed that Baduanjin exercise had a certain positive influence on COVID-19 patients in square-cabin hospitals, conducive to alleviating anxiety and depression symptoms (X.-B. Zhang et al., 2021). A systematic review confirmed the efficacy of Baduanjin exercise in reducing depression and anxiety symptoms in people with physical or mental illnesses (Zou et al., 2018). During the pandemic, people who exercise more have been less anxious than people who exercise less (Lesser & Nienhuis, 2020). Therefore, exercise helps to relieve COVID-19 anxiety, fear, and stress, although the detailed mechanism by which Baduanjin improves COVID-19-related anxiety is not fully understood. As a comprehensive, multi-component intervention, Baduanjin may act through many intermediate variables along the pathway to improve anxiety outcomes. In the future, it is still necessary to strengthen the research on the neurobiological mechanisms of Baduanjin exercise in improving COVID-19-related anxiety.

Another result of paper is that the Baduanjin group showed a significant decrease in the prevalence of lower back pain and improved psychological well-being. Statistically significant changes were observed in these measures after the 12-week intervention. This improvement may be due to the benefits of regular Baduanjin exercise, which adjusts breathing to make the process smoother, unifying the mind and breathing, strengthening muscles and tendons to make the body more flexible and unite the mind and body (Geng & Wang, 2008; X, 2012). At the same time, Baduanjin stresses "take the waist as the axis" in practice (Zhang & Ren, 2011). Therefore, regular Baduanjin exercise enhances participants' physical and mental health and decreases the prevalence of low back pain. Baduanjin exercise can relieve stress, promote sleep quality, and enhance mental health and well-being during the coronavirus pandemic.

In paper 2, for older people with MCI, one of the most remarkable findings was that the cognitive function (MMSE and MoCA) data after the intervention in the Baduanjin exercise group were significantly different from those in the walking group. Our results are the same as others, showing that Baduanjin exercise greatly improved participants' cognitive function (Lautenschlager et al., 2008; Liu et al., 2016; Reynolds III et al., 1999; Suzuki et al., 2013; Xiao et al., 2021; Yu et al., 2021; Zheng et al., 2020). For example, Yu et al.(Yu et al., 2021) reported that Baduanjin combined with traditional therapy significantly improved MCI participants' cognitive and memory functions compared with traditional therapy. In this intervention study of MCI participants, MMSE and MoCA were selected as the cognitive function measurement indicators. Although the study did not add other cognitive function measurement indicators, the research results were not affected and were consistent with others' research ideas and methods (Nascimento et al., 2015; Varela et al., 2012; Wei & Ji, 2014). The detailed mechanism by which Baduanjin improves cognitive function is not fully understood. A relative study showed that Tai Ji and Baduanjin could significantly increase grey matter volume in the insula, medial temporal lobe, and putamen after 12 weeks of exercise to modulate brain structure and memory function in older adults (Tao et al., 2017). These findings might reveal the likely neurobiological mechanisms of Baduanjin exercise in improving the memory and cognition of patients.

Although epidemiological research has established that cognitive dysfunction can have negative effects on quality of life and sleep (Reynolds III et al., 1999)，there is a gap in the literature regarding the impact of cognitive function on physical activity, lower limb function, and overall quality of life in older adults with MCI.

Another result of paper II was that the participants in the Baduanjin group showed improvement in quality of life and physical performance. The magnitude of the improvement was modest. It may be due to differences in the style, duration, and intensity of the Baduanjin intervention and the characteristics of the participants. Several factors may explain the positive effects of Baduanjin training on lower limb balance function and quality of life in elderly patients with MCI. First, the effect of Baduanjin on lower limb balance function among patients has been well-demonstrated in our study. The present study is in keeping with these findings since, as reported elsewhere, the lower limb balance function of the Baduanjin group was improved (Liu et al., 2016; Xiao et al., 2021). Second, we found significant improvements in quality of life from Baduanjin exercise in the present study. And the improvements in quality of life are associated with improving the cognitive function of patients with MCI. This result is consistent with the research of other scholars (HP, 2010; Uemura et al., 2013).

In paper 3, we found that Er Xian decoction combined with Baduanjin exercise had more advantageous effects on the prevention of bone loss and the improvement of BMD in patients with PMOP than either intervention alone. However, this study shows only that exercise combined with medicine may have a therapeutic advantage over each monotherapy in improving BMD; the detailed mechanism is not completely clear in terms of whether this is merely an additive benefit or whether some synergistic effect occurs. At present, no literature exists about the mechanism by which this combination improves BMD. Thus, a longer-term trial is required to evaluate the effects of Er Xian decoction combined with Baduanjin exercise on BMD.

Another result of paper III was that the participants in the EXD + BE group showed significant improvement in lower limb balance. This supports previous studies showing the improvement of lower limb balance function with the combination of Er Xian decoction and Baduanjin exercise (Nian et al., 2006; Qin et al., 2008; Tian et al., 2020; Wang et al., 2021; Zhu et al., 2021; ZOU et al., 2011). Interestingly, we observed significant improvements in mental health in the EXD + BE group. These improvements were related to improving BMD in patients with PMOP, and this result is consistent with the research of other scholars (Acimovic, 2018; Chan et al., 2014; Chen et al., 2008; Jing et al., 2018; Sze et al., 2009; Wang et al., 2014; Zhou et al., 2020). Positive effects of EXD + BE were observed on lower limb balance and mental health in women with PMOP, but the detailed mechanisms need further study.

General conclusions from the dissertation:

Baduanjin exercise, a Chinese traditional health Qigong, was useful for different genders and different age groups.

During the COVID-19 pandemic Baduanjin exercise can effectively decrease anxiety and depression in college students, further improving their physical and mental health.

For people with mild cognitive dysfunction, Baduanjin exercise is more obvious and safer. Twelve weeks of Baduanjin exercise not only significantly improved cognitive function but also improved lower limb balance ability (especially among the middle-aged and elderly groups).

As an important clinical intervention, Baduanjin exercise can be considered as one of the interventions supporting treatment of the osteoporosis in menopausal women as it improves bone density. The effect of Er Xian decoction combined with Baduanjin exercise was significantly better than that of each monotherapy.

LIMITATIONS OF THE STUDIES AND FUTURE RESEARCH DIRECTIONS

Limitations of the studies

First, this study has only speculated the possible mechanism of the effects of Baduanjin exercise as a single intervention and in combination with medicine on the physiological function, psychological state, and cognitive function of different age groups through indirect indicators. Nevertheless, it did not explain in more detail the mechanism of the central nervous system and biological indicators.

Secondly, a series of studies related to this study is limited by the impact of the COVID-19 pandemic, and the lack of representativeness of research data and participants. Its reference value for new clinical intervention methods is limited.

In addition, the measurement results of a series of studies related to this study - "the effects of Baduanjin exercise as a single intervention and in combination with medicine on the physiological function, psychological state, and cognitive function of different age groups" - rely too much on the use of scales. Therefore, the subjective measures might have introduced a bias, leading to the potential overestimation of intervention effects.

Finally, a series of studies related to this study lacks the follow-up process after the intervention and cannot determine whether the Baduanjin exercise as a single intervention and in combination with medicine will maintain the influence on the physiological function, psychological state, and cognitive function of different age groups for a long time. At present, there is no more intensive study, and the mechanism of the influence is not clear.

Future Research Directions

Baduanjin exercise seems to be a very interesting exercise for different groups in different countries. It can be adapted to different needs by individualizing internal load and intensity. It starts with a low dose and gradually increases it which makes it suitable for different groups.

Future research should further determine the potential function of this exercise mode through more detail about the mechanism of the central nervous system and biological indicators to understand why the Baduanjin exercise as a single intervention and in combination with medication can cause changes in the physiological function, psychological state, and cognitive function of different age groups.

Since a series of studies related to this study is a small sample of exercise intervention research, increase the sample size and increase the authority and validity of the data. Correlation studies should add different groups to strengthen and broaden the results, which is an important research direction in the future.

Baduanjin exercise may be used as the main single intervention or a clinical intervention with auxiliary drugs. It plays a very important role. Being safe and available, this regular and healthy exercise can be performed at home.

BIBLIOGRAPHY

Acimovic, I. (2018). The influence of health qigong on the subjectively expressed psychophysical state of patients with rheumatoid arthritis, rheum, osteoporosis, osteopenia. *Chinese Medicine and Culture, 1*(3), 150.

American Psychiatric Association, A. P. A. (2013). Diagnostic and statistical manual of mental disorders: *DSM-5. United States.*

Barlow, D. H. (1991). Disorders of Emotion. *Psychological Inquiry, 2*(1), 58-71.

Barrionuevo, P., Kapoor, E., Asi, N., Alahdab, F., Mohammed, K., Benkhadra, K., Almasri, J., Farah, W., Sarigianni, M., Muthusamy, K., Al Nofal, A., Haydour, Q., Wang, Z., & Murad, M. H. (2019). Efficacy of Pharmacological Therapies for the Prevention of Fractures in Postmenopausal Women: A Network Meta-Analysis. *The Journal of Clinical Endocrinology & Metabolism, 104*(5), 1623-1630. https://doi.org/10.1210/jc.2019-00192

Berg, K. O., Wood-Dauphinee, S. L., Williams, J. I., & Maki, B. (1992). Measuring balance in the elderly: validation of an instrument. *Canadian Journal of Public Health, 83 Suppl 2*, S7-11. https://www.ncbi.nlm.nih.gov/pubmed/1468055

Blake, G. M., & Fogelman, I. (2007). The role of DXA bone density scans in the diagnosis and treatment of osteoporosis. *Postgraduate Medical Journal, 83*(982), 509-517. https://doi.org/10.1136/pgmj.2007.057505

Bushnell, C., Bettger, J. P., Cockroft, K. M., Cramer, S. C., Edelen, M. O., Hanley, D., Katzan, I. L., Mattke, S., Nilsen, D. M., Piquado, T., Skidmore, E. R., Wing, K., & Yenokyan, G. (2015). Chronic Stroke Outcome Measures for Motor Function Intervention Trials: Expert Panel Recommendations. *Circulation: Cardiovascular Quality and Outcomes, 8*(6 Suppl 3), S163-169. https://doi.org/10.1161/CIRCOUTCOMES.115.002098

Caromano, F. A., de Amorim, C. A. P., de Fátima Rebelo, C., Contesini, A. M., Fávero, F. M., Frutuoso, J. R. C., Missa, M., & Kawai, M. C. V. (2015). Prolonged sitting and physical discomfort in university students. *CEP, 5360*(000).

Chan, J. S., Ho, R. T., Chung, K. F., Wang, C. W., Yao, T. J., Ng, S. M., & Chan, C. L. (2014). Qigong exercise alleviates fatigue, anxiety, and depressive symptoms, improves sleep quality, and shortens sleep latency in persons with chronic fatigue syndrome-like illness. *Evidence-Based Complementary and Alternative Medicine,* 2014, 106048. https://doi.org/10.1155/2014/106048

Chen, H. Y., Cho, W. C., Sze, S. C., & Tong, Y. (2008). Treatment of menopausal symptoms with Er-xian decoction: a systematic review. *The American Journal of Chinese medicine, 36*(2), 233-244. https://doi.org/10.1142/S0192415X08005746

Chen, Y., Xiong, X., Liu, H., Liu, X., Chen, Y., Wang, S., Xiong, Q., & Wen, Y. (2017). Effect of Baduanjin on musculoskeletal pain and quality of life in older adults. *China Naturop*, 25, 18-19.

Cosmides, L., & Tooby, J. (2000). Evolutionary psychology and the emotions. *Handbook of Emotions, 2*(2), 91-115.

de Barros, E. N., & Alexandre, N. M. (2003). Cross-cultural adaptation of the Nordic musculoskeletal questionnaire. *International Nursing Review, 50*(2), 101-108. https://doi.org/10.1046/j.1466-7657.2003.00188.x

Delaney, R. K. (2014). National survey of midlife development in the United States. *The International Journal of Aging and Human Development, 79*(4), 329-331. https://doi.org/10.1177/0091415015574174

Delmas, P. D. (2002). Treatment of postmenopausal osteoporosis. *Lancet, 359*(9322), 2018-2026. https://doi.org/10.1016/S0140-6736(02)08827-X

Ding, Y., & Wang, J. (2014). Effect of Baduanjin on pain in people with chronic low back pain. *Chinese Journal of Gerontology* , 29, 151-152.

Eastell, R., Rosen, C. J., Black, D. M., Cheung, A. M., Murad, M. H., & Shoback, D. (2019). Pharmacological Management of Osteoporosis in Postmenopausal Women: An Endocrine Society* Clinical Practice Guideline. *The Journal of Clinical Endocrinology & Metabolism, 104*(5), 1595-1622. https://doi.org/10.1210/jc.2019-00221

Ehlert, U., Gaab, J., & Heinrichs, M. (2001). Psychoneuroendocrinological contributions to the etiology of depression, posttraumatic stress disorder, and stress-related bodily disorders: the role of the hypothalamus–pituitary–adrenal axis. *Biological Psychology, 57*(1-3), 141-152.

Faisal, R. A., Jobe, M. C., Ahmed, O., & Sharker, T. (2022). Mental Health Status, Anxiety, and Depression Levels of Bangladeshi University Students During the COVID-19 Pandemic. *International Journal of Mental Health and Addiction, 20*(3), 1500-1515. https://doi.org/10.1007/s11469-020-00458-y

Fan Weiying, Z. L., Chen Feng, Zou Lianyu, Rao Yulian, Fang Xiaohong.(2021). Effect of Baduanjin Exercise on Anxiety and Depression of 38 Elderly Patients with Essential Hypertension. *Fujian Traditional Chinese Medicine.* 130-142

Feldman, H., Scheltens, P., Scarpini, E., Hermann, N., Mesenbrink, P., Mancione, L., Tekin, S., Lane, R., & Ferris, S. (2004). Behavioral symptoms in mild cognitive impairment.

Neurology, 62(7), 1199-1201. https://doi.org/10.1212/01.wnl.0000118301.92105.ee

Folstein, M. F., Folstein, S. E., & McHugh, P. R. (1975). "Mini-mental state". A practical method for grading the cognitive state of patients for the clinician. *Journal of Psychiatric Research, 12*(3), 189-198. https://doi.org/10.1016/0022-3956(75)90026-6

Gandek, B., Ware, J. E., Aaronson, N. K., Apolone, G., Bjorner, J. B., Brazier, J. E., Bullinger, M., Kaasa, S., Leplege, A., Prieto, L., & Sullivan, M. (1998). Cross-validation of item selection and scoring for the SF-12 Health Survey in nine countries: results from the IQOLA Project. International Quality of Life Assessment. *Journal of Clinical Epidemiology, 51*(11), 1171-1178. https://doi.org/10.1016/s0895-4356(98)00109-7

Gao, F., Yuan, S., Liu, N., & Zheng, S. (2018). Effect observation of Baduanjin training on chronic nonspecific low back pain. *Rehabilitation Medicine, 28*, 13-17.

Geng, Y., & Wang, X. (2008). Effect of Eight-Length Brocade Exercise on mental sub-health regulation based on the theory of emotion controlled by five zang-organs. *China Journal of Traditional Chinese Medicine and Pharmacy, 23*(4), 348-349.

Haroon, H., Mehmood, S., Imtiaz, F., Ali, S. A., & Sarfraz, M. (2018). Musculoskeletal pain and its associated risk factors among medical students of a public sector University in Karachi, Pakistan. *The Journal of the Pakistan Medical Association, 68*(4), 682-688.

HP, N. (2010). Effect of Qigong on physical and psychosocial status of Chinese COPD patients: A randomized controlled trial [Doctoral dissertation]. *The Hong Kong Polytechnic University.*

Hyland, P., Shevlin, M., McBride, O., Murphy, J., Karatzias, T., Bentall, R. P., Martinez, A., & Vallières, F. (2020). Anxiety and depression in the Republic of Ireland during the COVID-19 pandemic. *Acta Psychiatrica Scandinavica, 142*(3), 249-256.

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

Jankord, R., & Herman, J. P. (2008). Limbic regulation of hypothalamo-pituitary-adrenocortical function during acute and chronic stress. *Annals of the New York Academy of Sciences, 1148*(1), 64-73.

Jiang Yunzhi, Z. D., Ma Jipei. (2021). The effect of Ba Duanjin on the quality of life and psychological state of non-dialysis patients with chronic kidney disease .*Clinical Journal of Traditional Chinese Medicine.*110-113.

Jing, L., Jin, Y., Zhang, X., Wang, F., Song, Y., & Xing, F. (2018). The effect of Baduanjin qigong combined with CBT on physical fitness and psychological health of elderly housebound. *Medicine (Baltimore), 97*(51), e13654. https://doi.org/10.1097/MD.0000000000013654

Jones, B. M. (2001). Changes in cytokine production in healthy subjects practicing Guolin Qigong: a pilot study. *BMC Complementary and Alternative Medicine, 1*(1), 1-7.

Kanis, J. A. (1994). Assessment of fracture risk and its application to screening for postmenopausal osteoporosis: synopsis of a WHO report. WHO Study Group. *Osteoporosis International, 4*(6), 368-381. https://doi.org/10.1007/BF01622200

Kathirvel, N. (2020). Post COVID-19 pandemic mental health challenges. *Asian Journal of Psychiatry, 53*, 102430. https://doi.org/10.1016/j.ajp.2020.102430

Koh, T. C. (1982). Baduanjin -- an ancient Chinese exercise. *American Journal of Chinese Medicine, 10*(1-4), 14-21. https://doi.org/10.1142/S0192415X8200004X

Kuorinka, I., Jonsson, B., Kilbom, A., Vinterberg, H., Biering-Sorensen, F., Andersson, G., & Jorgensen, K. (1987). Standardised Nordic questionnaires for the analysis of musculoskeletal symptoms. *Applied Ergonomics, 18*(3), 233-237. https://doi.org/10.1016/0003-6870(87)90010-x

Lautenschlager, N. T., Cox, K. L., Flicker, L., Foster, J. K., van Bockxmeer, F. M., Xiao, J., Greenop, K. R., & Almeida, O. P. (2008). Effect of physical activity on cognitive function in older adults at risk for Alzheimer disease: a randomized trial. *JAMA, 300*(9), 1027-1037. https://doi.org/10.1001/jama.300.9.1027

Lee, S. A. (2020). Coronavirus Anxiety Scale: A brief mental health screener for COVID-19 related anxiety. *Death Studies, 44*(7), 393-401. https://doi.org/10.1080/07481187.2020.1748481

Lesser, I. A., & Nienhuis, C. P. (2020). The Impact of COVID-19 on Physical Activity Behavior and Well-Being of Canadians. *International Journal of Environmental Research And Public Health, 17*(11). https://doi.org/10.3390/ijerph17113899

Liu, Q., Shi, J., Yang, Y., Fang, Z., Liang, S., & Guo, R. (2005). Effects on secretory function of rat gonad by Erxian decoction and its disassembled prescriptions. *China Journal of Chinese Materia Medica, 30*(13), 1023-1026.

Liu, X. Y., Gao, J., Yin, B. X., Yang, X. Y., & Bai, D. X. (2016). Efficacy of Ba Duan Jin in Improving Balance: A Study in Chinese Community-Dwelling Older Adults. *Journal of Gerontological Nursing, 42*(5), 38-46. https://doi.org/10.3928/00989134-20160201-03

Ma, Q., Yang, Z., Zhu, F., Chen, H., Yang, H., & Wang, S. (2020). The effect of Baduanjin exercise on the quality of life in patients recovering from COVID-19: A protocol for systematic review and meta-analysis. *Medicine (Baltimore), 99*(37), e22229.

https://doi.org/10.1097/MD.0000000000022229

Martin, E., & Velayudhan, L. (2020). Neuropsychiatric Symptoms in Mild Cognitive Impairment: A Literature Review. *Dementia and Geriatric Cognitive Disorders, 49*(2), 146-155. https://doi.org/10.1159/000507078

McCaffrey, R., & Fowler, N. L. (2003). Qigong practice: a pathway to health and healing. *Holistic Nursing Practice, 17*(2), 110-116. https://doi.org/10.1097/00004650-200303000-00006

Mendonca, C. R., Noll, M., & Silveira, E. A. (2018). Adaptation and validation of body maps for musculoskeletal pain location in patients with severe obesity. *The Korean Journal of Pain, 31*(4), 268-276. https://doi.org/10.3344/kjp.2018.31.4.268

Meng, L. (2018).The effect of fitness baduanjin on cognitive function, emotion and quality of life of patients with chronic obstructive pulmonary disease in stable stage [Master dissertation]. *Shenyang institute of physical education.*

Michikawa, T., Nishiwaki, Y., Takebayashi, T., & Toyama, Y. (2009). One-leg standing test for elderly populations. *Journal of Orthopaedic Science, 14*(5), 675-685. https://doi.org/10.1007/s00776-009-1371-6

Mufson, E. J., Binder, L., Counts, S. E., DeKosky, S. T., de Toledo-Morrell, L., Ginsberg, S. D., Ikonomovic, M. D., Perez, S. E., & Scheff, S. W. (2012). Mild cognitive impairment: pathology and mechanisms. *Acta Neuropathologica, 123*(1), 13-30. https://doi.org/10.1007/s00401-011-0884-1

Mukwaya, E., Xu, F., Wong, M. S., & Zhang, Y. (2014). Chinese herbal medicine for bone health. *Pharmaceutical Biology, 52*(9), 1223-1228. https://doi.org/10.3109/13880209.2014.884606

Nascimento, C. M., Pereira, J. R., Pires de Andrade, L., Garuffi, M., Ayan, C., Kerr, D. S., Talib, L. L., Cominetti, M. R., & Stella, F. (2015). Physical exercise improves peripheral BDNF levels and cognitive functions in mild cognitive impairment elderly with different bdnf Val66Met genotypes. *Journal of Alzheimer's Disease, 43*(1), 81-91. https://doi.org/10.3233/JAD-140576

Nasreddine, Z. S., Phillips, N. A., Bedirian, V., Charbonneau, S., Whitehead, V., Collin, I., Cummings, J. L., & Chertkow, H. (2005). The Montreal Cognitive Assessment, MoCA: a brief screening tool for mild cognitive impairment. *Journal of the American Geriatrics Society, 53*(4), 695-699. https://doi.org/10.1111/j.1532-5415.2005.53221.x

Nian, H., Qin, L. P., Zhang, Q. Y., Zheng, H. C., Yu, Y., & Huang, B. K. (2006). Antiosteoporotic activity of Er-Xian Decoction, a traditional Chinese herbal formula, in ovariectomized rats. *Journal of Ethnopharmacology, 108*(1), 96-102. https://doi.org/10.1016/j.jep.2006.04.020

Ozemek, C., Lavie, C. J., & Rognmo, Ø. (2019). Global physical activity levels-Need for intervention. *Progress In Cardiovascular Diseases, 62*(2), 102-107.

P., E. (2003). Emotions revealed: recognizing faces and feelings to improve communication and emotional life. *New York. NY: Times books.*

Paggi, M. E., Jopp, D., & Hertzog, C. (2016). The importance of leisure activities in the relationship between physical health and well-being in a life span sample. *Gerontology, 62*(4), 450-458.

Pedersen, B. K., & Saltin, B. (2015). Exercise as medicine - evidence for prescribing exercise as therapy in 26 different chronic diseases. *Scandinavian Journal Of Medicine & Science in Sports,* 25 Suppl 3, 1-72. https://doi.org/10.1111/sms.12581

Peng, X., Li, Q., & Li, X. (2015). The efficacy of sitting Baduanjin exercise on lumbago and back pain of elderly patients with osteoporosis. *Journal of Nursing Science,* 20, 4-6.

Piepmeier, A. T., & Etnier, J. L. (2015). Brain-derived neurotrophic factor (BDNF) as a potential mechanism of the effects of acute exercise on cognitive performance. *Journal of Sport and Health Science, 4*(1), 14-23.

Pinheiro, F. A., Tróccoli, B. T., & Carvalho, C. V. d. (2002). Validity of the Nordic Musculoskeletal Questionnaire as morbidity measurement tool. *Revista de saude publica, 36*, 307-312.

Podsiadlo, D., & Richardson, S. (1991). The timed "Up & Go": a test of basic functional mobility for frail elderly persons. *Journal of the American geriatrics Society, 39*(2), 142-148. https://doi.org/10.1111/j.1532-5415.1991.tb01616.x

Qin, L., Han, T., Zhang, Q., Cao, D., Nian, H., Rahman, K., & Zheng, H. (2008). Antiosteoporotic chemical constituents from Er-Xian Decoction, a traditional Chinese herbal formula. *Journal of ethnopharmacology, 118*(2), 271-279. https://doi.org/10.1016/j.jep.2008.04.009

Reginster, J. Y., & Burlet, N. (2006). Osteoporosis: a still increasing prevalence. *Bone, 38*(2 Suppl 1), S4-9. https://doi.org/10.1016/j.bone.2005.11.024

Reynolds III, C. F., Frank, E., Perel, J. M., Imber, S. D., Cornes, C., Miller, M. D., Mazumdar, S., Houck, P. R., Dew, M. A., & Stack, J. A. (1999). Nortriptyline and interpersonal psychotherapy as maintenance therapies for recurrent major depression: a randomized controlled trial in patients older than 59 years. *JAMA, 281*(1), 39-45.

Rong, J., Li, J., Jing, F., Ren, Y., Xiao, Y., Pan, Q., Li, M., Lv, Y., Zhang, J., & Jing, F. (2021).

Efficacy of Baduanjin exercise for rehabilitation after COVID-19: A protocol for systematic review and meta-analysis. *Medicine (Baltimore), 100*(24), e26366. https://doi.org/10.1097/MD.0000000000026366

Ryff, C. D., & Keyes, C. L. (1995). The structure of psychological well-being revisited. *Journal of Personality And Social Psychology, 69*(4), 719-727. https://doi.org/10.1037//0022-3514.69.4.719

Saintier, D., Khanine, V., Uzan, B., Ea, H. K., de Vernejoul, M. C., & Cohen-Solal, M. E. (2006). Estradiol inhibits adhesion and promotes apoptosis in murine osteoclasts in vitro. *The Journal of Steroid Biochemistry And Molecular Biology, 99*(4-5), 165-173. https://doi.org/10.1016/j.jsbmb.2006.01.009

Shen, X., Fang, Z., & Wu, D. (1995). Effect of er-xian decoction and its disassembled prescription on enzyme activities and their gene expression of antioxidant enzymes in aging rat. *Chinese Journal of Integrated Traditional and Western Medicine, 15*(11), 672-674.

Smith-Ryan, A. E., Mock, M. G., Ryan, E. D., Gerstner, G. R., Trexler, E. T., & Hirsch, K. R. (2017). Validity and reliability of a 4-compartment body composition model using dual energy x-ray absorptiometry-derived body volume. *Clinical Nutrition, 36*(3), 825-830. https://doi.org/10.1016/j.clnu.2016.05.006

Stojanovska, L., Apostolopoulos, V., Polman, R., & Borkoles, E. (2014). To exercise, or, not to exercise, during menopause and beyond. *Maturitas, 77*(4), 318-323. https://doi.org/10.1016/j.maturitas.2014.01.006

Suzuki, T., Shimada, H., Makizako, H., Doi, T., Yoshida, D., Ito, K., Shimokata, H., Washimi, Y., Endo, H., & Kato, T. (2013). A randomized controlled trial of multicomponent exercise in older adults with mild cognitive impairment. *PLoS One, 8*(4), e61483. https://doi.org/10.1371/journal.pone.0061483

Sze, S. C., Tong, Y., Zhang, Y. B., Zhang, Z. J., Lau, A. S., Wong, H. K., Tsang, K. W., & Ng, T. B. (2009a). A novel mechanism: Erxian Decoction, a Chinese medicine formula, for relieving menopausal syndrome. *Journal of ethnopharmacology, 123*(1), 27-33. https://doi.org/10.1016/j.jep.2009.02.034

Tao, J., Liu, J., Liu, W., Huang, J., Xue, X., Chen, X., Wu, J., Zheng, G., Chen, B., Li, M., Sun, S., Jorgenson, K., Lang, C., Hu, K., Chen, S., Chen, L., & Kong, J. (2017). Tai Chi Chuan and Baduanjin Increase Grey Matter Volume in Older Adults: A Brain Imaging Study. *Journal of Alzheimer's Disease, 60*(2), 389-400. https://doi.org/10.3233/JAD-170477

Teut, M., Knilli, J., Daus, D., Roll, S., & Witt, C. M. (2016). Qigong or yoga versus no intervention in older adults with chronic low back pain—a randomized controlled trial. *The Journal of Pain, 17*(7), 796-805.

Tian, T., Cai, Y., Zhou, J., Liu, B., Chen, L., Shi, M., & Liang, H. (2020). Effect of eight-section brocade on bone mineral density in middle age and elderly people: Protocol for a systematic review and meta-analysis of randomised controlled trials. *Medicine (Baltimore), 99*(1), e18549. https://doi.org/10.1097/MD.0000000000018549

Uemura, K., Shimada, H., Makizako, H., Doi, T., Yoshida, D., Tsutsumimoto, K., Anan, Y., & Suzuki, T. (2013). Cognitive function affects trainability for physical performance in exercise intervention among older adults with mild cognitive impairment. *Clinical Interventions in Aging, 8,* 97-102. https://doi.org/10.2147/CIA.S39434

Varela, S., Ayan, C., Cancela, J. M., & Martin, V. (2012). Effects of two different intensities of aerobic exercise on elderly people with mild cognitive impairment: a randomized pilot study. *Clinical Rehabilitation, 26*(5), 442-450. https://doi.org/10.1177/0269215511425835

Vujcic, I., Stojilovic, N., Dubljanin, E., Ladjevic, N., Ladjevic, I., & Sipetic-Grujicic, S. (2018). Low back pain among medical students in Belgrade (Serbia): a cross-sectional study. *Pain Research and Management 2018*.

Wang, C., Liang, J., Si, Y., Li, Z., & Lu, A. (2022). The effectiveness of traditional Chinese medicine-based exercise on physical performance, balance and muscle strength among older adults: a systematic review with meta-analysis. *Aging Clinical and Experimental Research, 34*(4), 725-740. https://doi.org/10.1007/s40520-021-01964-2

Wang, C., Zhang, Z., & Ma, J. (1998). Treatment of 50 cases of osteoporosis with Er-Xian Decoction. *Shan Xi Zhong Yi*, 19, 205-206.

Wang, C.-W., Chan, C. H., Ho, R. T., Chan, J. S., Ng, S.-M., & Chan, C. L. (2014). Managing stress and anxiety through qigong exercise in healthy adults: a systematic review and meta-analysis of randomized controlled trials. *BMC Complementary and Alternative Medicine, 14*(1), 1-9.

Ware, J. E., Jr., & Sherbourne, C. D. (1992). The MOS 36-item short-form health survey (SF-36). I. Conceptual framework and item selection. *Medical Care, 30*(6), 473-483. https://www.ncbi.nlm.nih.gov/pubmed/1593914

Wei, X. H., & Ji, L. L. (2014). Effect of handball training on cognitive ability in elderly with mild cognitive impairment. *Neuroscience Letters, 566*, 98-101. https://doi.org/10.1016/j.neulet.2014.02.035

Wheaton, M. G., Abramowitz, J. S., Berman, N. C., Fabricant, L. E., & Olatunji, B. O. (2012).

Psychological predictors of anxiety in response to the H1N1 (swine flu) pandemic. *Cognitive Therapy and Research, 36*(3), 210-218.

Wu, T., Jia, X., Shi, H., Niu, J., Yin, X., Xie, J., & Wang, X. (2021). Prevalence of mental health problems during the COVID-19 pandemic: A systematic review and meta-analysis. *Journal of Affective Disorders, 281*, 91-98. https://doi.org/10.1016/j.jad.2020.11.117

X, J. (2012). A shallow discussion on the dialectical relationship between Baduanjin and health keeping in Chinese medicine. *Chinese Wushu Research,* 1:95–96.

Xiao, Y., Luo, Q., Yu, Y., Cao, B., Wu, M., Luo, Y., Zhao, Y., & Zhou, J. (2021). Effect of baduanjin on the fall and balance function in middle-aged and elderly people: A protocol for systematic review and meta-analysis. *Medicine (Baltimore), 100*(37), e27250. https://doi.org/10.1097/MD.0000000000027250

Xu, X., Han, L., Ma, L., & Zhang, J. (2018). Effect of BADUANJIN exercises combined with TUINA on low back pain and life quality of patients with non-acute-phase lumbar disc herniation. *Journal of Physical Education and Sport*, 30, 18-22.

Yu, L., Liu, F., Nie, P., Shen, C., Chen, J., & Yao, L. (2021). Systematic review and meta-analysis of randomized controlled trials assessing the impact of Baduanjin exercise on cognition and memory in patients with mild cognitive impairment. *Clinical Rehabilitation, 35*(4), 492-505. https://doi.org/10.1177/0269215520969661

Yuan, S., Lin, X., Hong, J., Qiu, C., & Chen, D. (2020). Effects of traditional Chinese exercise on lumbar disc herniation: A protocol of network meta-analysis of randomized controlled trials. *Medicine (Baltimore), 99*(5), e18781. https://doi.org/10.1097/MD.0000000000018781

Zhang, X., & Ren, S. (2011). The effect of Baduanjin on lumbar muscle strain. *Chinese Medicine Modern Distance Education of China,* 9, 105.

Zhang, X.-B., Zhang, J.-L., Li, M.-X., Yuan, Y.-P., & Sun, J. (2021). Baduanjin exercise can alleviate anxiety and depression of patients with COVID-19 in Square cabin hospital: a cross-sectional survey. *Medicine, 100*(32).

Zheng, G., Zheng, Y., Xiong, Z., & Ye, B. (2020). Effect of Baduanjin exercise on cognitive function in patients with post-stroke cognitive impairment: a randomized controlled trial. *Clinical Rehabilitation, 34*(8), 1028-1039. https://doi.org/10.1177/0269215520930256

Zhou, J., Yu, Y., Cao, B., Li, X., Wu, M., Wen, T., Xiong, Y., Jia, J., & Zhao, Y. (2020). Characteristic of Clinical Studies on Baduanjin during 2000-2019: A Comprehensive Review. *Evidence-Based Complementary and Alternative Medicine,* 2020, 4783915. https://doi.org/10.1155/2020/4783915

Zhu, L., Wu, W., Chen, M., Xu, D., Xu, H., Liu, L., Liu, J., & Zhu, Z. (2021). Effects of Nonpharmacological Interventions on Balance Function in Patients with Osteoporosis or Osteopenia: A Network Meta-Analysis of Randomized Controlled Trials. *Evidence-Based Complementary and Alternative Medicine,* 2021, 6662510. https://doi.org/10.1155/2021/6662510

Zou, J., Lin, F., & Zhang, L. (2011). Effect of Long Time Taijiquan Training on Bone Density and Balance Function in Post-menopause Women. *Chinese Journal of Rehabilitation Theory and Practice*, 01.

Zou, L., Yeung, A., Quan, X., Hui, S. S.-C., Hu, X., Chan, J. S., Wang, C., Boyden, S. D., Sun, L., & Wang, H. (2018). Mindfulness-based Baduanjin exercise for depression and anxiety in people with physical or mental illnesses: a systematic review and meta-analysis. *International Journal of Environmental Research and Public Health, 15*(2), 321.

Zung, W. W. (1965). A Self-Rating Depression Scale. *Archives of General Psychiatry,* 12, 63-70. https://doi.org/10.1001/archpsyc.1965.01720310065008

Zung, W. W. (1971). A rating instrument for anxiety disorders. *Psychosomatics: Journal of Consultation and Liaison Psychiatry*, 12(6), 371-379. https://doi.org/10.1016/S0033-3182(71)71479-0

ABSTRACT

Background

Increasing evidence supports the role of physical exercise on human physical and mental health. Baduanjin is a form of Chinese traditional Qigong exercise for health. Few studies have assessed the function of Baduanjin exercise. Its effects on physical and mental health and its related mechanisms have not been verified or explained.

Aims of research

This thesis aims to evaluate the value and function of Baduanjin as a traditional exercise in China. It also aims to explore the effects of Baduanjin exercise as a single intervention and combined with medicine on the physiological function, psychological state, and cognitive function of different age groups. It aims to further verify the safety, effectiveness, and scientificity of both the single intervention and the combined medicine and exercise intervention.

Participants and methods

All three papers reported on simple randomized controlled trials.

1. In the first published paper, 387 college student participants were randomly allocated in a 1:1 ratio to a 12-week Baduanjin exercise group (BEG, n = 195) or a 12-week control group (CG, n = 192).

2. In the second published paper, 60 participants with mild cognitive impairment were randomly allocated in a 1:1 ratio to a 12-week Baduanjin exercise group or a 12-week leisure walking group, with 30 cases in each group.

3. In the third published paper, 50 participants with postmenopausal osteoporosis were allocated to three groups: the Er Xian decoction group (EXD, n = 15), the Baduanjin exercise group (BE, n = 18), or the combined group (EXD + BE, n = 17). Participants were evaluated after 8 weeks and 16 weeks of the intervention treatment.

All the participants completed a field test (see papers). The sociodemographic data collected comprised age, gender, education, smoking status, drinking status, sedentary time, exercise frequency, employment status, body mass index, menopause duration, and marital status.

The first published paper used the Coronavirus Anxiety Scale (CAS), Psychological Well-being Scale (PWBS), and Nordic Musculoskeletal Questionnaire (NMQ).

The second published paper used the Mini Mental State Examination (MMSE), Montreal Cognitive Assessment (MoCA), Berg Balance Scale (BBS), Timed Up and Go (TUG) test, 10-

meter walking test (10 MWT), and 12-Item Short Form Survey (SF-12) with the Physical component score (PCS) and Mental component Score (PCS).

The third published paper used bone mineral density (BMD; The lumbar spine [LS] and the femoral neck [FN]), the one-leg standing test (OLST), BBS, TUG test, Self-Anxiety Scale (SAS), and Self-Rating Depression Scale (SDS).

Results

In the first published paper, the between-groups comparison showed that the Baduanjin group presented significant differences in comparison to the control group. The intervention effect on the Baduanjin exercise group was remarkably better than that of the control group ($p < 0.05$). Participants in the Baduanjin group had significantly improved COVID-19-related anxiety scores, decreasing from 5.22 ± 0.45 to 5.07 ± 0.27 ($p < 0.05$). The total psychological well-being score increased from 70.11 ± 8.65 to 84.12 ± 7.38 ($p < 0.05$), and the prevalence of low back pain decreased from 22.45 ± 1.67 to 18.35 ± 1.05 ($p < 0.05$) among college students.

In the second published paper, compared to participants in the leisure walking group, participants in the Baduanjin group showed a significant improvement in cognitive function (MMSE: from 21.83 ± 2.22 to 27.4 ± 2.07, $p < 0.05$; MoCA: from 19.96 ± 1.92 to 24.48 ± 2.33, $p < 0.05$). The Baduanjin exercise group showed significant improvement in lower limb balance function (BBS: from 47.68 ± 1.95 to 52.38 ± 2.19, $p < 0.05$; TUG: from 9.63 ± 0.15to 8.64 ± 0.21, $p < 0.05$); 10 MWT: from 0.93 ± 0.02to 1.27 ± 0.2, $p < 0.05$). Physical component score (PCS) and Mental component Score (PCS) are two important indicators reflecting the quality of life. The Baduanjin exercise group showed a greater effect on quality of life (PCS: from 47.88 ± 2.27 to 53.79 ± 1.95], $p < 0.05$; MCS: from 57.33 ± 1.84 to 62.55 ± 2.02, $p <0.05$). In addition, after the Baduanjin intervention, a significant positive correlation existed between lower limb balance (BBS) and improved cognitive function (MMSE; $r = 0.32$, $p < 0.05$). A significant positive correlation also existed between lower limb balance (10 MWT) and the improvement of cognitive function (MMSE; $r = 0.36$, $p < 0.05$). The change in quality of life (MCS) was positively correlated with cognitive function (MoCA) improvement ($r = 0.59$, $p < 0.01$).

In the third published paper, compared to the EXD and BE groups, the EXD + BE group showed the strongest effects on BMD (LS: increased from 0.75 ± 0.01 to 0.98 ± 0.01, $p < 0.05$; FN: increased from 0.73 ± 0.01 to 0.97 ± 0.01, $p < 0.01$). The EXD + BE group in Lower limb balance function has significantly improved. Mainly shown as follows (OLST: 3.88 ± 0.22 to 7.3 ± 0.19, $p < 0.01$; BBS: 39.31 ± 1.26 to 45.23 ±1.02, $p < 0.01$; TUG: 7.23 ± 0.14 to 6.54 ± 0.19, $p < 0.01$). The EXD + BE group plays a significant role in eliminating and reducing anxiety and depression. Mental health scores as follow (SDS: 50.71 ± 2.04 to 46.06 ± 2.26, $p < 0.01$; SAS: 53.37 ± 1.83 to 46.02 ± 1.23, $p < 0.001$). In the EXD + BE group, a correlation existed between BMD and lower limb balance (BBS: $r = 0.35$, $p < 0.05$; TUG: $r = -0.52$, $p < 0.01$). The change in mental health (SAS score) was correlated with BMD (FN) improvement ($r = -0.57$, $p < 0.01$).

Conclusion

These results show that Baduanjin exercise as a single intervention and in combination with medicine (Er Xian decoction) had significant effects on the physiological functions (bone density, lower limb balance), psychological state, and cognitive function of different age groups. The studies verified the safety, effectiveness, and scientificity of Chinese traditional health Qigong.

Streszczenie

Wprowadzenie

Coraz więcej dowodów wspiera tezę o znaczeniu ćwiczeń fizycznych dla zdrowia fizycznego i psychicznego człowieka. Baduanjin jest formą chińskiego tradycyjnego ćwiczenia zdrowotnego Qigong. Dotychczas niewiele badań podjęło się oceny funkcji jakie pełnią ćwiczenia Baduanjin. Ich wpływ na zdrowie fizyczne i psychiczne oraz związane z nimi mechanizmy oddziaływań nie zostały dotychczas wystarczająco zweryfikowane, czy wręcz wyjaśnione.

Cel badań

Głównym celem pracy była ocena terapeutycznej skuteczności Baduanjin jako tradycyjnej chińskiej formy aktywności fizycznej. W pracy przyjęto następujące zadanie badawcze: określenie wpływu 12. tygodniowych ćwiczeń Baduanjin rozumianych jako pojedyncza interwencja oraz w połączeniu z oddziaływaniem medycznym (spożywaniem wywaru Er-Xian) na stan psychiczny, funkcje poznawcze, równowagę ciała oraz mobilność funkcjonalną różnych grup wiekowych.

Osoby badane i metody badawcze

Prace stanowiły randomizowane badania kontrolne.

1. W pierwszej opublikowanej pracy, 387 uczestników, studentów college'u, zostało losowo przydzielonych w stosunku 1:1 do 12-tygodniowej grupy ćwiczeniowej Baduanjin (BEG, *n* = 195) lub 12-tygodniowej grupy kontrolnej (CG, *n* = 192).

2. W drugiej opublikowanej pracy, 60 uczestników z łagodnymi zaburzeniami poznawczymi zostało losowo przydzielonych w stosunku 1:1 do 12-tygodniowej grupy ćwiczeń Baduanjin lub 12-tygodniowej grupy spacerów rekreacyjnych, z 30 przypadkami w każdej grupie.

3. W trzeciej opublikowanej pracy 50 uczestników z osteoporozą pomenopauzalną zostało przydzielonych do trzech grup: grupa Er Xian (EXD, *n* = 15), grupa ćwiczeń Baduanjin (BE, *n* = 18) lub grupa łączona (EXD + BE, *n* = 17). Uczestnicy byli oceniani po 8 tygodniach i 16 tygodniach leczenia interwencyjnego.

Wszyscy uczestnicy wypełnili test terenowy. Zebrane dane socjodemograficzne obejmowały wiek, płeć, wykształcenie, status palenia tytoniu, status picia alkoholu, czas spędzony w pozycji siedzącej, częstotliwość ćwiczeń, status zatrudnienia, wskaźnik masy ciała, czas trwania menopauzy oraz stan cywilny.

W pierwszej opublikowanej pracy wykorzystano Skalę Lęku przed Koronawirusem

(CAS), Skalę Dobrostanu Psychologicznego (PWBS) oraz Nordycki Kwestionariusz Mięśniowo-Szkieletowy (NMQ).

W drugiej opublikowanej pracy wykorzystano Mini Mental State Examination (MMSE), Montreal Cognitive Assessment (MoCA), Berg Balance Scale (BBS), Timed Up and Go (TUG) test, 10-metrowy test chodzenia (10MWT) oraz 12-Item Short Form Survey (SF-12) z Physical component score (PCS) i Mental component Score (PCS).

W trzeciej opublikowanej pracy wykorzystano gęstość mineralną kości (BMD; kręgosłup lędźwiowy [LS] i szyjka kości udowej [FN]), test stania na jednej nodze (OLST), BBS, test TUG, Skalę Samopoczucia (SAS) i Skalę Samooceny Depresji (SDS).

Główne wyniki

W pierwszej opublikowanej pracy, porównanie między grupami wykazało, że grupa Baduanjin miała znacząco różniła się w stosunku do grupy kontrolnej. Efekt interwencji w grupie ćwiczącej Baduanjin był znacząco lepszy niż w grupie kontrolnej ($p < 0,05$). Uczestnicy grupy Baduanjin uzyskali znacząco lepsze wyniki na skali lęku związanego z COVID-19, zmniejszając je z 5,22 ± 0,45 do 5,07 ± 0,27 ($p < 0,05$). Całkowita punktacja dobrostanu psychologicznego wzrosła z 70,11 ± 8,65 do 84,12 ± 7,38 ($p < 0,05$), a częstość występowania bólu dolnej części pleców zmniejszyła się z 22,45 ± 1,67 do 18,35 ± 1,05 ($p < 0,05$) wśród studentów college'u.

W drugiej opublikowanej pracy, w porównaniu z uczestnikami grupy spacerującej rekreacyjnie, uczestnicy grupy Baduanjin wykazali znaczącą poprawę funkcji poznawczych (MMSE -3,56 [95% CI -4,65 do -2,48], $p < 0,05$) i MoCA (-1,68 [95% CI -2,85 do -0,52], $p < 0,05$). W grupie ćwiczeń Baduanjin stwierdzono istotną poprawę równowagi ciała (BBS -4,73 [95% CI -5,87 do -3,59], $p < 0,05$); TUG 0,52 [95% CI 0,42 do 0,61], $p < 0,05$); 10MWT -0,24 [95% CI -0,31 do -0,16], $p < 0,05$). Physical component score (PCS) i Mental component Score (PCS) to dwa ważne wskaźniki odzwierciedlające jakość życia. Grupa ćwicząca Baduanjin wykazała większy wpływ ćwiczeń na jakość życia (PCS -1,94 [95% CI -2,89 do -1], $p < 0,05$); MCS -1,8 [95% CI -2,86 do -0,75], $p < 0,05$).

Ponadto po interwencji Baduanjin zaobserwowano istotną dodatnią korelację pomiędzy równowagą ciała mierzoną w teście BBS a poprawą funkcji poznawczych (MMSE; $r = 0,32$, $p < 0,05$). Istotna dodatnia korelacja istniała również pomiędzy wynikami testu 10 MWT a poprawą funkcji poznawczych. Zmiana jakości życia (MCS) była pozytywnie skorelowana z poprawą funkcji poznawczych (MoCA) ($r = 0,59$, $p < 0,01$).

W trzeciej opublikowanej pracy, w porównaniu do grup EXD i BE, grupa EXD + BE wykazała najsilniejszy wpływ na BMD (LS: wzrosła z 0,75 ± 0,01 do 0,98 ± 0,01, $p < 0,05$;

FN: wzrosła z 0,73 ± 0,01 do 0,97 ± 0,01, $p < 0,01$). W grupie EXD + BE nastąpiła istotna statystycznie poprawa równowagi ciała (OLST: 3,88 ± 0,22 do 7,3 ± 0,19, $p < 0,01$; BBS: 39,31 ± 1,26 do 45,23 ± 1,02, $p < 0,01$) oraz mobilności funkcjonalnej (TUG: 7,23 ± 0,14 do 6,54 ± 0,19, $p < 0,01$). Interwencja w grupie EXD + BE odgrywała znaczącą rolę w eliminacji i redukcji lęku i depresji (SDS: 50,71 ± 2,04 do 46,06 ± 2,26, $p < 0,01$; SAS: 53,37 ± 1,83 do 46,02 ± 1,23, $p < 0,001$). W grupie EXD + BE istniała korelacja pomiędzy BMD a równowagą ciała w teście BBS ($r = 0,35$, $p < 0,05$) oraz mobilnością funkcjonalną w teście TUG ($r = -0,52$, $p < 0,01$). Zmiana stanu zdrowia psychicznego (SAS score) była skorelowana z poprawą BMD (FN) ($r = -0,57$, $p < 0,01$).

Wnioski

Przedstawione wyniki sugerują, że ćwiczenia Baduanjin bez i w połączeniu ze spożywaniem wywaru Er Xian miały pozytywny wpływ na gęstość kości, równowagę ciała, mobilność funkcjonalną oraz stan psychiczny i funkcje poznawcze w różnych grupach wiekowych.

SZKOŁA DOKTORSKA

STATEMENT OF THE CO-AUTHORS OF THE PUBLICATION

Li, K., Walczak-Kozłowska, T., Lipowski, M., Li, J., Krokosz, D., Su, Y., Yu, H., & Fan, H. (2022). The effect of the Baduanjin exercise on COVID-19-related anxiety, psychological well-being and lower back pain of college students during the pandemic. BMC Sports Science, Medicine and Rehabilitation, 14(1), 102. https://doi.org/10.1186/s13102-022-00493-3

We hereby declare that the individual contribution to the creation of the publication is as follows:

author	Individual (%) contribution	specification	signature
Keqiang Li	60%	ABCDEFG	Ke qiang Li
Tamara Walczak-Kozłowska	16%	ABDEFG	Tamara Walczak-Kozłowska
Mariusz Lipowski	10%	ABCFG	
Jianye Li	3%	ABF	Jianye Li
Daniel Krokosz	5%	ABE	Daniel Krokosz
Yuying Su	2%	ABF	Yu Ying Su
Hongli Yu	2%	ABF	Hongli Yu
Hongying Fan	2%	ABF	Fan Hongying

* **A** – Study Design, **B** – Data Collection, **C** – Statistical Analysis, **D** – Data Interpretation, **E** – Manuscript Preparation, **F** – Literature Search, **G** – Funds Collection

Keqiang Li

signature of the candidate for the doctoral degree

promoter's signature

Biuro Spraw Doktoranckich
szkola.doktorska@awf.gda.pl
+48 58 55 47 262, +48 603 766 393
ul. K. Górskiego 1, 80-336 Gdańsk

SZKOŁA DOKTORSKA

STATEMENT OF THE CO-AUTHORS OF THE PUBLICATION

Li, K., Yu, H., Kortas, J. A., Lin, X., Lipowski, M. (2022). The effect of 12 weeks of Baduanjin exercise on cognitive function, lower limb balance and quality of life of the elderly with mild cognitive impairment: a randomized controlled trial. Gazzetta Medica Italiana – Archivio per le Scienze Mediche,181, 811-23. https://doi.org/10.23736/S0393-3660.22.04802-1

We hereby declare that the individual contribution to the creation of the publication is as follows:

author	Individual (%) contribution	specification	signature
Keqiang Li	61%	ABCDEFG	Keqiang Li
Hongli Yu	2%	BC	Hongli Yu
Jakub Antoni Kortas	15%	ACDEFG	Jakub Kortas
Xiaojun Lin	8%	ACFG	Xiaojun Lin
Mariusz Lipowski	14%	ABFG	[signature]

* **A** – Study Design, **B** – Data Collection, **C** – Statistical Analysis, **D** – Data Interpretation, **E** – Manuscript Preparation, **F** – Literature Search, **G** – Funds Collection

Keqiang Li

signature of the candidate for the doctoral degree

promoter's signature

Biuro Spraw Doktoranckich
szkola.doktorska@awf.gda.pl
+48 58 55 47 262, +48 603 766 393
ul. K. Górskiego 1, 80-336 Gdańsk

SZKOŁA DOKTORSKA

STATEMENT OF THE CO-AUTHORS OF THE PUBLICATION

Li, K., Yu, H., Lin, X., Su, Y., Gao, L., Song, M., Fan, H., Krokosz, D., Yang, H., & Lipowski, M. (2022). The Effects of Er Xian Decoction Combined with Baduanjin Exercise on Bone Mineral Density, Lower Limb Balance Function, and Mental Health in Women with Postmenopausal Osteoporosis: A Randomized Controlled Trial. *Evidence-Based Complementary and Alternative Medicine, 2022*, 8602753. https://doi.org/10.1155/2022/8602753

We hereby declare that the individual contribution to the creation of the publication is as follows:

author	Individual (%) contribution	specification	signature
Keqiang Li	50%	ABCDEFG	Keqiang Li
Hongli Yu	15%	ABCDEF	Hongli Yu
Xiaojun Lin	4%	BCDE	Xiao Jun Lin
Yuying Su	2%	BF	YuYing Su
Lifeng Gao	3%	CDF	Li feng Gao
Minjia Song	2%	BF	Min Jia Song
Hongying Fan	2%	BF	Fan Hongying
Daniel Krokosz	4%	ACDF	Daniel Krokosz
Huixin Yang	3%	BDF	Hui xin Yang
Mariusz Lipowski	15%	ABCDEG	[signature]

* **A** – Study Design, **B** – Data Collection, **C** – Statistical Analysis, **D** – Data Interpretation, **E** – Manuscript Preparation, **F** – Literature Search, **G** – Funds Collection

Keqiang Li
signature of the candidate for the doctoral degree

promoter's signature

Biuro Spraw Doktoranckich
szkola.doktorska@awf.gda.pl
+48 58 55 47 262, +48 603 766 393
ul. K. Górskiego 1, 80-336 Gdańsk

Li *et al.*
BMC Sports Science, Medicine and Rehabilitation (2022) 14:102
https://doi.org/10.1186/s13102-022-00493-3

BMC Sports Science, Medicine and Rehabilitation

RESEARCH

Open Access

The effect of the Baduanjin exercise on COVID-19-related anxiety, psychological well-being and lower back pain of college students during the pandemic

Keqiang Li[1*], Tamara Walczak-Kozłowska[2], Mariusz Lipowski[1], Jianye Li[1], Daniel Krokosz[1], Yuying Su[3], Hongli Yu[1] and Hongying Fan[4]

Abstract

Background: This study aimed to examine the effect of Baduanjin exercise on COVID-19-related anxiety, psychological well-being, and the lower back pain of college students during the coronavirus pandemic in China.

Setting: The study was carried out in a temporary experimental center of four universities in Wenzhou city in Zhejiang Province, China.

Population: 387 participants who were college students were allocated to two groups: the Baduanjin exercise group(BEG, n = 195); and the Control group(CG,n = 192).

Methods: In this randomized controlled trial,387 participants who were college students were randomly allocated in a 1:1 ratio to 12-week Baduanjin exercise group (BEG, n = 195)and 12-week Control group(CG,n = 192). CAS(Coronavirus Anxiety Scale), PWBS(Psychological Well-being Scale),NMQ(Nordic Musculoskeletal Questionnaire), was used to assess COVID-19-related anxiety, psychological well-being, and lower back pain at second times (before and after the intervention). The paired t-test and an independent t-test (with a 95% confidence interval) was used to compare the outcome variables of the two groups.

Results: Within-group comparison, there was no significant difference in the control group before and after the intervention. In contrast, the Baduanjin group had a significant improvement before and after the intervention. Between-group comparison, the Baduanjin group had a significant difference from the control group. The intervention effect on the Baduanjin exercise group was remarkably better than that of the control group ($p < 0.05$). Participants in the Baduanjin group significantly improved the corvid-19-related anxiety score decreased from (5.22 ± 0.45 to 5.07 ± 0.27, $p < 0.05$). The total psychological well-being score increased from (70.11 ± 8.65 to 84.12 ± 7.38,$p < 0.05$) and the prevalence of low back pain decreased from (22.45 ± 1.67 to 18.35 ± 1.05, $p < 0.05$) among college students.

Conclusion: During the pandemic, the Baduanjin exercise contributes to the reduction of the perceived anxiety related to COVID-19, decreases the prevalence of the lower back pain, and improves the psychological well-being of college students.

*Trial registration***:** Clinicaltrials.gov, NCT04432038. Registered on June 16, 2020.

*Correspondence: keqiang.li@awf.gda.pl

[1] Gdansk University of Physical Education and Sport, Gdańsk, Poland
Full list of author information is available at the end of the article

Keywords: Qigong, Baduanjin exercise, College student, COVID-19-related anxiety, Mental health, The prevalence of low back pain, Pandemic

Background

Since the beginning of the COVID-19 pandemic until May 2021, numerous changes and restrictions have been introduced by countries that have significantly influenced the lifestyle of the inhabitants. People's traditional daily life and physical activities in China were highly affected by the government's policy as well as by the trajectory of changes in the pandemic situation (e.g. changes in the spread of COVID-19 virus, periods of increased mortality and morbidity). Meanwhile, the pandemic has made Chinese universities lockdown, and college students have to study online courses at home. Long-term online courses have increased students' sedentary time, while pandemics have reduced daily exercise and social time [1]. Long-term sedentary behavior resulting from COVID-19's isolation policy may have physical and psychological effects on college students [2–6], Those effects can lead to increase of the severity and prevalence of chronic diseases in different groups [7–17].

Numerous studies have shown that sedentary behavior has become a leading global public health problem, and as we all know this behavior is an important risk factor of several diseases, and even loss of life. In the sedentary behavior, the neck and lumbar spine and other body parts stay dormant for a long time. Students typically spend many hours seated on non-ergonomic chairs and assuming incorrect postures to carry out their curricular activities, leading to a general musculoskeletal overload [18], especially at the neck and low back [19]. Haroon et al. [20] reported university students use laptops for more than three hours per day as a risk factor for neck pain. This leads to an abnormal body position, causing pain in the waist, abdomen and back, in addition to decreased muscle strength. Sedentary behavior is one of the main risk factors for various chronic noncommunicable diseases, such as spondylosis, periarthritis of shoulder, non-specific low back pain and many others [21, 22]. It also increases the severity of perceived stress, and reduces people's quality of life and psychological well-being. Relevant research shows that chronic pain increases patient Perceived stress when our body perceives stress [23, 24]. Approximately 15 min after the onset of stress, cortisol levels rise systemically and remain elevated for several hours [25, 26]. However, although a stress-induced increase in cortisol secretion is adaptive in the short-term, excessive or prolonged cortisol secretion may have crippling effects, both physically and psychologically [24, 27, 28].and thus should be recognized as an additional risk factor during the pandemic when people generally report greater fear and more worries [29, 30]. There is growing evidence pointing that the COVID-19 pandemic contributes to the increased number of cases of mental health problems, anxiety, and depression [31–34].

Baduanjin, in terms of its effect as an exercise intervention, has been recognized in many international studies [35]. As a traditional Chinese mind-body aerobic exercise, Qigong is based on Taoist philosophy and traditional Chinese medicine theories [36]. Qigong is a combination of postures, meditation, and movements designed to improve holistic health and to facilitate mind-body integration [36, 37]. It consists of eight independent, simple, subtle, and smooth movements [38]. Although the potential effectiveness of each movement may be different, the overall Baduanjin exercise has been demonstrated to have a good effect on body and mind [38]. Baduanjin exercise can enhance Qi function through the whole exercise of body posture, movement, breathing, and meditation—that is, to draw upon natural forces to optimize and balance energy within, through the purposeful coordination of body, breath, and mind [39]. With the combination of self-awareness with self-correction of the posture and movement of the body, the flow of breath, and stilling of the mind, Baduanjin exercise is thought to comprise a state which activates the natural self-regulation capacity, stimulates the balanced release of endogenous neurohormones, and a wide array of natural health recovery mechanisms [40].

For instance, the Baduanjin exercise has been recognized as an effective way of alleviating the lower back pain (even its chronic condition) caused by lumbar disc herniation [41, 42]. It improves the strength and flexibility of the neck, shoulder, and back. Thus, it helps reducing the occurrence and development of diseases related to the above-mentioned parts of the body [43, 44]. The positive effect of the Baduanjin exercise on mental health was previously observed in cohorts of college students, as well as middle-aged and older people [45–47]. Beside, studies show that Baduanjin played an obvious role in adjuvant therapy and postoperative rehabilitation during COVID-19 epidemic [48–50].

However, little is known about the effect of the Baduanjin exercise on the prevalence of lower back pain, COVID-19-related anxiety and psychological well-being in college students during the pandemic. Thus, this article aims to explore the effects of Baduanjin intervention on physical and mental health of people during the pandemic, together with providing theoretical and practical references for healthy lifestyles for sedentary groups.

Materials and methods

Design

The purpose of the study was to examine whether Baduanjin exercises can decrease COVID-19-related anxiety, decrease the prevalence of lower back pain, and increase psychological well-being in College Students during the pandemic. The protocol of this study was approved by the Ethics Board for Research Projects at the Institute of Psychology, University of Gdansk, Poland (decision no. 33/2020). Figure 1 presents the stages of the study regarding also the flow of the respondents.

Participants

From September 2020 to December 2020, four universities students were randomly selected from Wenzhou City in Zhejiang Province, China. According to the inclusion criteria, the participants were between 20 and 30 years old. Furthermore, they must have worked, studied, or lived in a selected school for more than two months in the past year and needed to be able to participate in online and offline activities as well as answer questions from the surveys. Eventually, a total of 387 participants were qualified for the study.

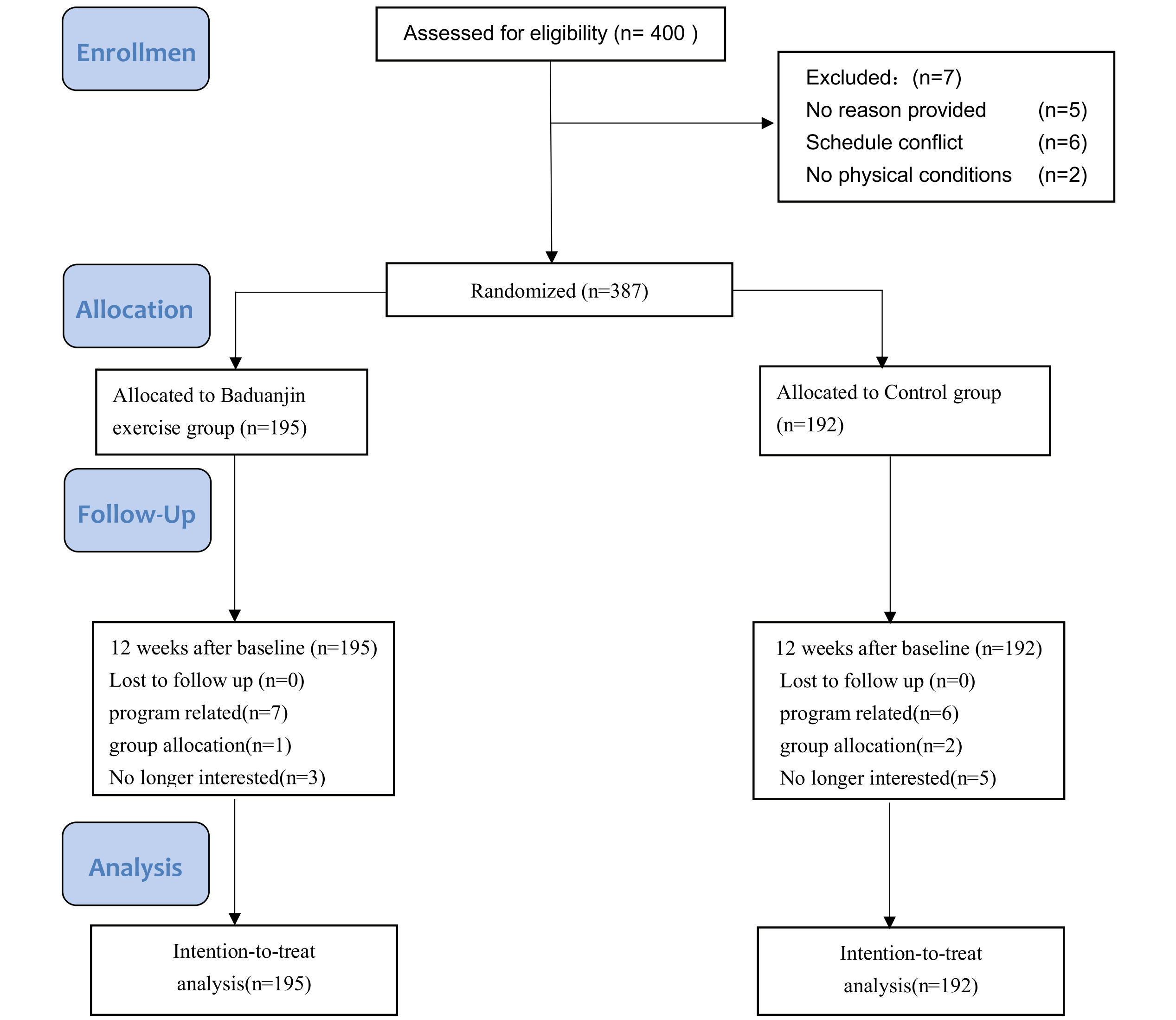

Fig. 1 Study flow diagram of the progress through the phases of the experiment

The intervention

2.3.1 Randomization and allocation

387 participants who fulfilled the eligibility criteria were allocated randomly to two intervention-based groups; the Baduanjin exercise group (BE; n = 195) or the Control group (CG; n = 192). To ensure blinding, an independent researcher who was not a part of this study performed the randomized allocation. A 1:1 simple randomization technique was employed. A unique, computer-generated random code was assigned for each participant via SPSS (version 26.0, Armonk, New York, USA) statistical software. The allocation was concealed in sealed opaque envelopes, which were provided to researchers before applying the assigned interventions. All study personnel and participants were blinded to treatment assignment for the trial duration. The experimental intervention time for the two groups was 12 weeks.

Baduanjin exercise group

In this group, the participants were performing the Baduanjin exercises for 12 weeks. They were guided by a professional Qigong Baduanjin coach in the first week and then began a formal 11-week intervention period of Baduanjin exercises after mastering moving and breathing methods. During this intervention period, the participants were exercising independently, and each week they have been doing the Baduanjin exercises no fewer than five times for a total duration of 45 min per session [51]. They were required to wear sportswear and sports shoes during these exercises. Participants performed a warm-up exercise for approx. 5–10 min before the practice, with formal exercises beginning after 3–5 min of Qi practicing. Stretching exercises for 5 min after the exercise were also performed by the participants. The coach guided subjects through a group exercise once a week (during the formal 11-week intervention period). Participants need to provide instant feedback which they had encountered in their daily exercises to the doctor and coach at any time.

Control group

To examine the validity of the pre and post-test learning health knowledge, participants needed to join a WeChat group to finish the test. Participants were instructed to learn health knowledge on the Internet independently during the learning process. They were asked to be learning for 12 consecutive weeks. Each week, they had to learn no fewer than 5 times and learn at least 30 min every time. To ensure that participants learn health knowledge independently, each participant was asked to check-in before and after learning in a WeChat group. And participants had to complete the quiz after learning the health knowledge course each time. Management staff undertook a return visit to the control group every other week and showed each course's quiz results.

Measurements

Nordic musculoskeletal questionnaire (NMQ)

The Nordic Musculoskeletal Questionnaire was applied to measure the musculoskeletal pain [52–54]. Nordic Musculoskeletal Questionnaire (NMQ) were collected [55]. NMQ is valid, reliable and responsive [56, 57]. Both English and Chinese versions of the NMQ have been used in several studies for the analysis of musculoskeletal symptoms in an occupational health context [58]. This questionnaire addresses three main parts. The first part is about any trouble (such as pain, ache, discomfort and numbness) felt by the respondent in the last 12 months. The second part asks the same question but for the last seven days. The final part is about the disability caused by the trouble in the last 12 months. In each part, the data collected were about different anatomical areas: neck, upper back, lower back, shoulders, elbows, wrists/hands, hips/thighs/buttocks, knees and ankle/feet. The responses were recorded in the form of binary options ("yes" and "no").Severe pain was assessed using the Numerical Pain Rating Scale [59], which classifies a score of eight or higher as severe pain. Severe pain was classified according to the criteria of Boonstra et al. (2016), which considers: no pain (score = 0), mild pain (≤ 5), moderate pain (6 and 7), and severe pain (≥ 8) [60]. Previous studies have demonstrated that NMQ is well-validated [35].The internal consistency of the Nordic Musculoskeletal Questionnaire in our study was $\alpha = 0.93$.

The coronavirus anxiety scale (CAS)

For the research purposes, we used the Coronavirus Anxiety Scale (CAS) developed by [61] which consists of 5 items developed based on the psychological descriptions of fear and anxiety symptoms [38, 62–64]. The five items of the CAS (Lee, 2020) were presented to the participants: dizziness, sleep disturbances, tonic immobility, appetite loss, and abdominal distress. Participants had to rate them on the same 5-point scale as in the original version (How often have you experienced any of the following in the past 2 weeks? 0 = not at all; 1 = rare, less than a day or two; 2 = several days; 3 = more than 7 days; 4 = nearly every day over the last 2 weeks). The total score is calculated by adding the scores for each of the responses [61]. The internal consistency of the Coronavirus Anxiety Scale CAS scale in our study was $\alpha = 0.793$.

Psychological well-being scale (PWBS)

This questionnaire was originally designed and proposed by Ryff [65], yet we used the version developed by Ryff and Almeida [66] for this study, which is more in line with the current pandemic situation. After being quoted by many experts and scholars [67–69], it's reliability was scored as being high. PWBS is a measurement tool with a multi-dimensional structure, this scale has six subscales. They are principal elements of psychological well-being. These subscales are autonomy, personal growth, environmental mastery, purpose in life, positive relations with others, and self-acceptance. Each subscale entails three items rated on a 6-point Likert scale (from strongly disagree = 1 to strongly agree = 6). Eight-item this scale are reverse scored. This scale has a score range of 18–108, with a higher score indicating better PWB.The internal consistency of the PWBS total scale in our study was α = 0.78.

Statistical analyses

IBM SPSS Statistics, Version 26.0 (IBM, Armonk, New York, USA) was used for statistical analysis. A one-way analysis of variance and chi-square tests were used to analyze baseline demographic characteristics between two groups. After analyzing normal distribution with the Kolmogorov-Smirnoff (K-S) test, the descriptive characteristics of variables were expressed using means and standard deviations (SD). The paired t-test (t-test for dependent variables) was used to verify the group's changes before and after the intervention. An independent sample t-test (t-test for independent variables with a 95% confidence interval) was used to compare the two groups' mean values after the intervention. The tests were conducted to examine the effect of Baduanjin exercise on COVID-19-related anxiety, psychological well-being, and the prevalence of lower back pain of college students. P-value of 0.05 has been adopted for the standard evaluation of significant differences, and $p = 0.01$—for noticeable significant differences. The correlation analysis was used to analyze the correlation between the prevalence of lower back pain, changes in psychological well-being, and improvement of COVID-19-related anxiety.

Results

Descriptive statistics of sociodemographic information of Baduanjin exercise group and controls

A total of 387 participants were in this study, and most of them were College/Undergraduate students (57.62%). Men covered 50.9%. There were no significant differences between the Baduanjin exercise group and the control group regarding gender, age, education level, marital status, smoking history, drinking history, Sedentary time, Frequency of participation in exercise ($p > 0.05$). More detailed statistics of the participants' characteristics are presented in Table 1.

The musculoskeletal pain among the participants of the study

Before we started analyzing between-group and within-group differences, we decided to find out which part of the body college students most commonly experience pain. The analysis of scores obtained in the Nordic

Table 1 Descriptive statistics of sociodemographic information of Baduanjin exercise group and controls; n = 387

Variable		BEG (n = 195)	CG (n = 192)	X^2	p
Age (years)		24 ± 4	23 ± 3	− 0.32	0.964
Gender (M/F)	Men	106 (54.3%)	91 (47.3%)		0.716
	Female	89 (45.7%)	101 (52.7%)		
Education	College/Undergraduate	114 (58.4%)	109 (56.7%)	1.493	0.439
	Postgraduate Student	49 (25.25%)	61(31.9%)		
	Doctoral candidate	20(10.4%)	22(11.4%)		
Marital status	Married	19 (9.7%)	13 (6.7%)	0.719	0.35
	Other	176 (90.3%)	179 (93.3%)		
Smoking status	Never Yes Ever smoking	104 (53.3%) 65 (33.3%) 26 (13.4%)	99 (51.56%) 70 (36.4%) 23 (12.04%)	0.819	0.631
Drinking status	Never Yes Ever drinking	106 (54.35%) 77 (39.4%) 12 (6.25%)	109 (56.7%) 69 (35.9%) 14 (7.4%)	0.496	0.774
Sedentary time (hour)	≤ 5 5–9 10 ≥	40 (20.5%) 58 (29.8%) 97 (49.7%)	37 (19.2%) 63 (32.9%) 92 (47.9%)	1.33	0.628
Frequency of participation in exercise (times / week)	≤ 3 3–5 5 ≥	83 (42.5%) 70 (35.8%) 42 (21.7%)	78 (40.6%) 67 (34.8%) 47 (24.6%)	− 0.25	0.356

In the case of variables with a quantitative measurement scale, the data was presented using mean ± standard deviation

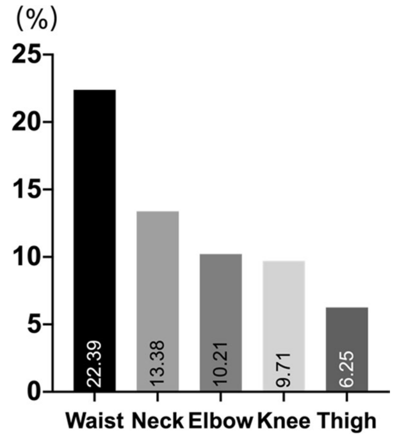

Fig. 2 The musculoskeletal pain among the participants of the study; n = 387

Table 2 Nordic Musculoskeletal Questionnaire (NMQ): scores before and after intervention in the two groups (BEG vs. CG); n = 387

Group	Before intervention	After intervention	p^2
CG(n = 192)	22.51 ± 1.81	22.47 ± 1.46	> 0.05
BEG (n = 195)	22.45 ± 1.67	18.35 ± 1.05**	< 0.05
p^1	> 0.05	< 0.05	

CG Control group, *BEG* Baduanjin exercise group

[1] Between-group difference

[2] Within-group difference

* $p < 0.05$

** $p < 0.01$

Musculoskeletal Questionnaire (NMQ)[35] before the intervention (at baseline) revealed that among 387 of participants, the highest prevalence of pain was in the waist (22.39%), and the lowest prevalence—in the thigh (6.25%). The details are presented in Fig. 2.

Nordic musculoskeletal questionnaire (NMQ): before and after the intervention

Before the intervention, there were no significant differences in scores obtained in the Nordic Musculoskeletal Questionnaire (NMQ) between BEG and CG ($p > 0.05$), and after the intervention, BEG group scored significantly lower than CG group in NMQ ($p > 0.05$). There was significant decrease in scores obtained in NMQ between the two assessments in the BEG group, yet the difference between the two measurements in the CG group was insignificant (see Table 2 and Fig. 3 for the details).

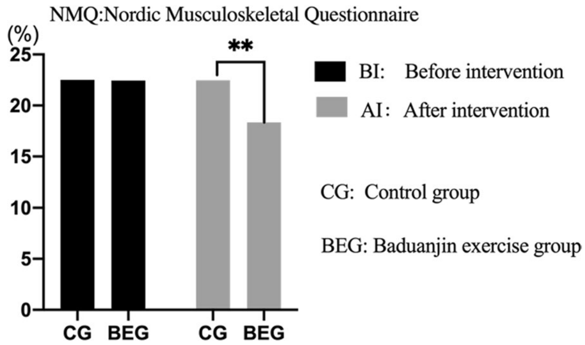

Fig. 3 NMQ: before and after intervention between the two groups: control group vs. Baduanjin exercise group. $p^* < 0.05$; $p^{**} < 0.01$

Table 3 Coronavirus Anxiety Scale (CAS) before and after intervention between the two groups (BEG vs. CG); n = 387

Group	Before intervention	After intervention	p^2
CG(n = 192)	5.21 ± 0.67	5.18 ± 0.78	< 0.05
BEG (n = 195)	5.22 ± 0.45	5.07 ± 0.27**	< 0.01
p^1	> 0.05	< 0.05	

Control group; *BEG* Baduanjin exercise group

p^1: Between-group difference

p^2: Within-group difference

* $p < 0.05$

** $p < 0.01$

Coronavirus anxiety scale (CAS): before and after the intervention

Before the intervention, there was no significant difference between BEG and CG in scores obtained in the CAS ($p > 0.05$), however, such a between-group difference was found after the intervention ($p < 0.05$). Moreover, in both—the BEG and CG, the scores obtained in CAS decreased in exercise time (BEG: $p < 0.01$; CG: $p < 0.05$). The Baduanjin exercise group was significantly lower than the control group ($p < 0.05$). Table 3 and Fig. 4 provides more details.

Psychological well-being (PWBS): before and after intervention

Before the intervention, there were no significant differences in the PWBS scores between BEG and CG ($p > 0.05$). However, groups differed significantly after the intervention ($p < 0.05$) with BEG group scoring significantly better in environmental mastery, personal growth, self-acceptance, and PWBS total score. Significant improvement between the two assessments was observed only in the BEG group: participants received better scores in such PWBS's subscales as environmental

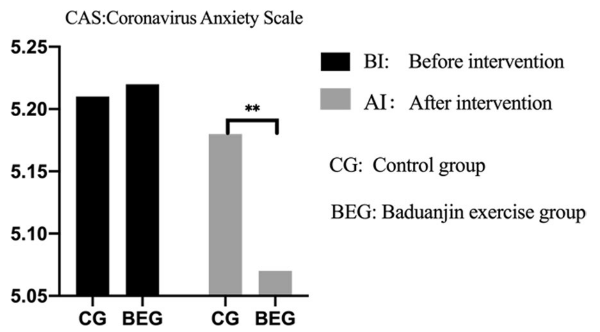

Fig. 4 CAS: before and after intervention between the two groups: control group vs Baduanjin exercise group; $p * < 0.05$; $p ** < 0.01$

mastery, personal growth, positive relations with others, self-acceptance, and in the PWBS total score (see Table 4 and Fig. 5 for the details).

Correlation between the prevalence of low back pain, changes of psychological well-being, and improvement of COVID-19 related anxiety

After 12 weeks of intervention, COVID-19-related anxiety, the prevalence of low back pain and psychological well-being in participants in the two groups have improved in comparison to the assessment before the intervention. Partial correlation analysis was used to analyze the correlation between the prevalence of low back pain, changes in psychological well-being, and improvement of COVID-19 related anxiety. The results (Table 5) show that when controlling for age and sex, there is a significant positive correlation between the changes in the prevalence of low back pain (NMQ) and the COVID-19-related anxiety (CAS) score ($r = 0.445$, $p < 0.05$). In addition, the change of psychological well-being (PWBS) was negatively correlated with the change in COVID-19-related anxiety (CAS) ($r = -0.631$, $P < 0.01$). Table 5 and Fig. 6 provides more details.

Table 5 Correlations between changes in the prevalence of low back pain, psychological well-being and Coronavirus-related anxiety

Variable	NMQ	PWBS
CAS	0.445*	−0.631*

The data in the table is the correlation coefficient (r)

$p^* < 0.05$; $p^{**} < 0.01$

CAS Coronavirus anxiety scale, *NMQ* Nordic musculoskeletal questionnaire, *PWBS* Psychological well-being

Table 4 Psychological Well-Being (PWBS) before and after intervention between the two groups (BEG vs. CG); n = 387

Group		AU	EM	PG	PRWO	PL	SA	TS
CG (n = 192)	Before intervention	12.19 ± 2.12	11.40 ± 1.68	8.15 ± 2.21	13.73 ± 2.15	13.33 ± 2.38	10.12 ± 1.67	68.92 ± 6.72
	After intervention	12.22 ± 1.81	11.43 ± 2.01	8.23 ± 1.89	13.88 ± 2.46	13.39 ± 2.63	10.07 ± 1.35	69.22 ± 5.34
BEG (n = 195)	Before intervention	13.21 ± 2.06	11.48 ± 2.19	8.45 ± 2.33	13.54 ± 2.47	13.46 ± 2.24	9.97 ± 1.38	70.11 ± 8.65
	After intervention	13.28 ± 2.37	14.23 ± 2.04*	14.31 ± 2.43*	14.32 ± 1.78	13.51 ± 2.27	13.47 ± 2.65*	84.12 ± 7.38**

AU: Autonomy; EM: Environmental Mastery; PG: Personal Growth; PRWO: Positive Relations with Others; PL: Purpose in Life; SA: Self-Acceptance; TS: PWBS total score; CG: Control group; BEG: Baduanjin exercise group

*p < 0.05; **p < 0.01

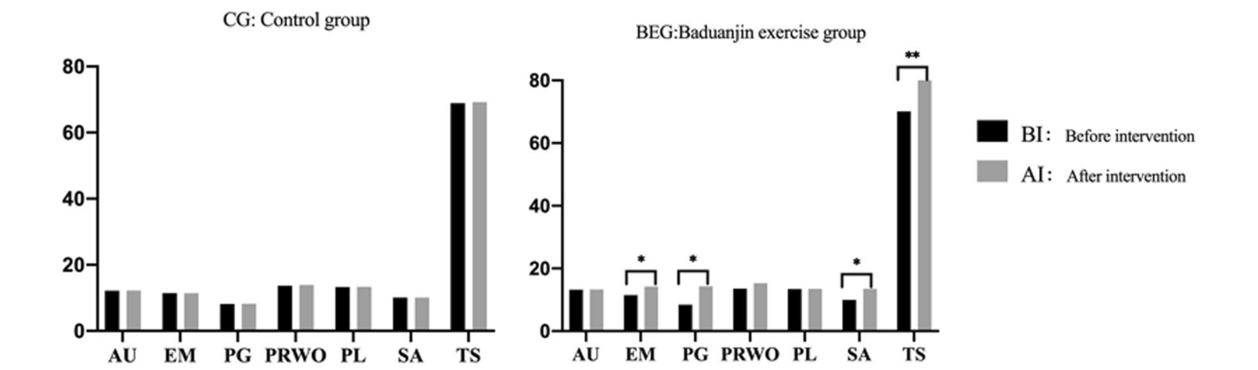

Fig. 5 PWBS: before and after intervention between the two groups: control group vs Baduanjin exercise group; *p < 0.05; **p < 0.01

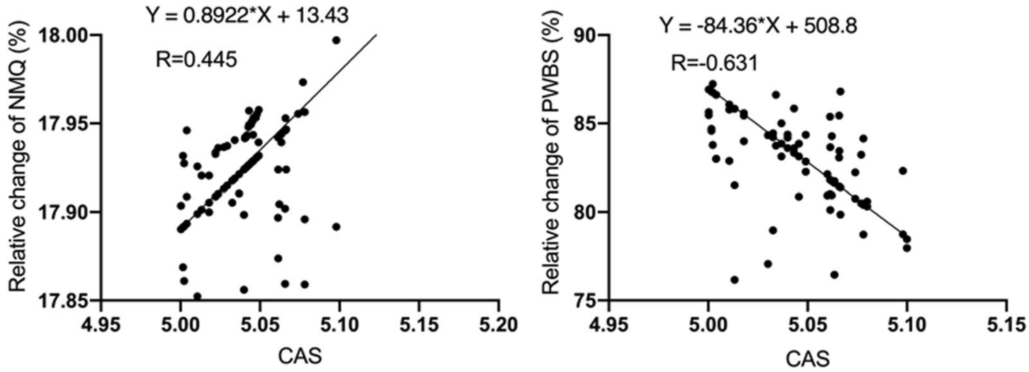

Fig. 6 Correlations between changes in the prevalence of low back pain, psychological well-being and Coronavirus-related anxiety

Discussion

This study aimed to evaluate the effectiveness of the Baduanjin intervention on the physical and mental health of college students during the COVID-19 pandemic. The research purpose was underlying the practical need to explore and find a harmless, non-drug intervention with minimal side effects in musculoskeletal and mental health problems caused by the COVID-19 pandemic and sedentary behavior. And further support the feasibility and acceptability of clinical trials of Baduanjin exercise. The main finding was that the reduction of COVID-19-related anxiety of college students is due to the 12-week training of Baduanjin. While no improvement was observed in the health education control group. In addition, participants in the Baduanjin group also showed a simultaneous decrease in the prevalence of lower back pain and psychological well-being. And the change of the prevalence of lower back pain and psychological well-being is significantly correlated with the improvement of COVID-19-related anxiety. Participants had no adverse reactions during the exercise intervention, and all participants were satisfied with the exercise program.

In our research, one of the most remarkable findings was that the effect of the Baduanjin intervention on COVID-19-related anxiety was significant and higher than that of the health education control group. After the intervention of the Baduanjin exercise, COVID-19-related anxiety has decreased significantly from 5.22 ± 0.45 to5.07 ± 0.27. The results are consistent with other studies [70–73] showing the Baduanjin exercise has a significant effect on alleviating anxiety symptoms. For example, Yu L et al. proposed that the Baduanjin exercise has a certain positive influence on COVID-19 patients in the Square cabin hospital, which is conducive to alleviating the anxiety and depression symptoms of the patients [72]. A systematic review concluded that the efficacy of Baduanjin exercise in reducing depression and anxiety symptoms in people with physical or mental illnesses [73]. In addition, some studies have shown that excessive exercise or exercise addiction harms anxiety and psychological well-being [74]. Simultaneously, during the pandemic, people who exercise more are less anxious than people who exercise less [75]. Therefore, exercise helps to relieve COVID-19 anxiety, fear, and stress.

Although the detailed mechanism by which Baduanjin improves COVID-19-related anxiety is not fully understood. As a comprehensive, multi-component intervention, Baduanjin may act through many intermediate variables along the pathway to improved anxiety outcomes. Several studies have suggested that COVID-19 is a new infectious disease with the characteristics of human-to-human transmission, long latency and high mortality [76–79]. There is still a lot of uncertainty about the origin, nature and process of the disease. Therefore, people are extremely lack of understanding of it. For the time being, there is no specific cure for the disease, which also aggravates people's panic and fear of COVID-19. Therefore, it is necessary to find suitable ways to alleviate people's anxiety and depression. These findings suggest that exercise-induced changes in the HPA axis modulate stress reactivity and anxiety in humans [80, 81]. Another possible mechanism for the anxiolytic effects of exercise is via mediation by the endogenous opioid system. Endogenous opioids have a role in the regulation of mood and emotional responses [82]. As a traditional qigong exercise, Baduanjin exercise has the advantage of accessible learning and no need for physical strength, relaxing the mind, and promoting sleep [83]. Some studies have also shown that Baduanjin exercise significantly reduces anxiety and depression [84–86]. These findings might reveal the likely neurobiological mechanisms of Baduanjin exercise in improving COVID-19-related anxiety of people.

Another result of our study found that with the improvement of COVID-19-related anxiety, the participants in the Baduanjin Group also showed significantly decrease in the prevalence of lower back pain and psychological well-being. Statistically significant changes were observed in these measures after the 12-week intervention. This improvement may be due to the benefits of regular Baduanjin exercise are expressed through adjusting breathing to make the process smoother, unifying mind and breathing, strengthening muscles and tendons to make the body more flexible, and the union of mind and body [87, 88]. At the same time, Baduanjin stresses 'take the waist as the axis' in practice [89]. Therefore, regular Baduanjin exercise enhances participants' physical and mental health and decreases the prevalence of low back pain.

Several factors may explain the positive effects of Baduanjin training on the prevalence of lower back pain and psychological well-being in college students. First, the Baduanjin exercise can effectively decrease the prevalence of lower back pain. The present study is in keeping with these findings, since, as reported elsewhere, Baduanjin exercise can reduce lower back pain [43, 90]. And a significant positive correlation between the prevalence of lower back pain(NMQ)and COVID-19-related anxiety(CAS) ($r=0.445$) was observed in the present study. Second, it found significant improvements in psychological well-being from Baduanjin training in the present study, related to the decrease of COVID-19-related anxiety of college students. This result is consistent with the research of other scholars [5, 91–94]. There was also a significant negative relationship between changes in COVID-19-related anxiety(CAS)and psychological well-being (PWBS) ($r=-0.631$).

During the coronavirus pandemic, Baduanjin exercise can relieve stress and promote sleep quality, enhance mental health and well-being.

Limited of the study

The function of Baduanjin during the COVID-19 pandemic has been mentioned many times above. Meanwhile, Baduanjin seemes to be a very interesting exercise for college students in different countries. It can be adapted to different needs by individualizing internal loadand intensity. It starts with a low dose and gradually increases itwhich makes it suitable for different groups.While this study has revealed many new angles for further research, there are limitations to the current findings.

First, This study has only speculated the possible mechanism of the Baduanjin exercise's influence on COVID-19-related anxiety, the prevalence of lower back pain, and psychological well-being through indirect indicators. Nevertheless, it did not explain in more detail the mechanism of the central nervous system and biological indicators.

Second, this study is limited by the impact of the pandemic, the lack of representativeness of research data and participants. Participants group consisted only on college students. Correlation studies should add different groups to strengthen and broaden the results, which is an important research direction in the future. Besides, outcomes of COVID-19-related anxiety and psychological well-being in this study were measured by subjective questionnaires (CAS and PWBS). Therefore, the subjective measures might have introduced a bias, leading to the potential overestimated intervention effects.

Third, the study did not mention the current pain level, whether the participants had chronic pain or whether participants took painkillers. It is worth considering in the future research.

Finally, the results show that the absence of follow-up beyond the 12-week Baduanjin exercise intervention period has had a beneficial effect on lower back pain, COVID-19-related anxiety, and psychological well-being. However, it is not sure whether the intervention effect still exists after 12 weeks.

Conclusion

In short, this research shows that during the epidemic period, the 12-week Baduanjin exercise can alleviate the anxiety of college students about COVID-19, decrease the prevalence of low back pain, further promote the health of college students and enhance their psychological well-being. Besides, the Baduanjin is an effective, safe, and helpful exercise, which can improve different groups' physical and mental health. In the future, more research should focus on the intervention means of the combination of non-drugs or the lowest dose of drugs that can bring health benefits to the different groups with sedentary lifestyle.

Acknowledgements
We also would like to thank all the participants of this study.

Author contributions
Conceptualization, K.L.,T.W-K., J.L., H.Y., D.K., Y.S.,H.F., and Mariusz L.; methodology, K.L., T.W-K. and Mariusz L.; software, K.L.; validation, K.L. and Mariusz L.; formal analysis, K.L. and D.K.; investigation, K.L. and Mariusz L.; resources, K.L., H.Y., Y.S.,H.F., and Mariusz L.; data curation, K.L. and Mariusz.; writing—original draft preparation, K.L.,T.W-K., and Mariusz L.; writing—review and editing, K.L., H.Y., H.F., D.K., and Mariusz L.; visualization, K.L.,T.W-K., J.L., H.Y., D.K., Y.S.,H.F., and Mariusz L.; project administration, K.L., T.W-K. and Mariusz L.; funding acquisition, K.L., T.W-K. and Mariusz L.; All authors have read and agreed to the published version of the manuscript.

Funding
The Polish National Agency for Academic Exchange under the Urgency Grants program (BPN/GIN/2021/1/00010/U/00001 to Prof. M. Lipowski and Dr Daniel Krokosz).

Availability of data and materials
The datasets analyzed during the current study are available from the corresponding author on reasonable request. And the data used for this study were part of a large international research project registered in the Protocol Registration and Results System. (ClinicalTrials.gov; https://clinicaltrials.gov/ct2/show/NCT04432038).

Declarations

Ethics approval and consent to participate
The protocol of this study was approved by the Ethics Board for Research Projects at the Institute of Psychology, University of Gdańsk, Poland (decision no. 33/2020). Participation in this study was voluntary. All participants provided oral informed consent before inclusion.A statement to confirm that all methods were carried out in accordance with relevant guidelines and regulations.

Consent for publication
All participants gave their consent.

Competing interests
The authors have no competing interests or potential conflicts to disclose.

Author details
[1]Gdansk University of Physical Education and Sport, Gdańsk, Poland. [2]Division of Neuropsychology, Department of the Social Sciences, Institute of Psychology, University of Gdańsk, Gdańsk, Poland. [3]Physical Education College, Bohai University, Jinzhou, China. [4]School of Psychology, Beijing Sport University, Beijing, China.

Received: 3 December 2021 Accepted: 18 May 2022
Published online: 08 June 2022

References
1. Jia P, Zhang L, Yu W, Yu B, Liu M, Zhang D, Yang S. Correction: Impact of COVID-19 lockdown on activity patterns and weight status among youths in China: the COVID-19 Impact on lifestyle change survey (COINLICS). Int J Obes (Lond). 2021;45(4):920.
2. Salimi N, Gere B, Talley W, Irioogbe B. College students mental health challenges: concerns and considerations in the COVID-19 pandemic. J Coll Stud Psychother. 2021. https://doi.org/10.1080/87568225.2021.1890298.
3. Wang X, Hegde S, Son C, Keller B, Smith A, Sasangohar F. Investigating mental health of US college students during the COVID-19 pandemic: cross-sectional survey study. J Med Internet Res. 2020;22(9):228-17.
4. Fruehwirth JC, Biswas S, Perreira KM. The covid-19 pandemic and mental health of first-year college students: examining the effect of Covid-19 stressors using longitudinal data. PLoS One. 2021;16(3):e0247999.
5. Zhang Y, Zhang H, Ma X, Di Q. Mental health problems during the COVID-19 pandemics and the mitigation effects of exercise: a longitudinal study of college students in China. Int J Environ Res Public Health. 2020;17(10):3722.
6. Ma Z, Zhao J, Li Y, Chen D, Wang T, Zhang Z, Chen Z, Yu Q, Jiang J, Fan F, et al. Mental health problems and correlates among 746 217 college students during the coronavirus disease 2019 outbreak in China. Epidemiol Psychiatr Sci. 2020;29:e181.
7. Hall G, Laddu DR, Phillips SA, Lavie CJ, Arena R. A tale of two pandemics: How will COVID-19 and global trends in physical inactivity and sedentary behavior affect one another? Prog Cardiovasc Dis. 2021;64:108–10.
8. Alyammahi SK, Abdin SM, Alhamad DW, Elgendy SM, Altell AT, Omar HA. The dynamic association between COVID-19 and chronic disorders: an updated insight into prevalence, mechanisms and therapeutic modalities. Infect Genet Evol. 2021;87:104647.
9. Emami A, Javanmardi F, Pirbonyeh N, Akbari A. Prevalence of underlying diseases in hospitalized patients with COVID-19: a systematic review and meta-analysis. Arch Acad Emerg Med. 2020;8(1):e35.
10. Yang J, Zheng Y, Gou X, Pu K, Chen Z, Guo Q, Ji R, Wang H, Wang Y, Zhou Y: Prevalence of comorbidities in the novel Wuhan coronavirus (COVID-19) infection: a systematic review and meta-analysis. Int J Infect Dis. 2020;10–16.
11. Ball S, Banerjee A, Berry C, Boyle JR, Bray B, Bradlow W, Chaudhry A, Crawley R, Danesh J, Denniston A, et al. Monitoring indirect impact of COVID-19 pandemic on services for cardiovascular diseases in the UK. Heart. 2020;106(24):1890–7.
12. Ogliari G, Lunt E, Ong T, Marshall L, Sahota O. The impact of lockdown during the COVID-19 pandemic on osteoporotic fragility fractures: an observational study. Arch Osteoporos. 2020;15(1):156.
13. Yu M, Tian F, Cui Q, Wu H. Prevalence and its associated factors of depressive symptoms among Chinese college students during the COVID-19 pandemic. BMC Psychiatry. 2021;21(1):66.
14. Salari N, Hosseinian-Far A, Jalali R, Vaisi-Raygani A, Rasoulpoor S, Mohammadi M, Rasoulpoor S, Khaledi-Paveh B. Prevalence of stress, anxiety, depression among the general population during the COVID-19 pandemic: a systematic review and meta-analysis. Global Health. 2020;16(1):57.
15. Stavridou A, Kapsali E, Panagouli E, Thirios A, Polychronis K, Bacopoulou F, Psaltopoulou T, Tsolia M, Sergentanis TN, Tsitsika A. Obesity in children and adolescents during COVID-19 pandemic. Children (Basel). 2021;8(2):135-10.
16. Borsa S, Pluderi M, Carrabba G, Ampollini A, Pirovano M, Lombardi F, Tomei M, Locatelli M. Letter to the editor: impact of COVID-19 outbreak on acute low back pain. World Neurosurg. 2020;139:749.
17. Organization WH: WHO Coronavirus(COVID-19)Dash-board[EB/OL]. https: / / covid19who,int / table. 2021.
18. Caromano FA, de Amorim CAP, de Fátima Rebelo C, Contesini AM, Fávero FM, Frutuoso JRC, Missa M, Kawai MCV: Prolonged sitting and physical discomfort in university students. CEP. 2015;536–100.
19. Vujcic I, Stojilovic N, Dubljanin E, Ladjevic N, Ladjevic I, Sipetic-Grujicic S. Low Back pain among medical students in Belgrade (Serbia): a cross-sectional study. Pain Res Manag. 2018;2018:8317906.
20. Haroon H, Mehmood S, Imtiaz F, Ali SA, Sarfraz M. Musculoskeletal pain and its associated risk factors among medical students of a public sector University in Karachi, Pakistan. JPMA J Pak Med Assoc. 2018;68(4):682–8.
21. Bjorck-van Dijken C, Fjellman-Wiklund A, Hildingsson C. Low back pain, lifestyle factors and physical activity: a population based-study. J Rehabil Med. 2008;40(10):864–9.
22. Mahdavi SB, Kelishadi R. Impact of sedentary behavior on bodily pain while staying at home in COVID-19 pandemic and potential preventive strategies. Asian J Sports Med. 2020;11(2):e103511.
23. Ehlert U, Gaab J, Heinrichs M. Psychoneuroendocrinological contributions to the etiology of depression, posttraumatic stress disorder, and stress-related bodily disorders: the role of the hypothalamus–pituitary–adrenal axis. Biol Psychol. 2001;57(1–3):141–52.
24. Jankord R, Herman JP. Limbic regulation of hypothalamo-pituitary-adrenocortical function during acute and chronic stress. Ann N Y Acad Sci. 2008;1148(1):64–73.
25. Blackburn-Munro G, Blackburn-Munro R. Pain in the brain: are hormones to blame? Trends Endocrinol Metab. 2003;14(1):20–7.
26. Dedovic K, Duchesne A, Andrews J, Engert V, Pruessner JC. The brain and the stress axis: the neural correlates of cortisol regulation in response to stress. Neuroimage. 2009;47(3):864–71.
27. Heim C, Ehlert U, Hellhammer DH. The potential role of hypocortisolism in the pathophysiology of stress-related bodily disorders. Psychoneuroendocrinology. 2000;25(1):1–35.
28. McEwen BS. Central effects of stress hormones in health and disease: Understanding the protective and damaging effects of stress and stress mediators. Eur J Pharmacol. 2008;583(2–3):174–85.
29. Kontoangelos K, Economou M, Papageorgiou C. Mental health effects of COVID-19 pandemia: a review of clinical and psychological traits. Psychiatry Investig. 2020;17(6):491.
30. Taylor S, Landry CA, Paluszek MM, Fergus TA, McKay D, Asmundson GJG. COVID stress syndrome: Concept, structure, and correlates. Depress Anxiety. 2020;37(8):706–14.
31. Hyland P, Shevlin M, McBride O, Murphy J, Karatzias T, Bentall RP, Martinez A, Vallières F. Anxiety and depression in the Republic of Ireland during the COVID-19 pandemic. Acta Psychiatr Scand. 2020;142(3):249–56.
32. Faisal RA, Jobe MC, Ahmed O, Sharker T. Mental health status, anxiety, and depression levels of bangladeshi university students during the

COVID-19 pandemic. Int J Ment Health Addict. 2021. https://doi.org/10.1007/s11469-020-00458-y.
33. Kathirvel N. Post COVID-19 pandemic mental health challenges. Asian J Psychiatr. 2020;53:102430.
34. Wu T, Jia X, Shi H, Niu J, Yin X, Xie J, Wang X. Prevalence of mental health problems during the COVID-19 pandemic: a systematic review and meta-analysis. J Affect Disord. 2021;281:91–8.
35. Kuorinka I, Jonsson B, Kilbom A, Vinterberg H, Biering-Sorensen F, Andersson G, Jorgensen K. Standardised Nordic questionnaires for the analysis of musculoskeletal symptoms. Appl Ergon. 1987;18(3):233–7.
36. Jones BM. Changes in cytokine production in healthy subjects practicing Guolin Qigong: a pilot study. BMC Complement Altern Med. 2001;1(1):1–7.
37. McCaffrey R, Fowler NL. Qigong practice: a pathway to health and healing. Holist Nurs Pract. 2003;17(2):110–6.
38. Ekman, Paul. Emotions revealed: recognizing faces and feelings to improve communication and emotional life. New York NY: Times books 2003.
39. Koh TC. Baduanjin – an ancient Chinese exercise. Am J Chin Med. 1982;10(1–4):14–21.
40. 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):e1–25.
41. Xu X, Han L, Ma L, Zhang J. Effect of BADUANJIN exercises combined with TUINA on low back pain and life quality of patients with non-acute-phase lumbar disc herniation. J Chin Orth. 2018;30:18–22.
42. Yuan S, Lin X, Hong J, Qiu C, Chen D. Effects of traditional Chinese exercise on lumbar disc herniation: a protocol of network meta-analysis of randomized controlled trials. Medicine (Baltimore). 2020;99(5):e18781.
43. Gao F, Yuan S, Liu N, Zheng S. Effect observation of Baduanjin training on chronic nonspecific low back pain. Rehabil Med. 2018;28:13–7.
44. Teut M, Knilli J, Daus D, Roll S, Witt CM. Qigong or yoga versus no intervention in older adults with chronic low back pain—a randomized controlled trial. J Pain. 2016;17(7):796–805.
45. Chen Y, Xiong X, Liu H, Liu X, Chen Y, Wang S, Xiong Q, Wen Y. Effect of Baduanjin on musculoskeletal pain and quality of life in older adults. China Naturop. 2017;25:18–9.
46. Ding Y, Wang J. Effect of Baduanjin on pain in people with chronic low back pain. Chin J Gerontol. 2014;29:151–2.
47. Peng X, Li Q, Li X. The efficacy of sitting Baduanjin exercise on lumbago and back pain of elderly patients with osteoporosis. J Nurs Sci. 2015;20:4–6.
48. Ma Q, Yang Z, Zhu F, Chen H, Yang H, Wang S. The effect of Baduanjin exercise on the quality of life in patients recovering from COVID-19: a protocol for systematic review and meta-analysis. Medicine (Baltimore). 2020;99(37):e22229.
49. Rong J, Li J, Jing F, Ren Y, Xiao Y, Pan Q, Li M, Lv Y, Zhang J, Jing F. Efficacy of Baduanjin exercise for rehabilitation after COVID-19: a protocol for systematic review and meta-analysis. Medicine (Baltimore). 2021;100(24):e26366.
50. Feng F, Tuchman S, Denninger JW, Fricchione GL, Yeung A. Qigong for the prevention, treatment, and rehabilitation of COVID-19 infection in older adults. Am J Geriatr Psychiatry. 2020;28(8):812–9.
51. Li M, Fang Q, Li J, Zheng X, Tao J, Yan X, Lin Q, Lan X, Chen B, Zheng G, et al. The effect of chinese traditional exercise-Baduanjin on physical and psychological well-being of college students: a randomized controlled trial. PLoS One. 2015;10(7):e0130544.
52. Pinheiro FA, Tróccoli BT. Carvalho CVd: validity of the nordic musculoskeletal questionnaire as morbidity measurement tool. Rev Saude Publica. 2002;36:307–12.
53. de Barros EN, Alexandre NM. Cross-cultural adaptation of the Nordic musculoskeletal questionnaire. Int Nurs Rev. 2003;50(2):101–8.
54. Mendonca CR, Noll M, Silveira EA. Adaptation and validation of body maps for musculoskeletal pain location in patients with severe obesity. Korean J Pain. 2018;31(4):268–76.
55. Darwish MA, Al-Zuhair SZ. Musculoskeletal pain disorders among secondary school Saudi female teachers. Pain Res Treat. 2013. https://doi.org/10.1155/2013/878570.
56. Crawford JO. The Nordic musculoskeletal questionnaire. Occup Med. 2007;57(4):300–1.
57. Pugh JD, Gelder L, Williams AM, Twigg DE, Wilkinson AM, Blazevich AJ. Validity and reliability of an online extended version of the nordic musculoskeletal questionnaire (NMQ-E2) to measure nurses' fitness. J Clin Nurs. 2015;24(23–24):3550–63.
58. Yue P, Xu G, Li L, Wang S. Prevalence of musculoskeletal symptoms in relation to psychosocial factors. Occup Med (Lond). 2014;64(3):211–6.
59. Haefeli M, Elfering A. Pain assessment. Eur Spine J. 2006;15(1):S17–24.
60. Boonstra AM, Stewart RE, Köke AJ, Oosterwijk RF, Swaan JL, Schreurs KM, Schiphorst Preuper HR. Cut-off points for mild, moderate, and severe pain on the numeric rating scale for pain in patients with chronic musculoskeletal pain: variability and influence of sex and catastrophizing. Front Psychol. 2016;7:1466.
61. Lee SA. Coronavirus anxiety scale: a brief mental health screener for COVID-19 related anxiety. Death Stud. 2020;44(7):393–401.
62. American Psychiatric Association . Diagnostic and statistical manual of mental disorders: DSM-5. United States 2013. https://en.wikipedia.org/wiki/DSM-5.
63. Barlow DH. Disorders of emotion. Psychol Inq. 1991;2(1):58–71.
64. Cosmides L, Tooby J. Evolutionary psychology and the emotions. Handb Emot. 2000;2(2):91–115.
65. Ryff CD, Keyes CL. The structure of psychological well-being revisited. J Pers Soc Psychol. 1995;69(4):719–27.
66. Delaney RK. National survey of midlife development in the United States. Int J Aging Hum Dev. 2014;79(4):329–31.
67. Wilson D, de Oliveira DR, Palace-Berl F, de Mello PB, Rissatti LF, Pollizi VP, de Miranda FS, D'Almeida V, Demarzo M. Fostering emotional self-regulation in female teachers at the public teaching network: a mindfulness-based intervention improving psychological measures and inflammatory biomarkers. Brain Behav Immun-Health. 2022;21:100427.
68. Alsheikh Ali ASS. Efficiency of intervention counseling program on the enhanced psychological well-being and reduced post-traumatic stress disorder symptoms among syrian women refugee survivors. Clin Pract Epidemiol Ment Health. 2020;16(Suppl-1):134–41.
69. Xu X, Zhou L, Asante-Antwi H, Boafo-Arthur A, Mustafa T. Reconstructing family doctors' psychological well-being and motivation for effective performance in China: the intervening role of psychological capital. BMC Fam Pract. 2020;21(1):137.
70. Paggi ME, Jopp D, Hertzog C. The importance of leisure activities in the relationship between physical health and well-being in a life span sample. Gerontology. 2016;62(4):450–8.
71. Wheaton MG, Abramowitz JS, Berman NC, Fabricant LE, Olatunji BO. Psychological predictors of anxiety in response to the H1N1 (swine flu) pandemic. Cogn Ther Res. 2012;36(3):210–8.
72. Zhang X-B, Zhang J-L, Li M-X, Yuan Y-P, Sun J. Baduanjin exercise can alleviate anxiety and depression of patients with COVID-19 in Square cabin hospital: a cross-sectional survey. Medicine. 2021;100(32):268–98.
73. Zou L, Yeung A, Quan X, Hui SSC, Hu X, Chan JS, Wang C, Boyden SD, Sun L, 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(2):321.
74. Shibata M, Burkauskas J, Dores AR, Kobayashi K, Yoshimura S, Simonato P, De Luca I, Cicconcelli D, Giorgetti V, Carvalho IP. Exploring the relationship between mental well-being, exercise routines, and the intake of image and performance enhancing drugs during the coronavirus disease 2019 pandemic: a comparison across sport disciplines. Front Psychol. 2021;12:689–58.
75. Lesser IA, Nienhuis CP. The impact of COVID-19 on physical activity behavior and well-being of Canadians. Int J Environ Res Public Health. 2020;17(11):389–9.
76. Sun P, Lu X, Xu C, Sun W, Pan B. Understanding of COVID-19 based on current evidence. J Med Virol. 2020;92(6):548–51.
77. Rothan HA, Byrareddy SN. The epidemiology and pathogenesis of coronavirus disease (COVID-19) outbreak. J Autoimmun. 2020;109:102433.
78. Carlos WG, Dela Cruz CS, Cao B, Pasnick S, Jamil S. Novel Wuhan (2019-nCoV) coronavirus. Am J Respir Crit Care Med. 2020;201(4):P7–8.
79. Ahn DG, Shin HJ, Kim MH, Lee S, Kim HS, Myoung J, Kim BT, Kim SJ. Current status of epidemiology, diagnosis, therapeutics, and vaccines for novel coronavirus disease 2019 (COVID-19). J Microbiol Biotechnol. 2020;30(3):313–24.

80. Landgraf R, Wigger A, Holsboer F, Neumann ID. Hyper-reactive hypothalamo-pituitary-adrenocortical axis in rats bred for high anxiety-related behaviour. J Neuroendocrinol. 1999;11(6):405–7.
81. de Kloet ER, Joels M, Holsboer F. Stress and the brain: from adaptation to disease. Nat Rev Neurosci. 2005;6(6):463–75.
82. Bodnar RJ, Klein GE. Endogenous opiates and behavior: 2005. Peptides. 2006;27(12):3391–478.
83. Chen MC, Liu HE, Huang HY, Chiou AF. The effect of a simple traditional exercise programme (Baduanjin exercise) on sleep quality of older adults: a randomized controlled trial. Int J Nurs Stud. 2012;49(3):265–73.
84. Wang C-W, Chan CH, Ho RT, Chan JS, Ng S-M, Chan CL. Managing stress and anxiety through qigong exercise in healthy adults: a systematic review and meta-analysis of randomized controlled trials. BMC Complement Altern Med. 2014;14(1):1–9.
85. Chan JS, Ho RT, Chung KF, Wang CW, Yao TJ, Ng SM, Chan CL. Qigong exercise alleviates fatigue, anxiety, and depressive symptoms, improves sleep quality, and shortens sleep latency in persons with chronic fatigue syndrome-like illness. Evid Based Complement Altern Med. 2014. https://doi.org/10.1155/2014/106048.
86. Wang F, Man JK, Lee EK, Wu T, Benson H, Fricchione GL, Wang W, Yeung A. The effects of qigong on anxiety, depression, and psychological well-being: a systematic review and meta-analysis. Evid Based Complement Alternat Med. 2013;2013:152738.
87. Jiang X. A shallow discussion on the dialectical relationship between Baduanjin and health keeping in Chinese medicine. Chin Wushu Res. 2012;1:95–6.
88. Geng Y, Wang X. Effect of eight-length brocade exercise on mental sub-health regulation based on the theory of emotion controlled by five zang-organs. China J Tradit Chin Med Pharm. 2008;23(4):348–9.
89. Zhang X, Ren S. The effect of Baduanjin on lumbar muscle strain. Chin Med Mod Distance Educ China. 2011;9:105.
90. Zhang Y, Loprinzi PD, Yang L, Liu J, Liu S, Zou L. The beneficial effects of traditional chinese exercises for adults with low back pain: a meta-analysis of randomized controlled trials. Medicina (Kaunas). 2019;55(5):118–1.
91. Liu Q, Shono M, Kitamura T. Psychological well-being, depression, and anxiety in Japanese university students. Depress Anxiety. 2009;26(8):E99–105.
92. Tramonti F, Maestri M, Gronchi A, Fabbrini M, Di Coscio E, Carnicelli L, Bonanni E. Psychological well-being of patients with insomnia and its relationship with anxiety and depression. Psychol Health Med. 2016;21(3):309–16.
93. Takebayashi Y, Tanaka K, Sugiura Y, Sugiura T. Well-being and generalized anxiety in Japanese undergraduates: a prospective cohort study. J Happiness Stud. 2018;19(3):917–37.
94. Zheng G, Li M, Lan X, Yan X, Lin Q, Chen L, Tao J, Zheng X, Li J, Chen B, et al. The effect of Baduanjin exercise for physical and psychological well-being of college students: study protocol for a randomized controlled trial. Trials. 2013;14:422.

Publisher's Note

© 2022 EDIZIONI MINERVA MEDICA
Online version at https://www.minervamedica.it

Gazzetta Medica Italiana - Archivio per le Scienze Mediche 2022 November;181(11):811-23
DOI: 10.23736/S0393-3660.22.04802-1

ORIGINAL ARTICLE

The effect of 12 weeks of Baduanjin exercise on cognitive function, lower limb balance and quality of life of the elderly with mild cognitive impairment: a randomized controlled trial

Keqiang LI [1] *, Hongli YU [1], Jakub A. KORTAS [2], Xiaojun LIN [3], Mariusz LIPOWSKI [1]

[1]Gdansk University of Physical Education and Sport, Gdańsk, Poland; [2]Department of Health and Life Sciences, Gdansk University of Physical Education and Sport, Gdansk, Poland; [3]School of Public Health and Management,Wenzhou Medical University,Wenzhou, China

*Corresponding author: Keqiang Li, Phd student, Gdansk University of Physical Education and Sport, Gdańsk 80-070, Poland.
E-mail: keqiang.li@awf.gda.pl

ABSTRACT

BACKGROUND: Mild cognitive impairment (MCI is called the precursor state of Alzheimer disease (AD) Has a great impact on people's health.While there is accumulating evidence supporting Baduanjin exercise has an effect on MCI, few studies have objectively assessed these specific benefits, particularly related to the Baduanjin exercise and MCI. This study aims to explore the effect of Baduanjin on cognitive function, lower limb balance function, and quality of life of the elderly with mild cognitive impairment. A randomized controlled trial study, with pre and post-testing of two parallel groups (BEG, LWG). Sixty participants with MCI were allocated to three groups: the Baduanjin exercise group (BEG=30); and the Leisure walking group (LWG=30).

METHODS: In this randomized controlled trial, 60 participants with MCI were randomly allocated in a 1:1 ratio to 12-week Baduanjin exercise group and 12-week leisure walking group, with 30 cases in each group. MMSE(mini-mental state examination scale), MoCA (Montreal cognitive assessment), BBS (Berg Balance Scale), TUG (Timed Up and Go Test), 10MWT (10-meter walking test), SF-12 (12-Item Short Form Survey) was used to assess the cognitive function, the lower limb balance function and quality of life at second times (before and after the intervention). The paired t-test and an independent t-test (with a 95% confidence interval) was used to compare the outcome variables of the two groups.

RESULTS: There were no significant differences between the Baduanjin exercise and the control group at baseline in demographic. Compared to participants in the leisure walking group, participants in the Baduanjin group had a significantly improvement in the Cognitive function (MMSE -3.56 [95% CI, -4.65to-2.48], P<0.05) and MoCA(-1.68 [95% CI,-2.85to-0.52], P<0.05); Baduanjin exercise group shows significantly improvement in the lower limb balance function (BBS -4.73 [95% CI, -5.87to-3.59], P<0.05); TUG (0.52 [95%CI, 0.42 to 0.61], P<0.05); 10MWT(-0.24 [95CI, -0.31to-0.16], P<0.05);Baduanjin exercise group have great effect on quality of life (PCS -1.94 [95% CI, -2.89to-1], P<0.05) and MCS (-1.8 [95%CI,-2.86 to-0.75], P<0.05, increased from 59.39±2.41 to 62.65±1.56, P<0.05;) In addition, after the intervention of Baduanjin, there is a significant positive correlation between Lower Limb Balance (BBS) and the improvement of Cognitive Function (MMSE) Score (r=0.328, P<0.05). A significant positive correlation between Lower Limb Balance (10MWT) and the improvement of Cognitive Function (MMSE) score (r=0.366, P<0.05). Meanwhile, the change of Quality of life (MCS) was positively correlated with Cognitive Function (MoCA)improvement (r=0.593, P<0.01).

CONCLUSIONS: Baduanjin exercise appears to be a feasible and acceptable intervention to improve the cognitive function and lower limb balance function and quality of life of the elderly with MCI among older adults. Our findings emphasize the significance of Baduanjin exercise into elder health management.Feasibility of the approach for a large scale RCT was also confirmed.

(*Cite this article as:* Li K, Kortas JA, Lin X, Yu H, Lipowski M. The effect of 12 weeks of Baduanjin exercise on cognitive function, lower limb balance and quality of life of the elderly with mild cognitive impairment: a randomized controlled trial. Gazz Med Ital - Arch Sci Med 2022;181:811-23. DOI: 10.23736/S0393-3660.22.04802-1)

KEY WORDS: Qigong; Cognitive dysfunction; Alzheimer disease; Cognition; Mental Health.

Mild cognitive impairment (MCI) refers to the average self-care ability in daily life with mild memory or cognitive impairment. It's an unstable clinical state of cognitive decline between normal ageing and dementia and is called the precursor state of Alzheimer disease (AD).[1] 10%-15% of MCI patients progress to dementia every year, and AD accounts for the vast majority.[2] There are nearly 37 million MCI patients in mainland China.[3] Graham found that non-dementia cognitive dysfunction in the elderly aged 60 and over in North America is 16.8%, while the incidence of MCI in Japan is 6.1%.[4, 5] The incidence of MCI and Alzheimer's disease increases with age,[6, 7] Many research results show that mild cognitive impairment has no effect on daily life in the early stage. If mild cognitive impairment cannot be prevented and treated on time, the decline of cognitive function will affect patients' daily walking speed, balance ability, and physical function.[8-13] Patients will eventually be unable to live independently. Thus, the quality of life will be seriously affected and bring a heavy burden to individuals and families. Taking effective measures to intervene in patients with mild cognitive impairment would significantly reduce the prevalence rate of dementia.

Clinical studies[14-18] found that exercise is an effective strategy to avoid the early diagnosis of AD and prevents the occurrence of illness. As traditional Chinese health qigong, Baduanjin is widely popular in China. Similar to well-recognized traditional Tai Ji, Baduanjin qigong is also characterized by slow and relaxing movements.A set of Baduanjin exercises consists of only 8 separate and smooth movements.[19] In addition,The latest studies have found that In China, Baduanjin has been used as an essential adjuvant therapy in COVID-19.[20-22] Meanwhile, Baduanjin can promote lower limb function, especially lower limb balance ability and muscle strength development and quality of life to a certain extent.[23-25] Yuen M *et al.* show that Baduanjin is effective in improving balance, leg strength, and mobility and is a safe and sustainable form of home-based exercise for people with chronic stroke.[26] Shijia *et al.* found that the Baduanjin exercise significantly enhanced cognitive function and decreased negative emotion of patients with brain injuries in the early rehabilitation period.[27] A recent randomized controlled trial also showed that participating in the Baduanjin exercise positively impacted anxiety, depression, and the quality of life of patients with ulcerative colitis [28]. It has been shown that the Baduanjin exercise increase the flexibility of joint motion,[29] balance and stability in the lower limbs of the elderly.[30]

In this paper, leisure walking and Baduanjin are selected as the main intervention measures because these exercises are easy to learn and practice and unlikely to cause injury. Therefore, it is a suitable type of exercise for MCI patients. The aim of this study is to explore the influence of the Baduanjin exercise on cognitive function, lower limb balance function, and quality of life among the elderly with mild cognitive impairment. This research provides an excellent theoretical basis for the choice of non-drug intervention methods for patients with mild cognitive impairment. It also provides a basis for the popularization and application of Qigong.

Materials and methods

Experimental design

This study enrolled 76 participants for the first time. After the first screening, 16 participants dropped out. Only 60 were left. Due to personal reasons, unrelated to the study. For example: 6 for No reason provided;7 for Schedule conflict;3 for No physical condition. The remaining 60 eligible subjects were enrolled and randomly assigned to the Baduanjin group (N.=30) or the leisure walking group (N.=30). 30 completed the entire Baduanjin exercise intervention. In the leisure walking group, 30 completed the entire leisure walking exercise intervention. Eventually, data from 30 participants in the Baduanjin group and 30participants in the control group were included in the final analyses. The Ethics Board approved the protocol of this study for Research Projects at the Institute of Psychology, University of Gdansk, Poland (decision no. 33/2020). Figure 1 presents the stages of the study regarding also the flow of the respondents (Figure 1).

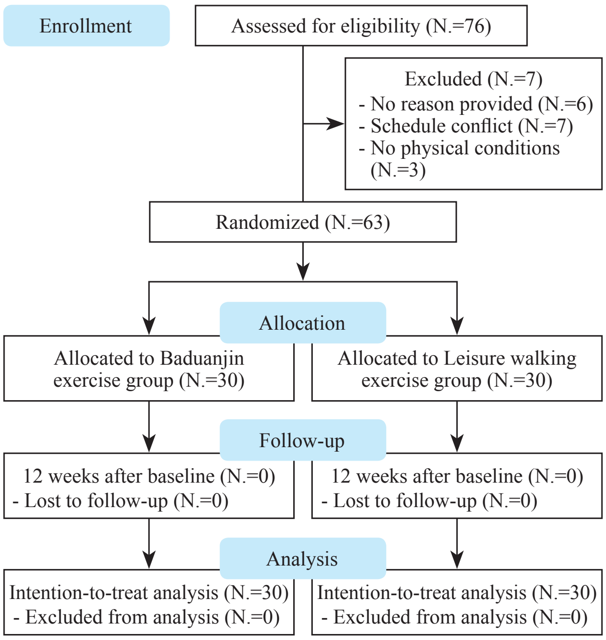

Figure 1.—Stages of the study regarding also the flow of the respondents.

Subjects

From October 2021 to January 2022, 76 elderly citizens from 6 villages were randomly selected from the Lingxi Township of Wenzhou City, Zhejiang Province, China. The participants were between 55-65 years old. Participants must have lived in the selected villages for more than 6 months in the past year. According to the inclusion criteria and exclusion criteria, 76 residents completed the questionnaire survey of this study. After the screening, 6 participants were excluded with no reason provided, 7 were excluded due to plan conflicts, and 3 were excluded because their physical conditions were unsuitable. Finally, a total of 60 participants qualified for the study.

Diagnostic criteria for recruitment of subjects

Inclusion criteria

- Age ≥55 years old, no significant difference in physical condition;
- compliance with MCI diagnostic criteria;[31]
- has specific cognitive dysfunction but does not meet the diagnostic criteria of dementia (MoCA<26, MMSE>24);
- has the main complaint of memory loss, and other cognitive functions are normal;
- activities of daily living are normal, ADL<26;
- irregular exercise, and can complete a certain degree of sports activities in the state of sports monitoring;
- there are no terrible living habits, such as alcoholism and excessive smoking, and the body is healthy without organic diseases;
- no binocular or corrected vision above 1.0, and normal hearing (above 20dB).

Exclusion criteria

- Serious cardiovascular diseases (high blood pressure, BP>166/96 mmHg);
- severe myopathy, the history of upper limb injury in the past 6 months, lumbar dysfunction or damage, various diseases that are not suitable for long-standing, severe osteoporosis, etc.;
- has experienced invasive treatment in the past 6 weeks, or have undergone these treatment plans in the next 10 weeks;
- severe cognitive impairment, mental illness or other neurodegenerative diseases (PD, stroke, frontotemporal degeneration, vascular dementia, Lewy body dementia, etc.);
- taking psychotropic drugs, drugs affecting physical mobility, cholinesterase inhibitors, and other medications recently or for a prolonged period of time.

The intervention

Randomization and allocation

Sixty participants who fulfilled the eligibility criteria were allocated randomly to two intervention-based groups; the Baduanjin exercise group (BEG; N.=30) or the Leisure walking group (WG, N.=30). To ensure blinding, an independent researcher who was not a part of this study performed the randomized allocation. A 1:1 simple randomization technique was employed. A unique, computer-generated random code was assigned for each participant via SPSS (version 26.0, Armonk, New York, NY, USA) statistical software. The allocation was concealed in sealed opaque envelopes, which were provided to researchers before applying the assigned interventions. All study personnel and participants were blinded to treatment assignment for the trial duration. The experimental intervention time for the two groups was 12 weeks.

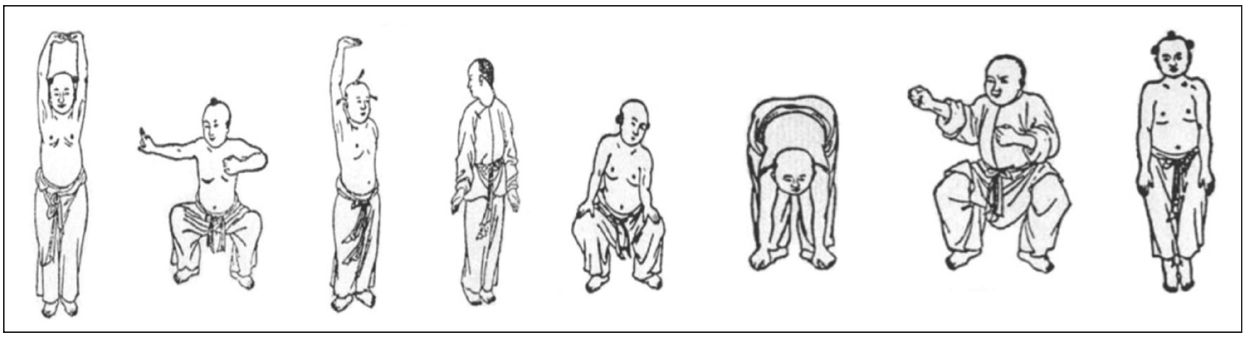

Figure 2.—Eight postures.

Baduanjin exercise group

The general plan is 30 Participants in the Baduanjin exercise group will receive 12 weeks of Baduanjin exercise training with a frequency of 5 days a week and 45 min a day, including 10 min warm-up and finish. The training scheme originated from Health Qigong - Baduanjin, published by the General Administration of Sport of China.[32] The whole Baduanjin exercise training plan is divided into two periods. The main task of the first periods (1 week) as to get the whole set of Baduanjin exercises consisting of 8 postures (Figure 2). Two professional Qigong Baduanjin coaches guided them in the first-week, until mastering moving and breathing methods. The second periods (11 week) was an essential part of the programme. Participants begin a formal 11-week intervention period of Baduanjin exercises. During this intervention period, the participants were exercising independently.The coach would guide subjects through a group exercise every week for 1 time during the 11 week. Participants should communicate with doctors and coaches if they encounter any problems in the daily routine process. If any of the participants suffered from acute exacerbation of cognitive impairment during the experimental period, the participants should follow the doctor's advice and quit.

Leisure walking group

Participants should keep leisure walking exercise every week. The exercise time and place were not limited. Leisure walking practice should be 5 times a week, and the total duration of each exercise was 45min/time. They were required to walk exercise for 12 consecutive weeks. The coach undertook a return visit to the leisure walking group every other week. Participants should communicate with doctors and coaches if they encounter any problems in the daily routine process. If any of the participants suffered from acute exacerbation of cognitive impairment during the experimental period, the participants should follow the doctor's advice and quit.

Measurements

Montreal Cognitive Assessment Score

Montreal Cognitive Assessment Score (MoCA) is mainly used to screen the elderly who complain of memory loss, but the MMSE score is still in the normal range, with high sensitivity, good reliability, and validity. MoCA includes seven dimensions, including: visual space and executive function; naming; attention; language; abstraction; delayed recall; and orientation. This has a total score of 30 points,[33] and the higher the score, the better the cognitive function. The evaluation refers to the educational level. If the educational years are ≥12 years, the MoCA score<26 is considered to belong to MCI patients, and the MoCA Score ≥ 26 means that the cognitive function is normal. For those with less than 12 years of education, the score of MoCA<25 is considered MCI patient, and the score of MoCA≥25 is considered as normal cognitive function. Cronbach-α value of this paper is 0.84.

Mini-Mental State Examination

The Mini-Mental State Examination (MMSE) was used to evaluate the cognitive status of the subjects before and after the intervention. This tool is a simple tool for the classification of cognitive impairment in the elderly. It consists of five parts: orientation; memory (instantaneous and short-term memory); attention and calculation; aphasia (oral expression, naming, retelling, reading, listening and understanding, writing); and vision. There are 30 items with a total score of 30. The higher the score, the better the cognitive function.[34] Combined with the education level and cognitive score of the elderly, the cognitive status was comprehensively evaluated. In so doing, the evaluation criteria of cognitive impairment in the elderly were acquired. According to educational level, MMSE scores were determined as follows: ≤19 (illiterate), ≤22 (primary school), ≤26 (junior high school and above) were divided into cognitive impairment; MMSE scores 17-19 (illiteracy), 20-22 (primary school), 24-26 (junior high school and above) were classified as mild cognitive impairment. Cronbach-α value of this paper is 0.862.

Berg Balance Scale

Berg Balance Scale (BBS) includes 14 items: standing up from sitting position; standing without support; sitting position without a backrest, but landing with both feet or putting them on a stool; sitting down from standing position; transferring; closing eyes without support; standing with both feet together without support; upper limbs stretching and moving forward in standing position; picking up articles from the ground in a standing position; turning to look back in a standing position; turning 360 degrees; putting one foot on a step or stool in standing position without support; and standing without support with one foot in front. The scoring standard of each item is from 0 to 4, and the total score is from 0 to 56. This is divided into five grades: zero; poor; fair; good; and normal.[35] Cronbach-α value of this paper is 0.78.

Timed Up and Go Test

The subjects are wearing the shoes they usually wear, sitting on the back chair (the height of the chair is about 45cm), leaning against the chair's back with their hands on both sides of the body. After hearing the "Start" instruction, the subjects immediately get up from the back chair, and then walk forward for 3 meters according to the usual walking gait, turn around after bypassing the marker. They then walk back to the back chair and turn to sit down, ending with leaning back on the back chair. No help can be given to anybody during the test.[36] The time is recorded (in seconds) with a stopwatch. Before the formal test, the subjects can practice 1-2 times to ensure that the subjects understand the whole test process. The formal test is conducted 3 times, and the average value is taken, with the scoring criteria is as follows: 1) if completion time <10 seconds, the subjects can conduct free movement; 2) if completion time <20 seconds, most of them can move independently; 3) if completion time is 20-29 seconds, the activity is unstable, and there is a high risk of falling; 4) if completion time>30 seconds, there is activity obstacle. The Cronbach-α value of this paper is 0.74.

10-meter walk test

The 10-meter walking test (10MWT) evaluates walking ability: walk on a 14-meter straight line marked at 2 m and 12 m, respectively. Participants must walk along the line, starting from 2 m and finishing at 12 m. The time and steps taken for walking between 2 m and 12 m are recorded. The pace is then calculated, and the calculation formula is: [pace (m/s)=10/ time], and the stopwatch can be used to time the test.[37] The Cronbach-α value of this paper is 0.77.

Quality of life assessment SF-12

This questionnaire was designed and put forward by JE Ware and CD Sherbourne. This paper uses the American version developed by GandekB, WareJE, Aaronson NK, and others.[38] This version is also in line with the current research situation and has sufficient reliability and effectiveness. SF-12 consists of 12 items and 8 sub-items: physical function (PF), role body (RP), physical pain (BP), general health (GH), vitality (VT), social function (SF), role-emotion (RE), and mental health (MH). The subscales PF, RP, BP, and GH constitute the scores of body composition summary (PCS), while the subscales VT, SF, RE, and MH constitute the scores of mental composition summary (MCS). The answer categories of each item in the questionnaire ranged from 2 to 6, and the original scores range from 1 to 6. The actual scores obtained by the participants were counted and scored. The higher the score, the better the physical condition of the participants. Cronbach-α value of this paper is 0.81.

Statistical analysis

Statistical analysis was performed using SPSS (version 26.0, Armonk, New York, USA). The Shapiro-Wilk tests were performed to determine the normality of the data distribution. Normally distributed data were expressed as means with SDs, and the student's t-test was used to compare between-group differences at baseline. Non-normally distributed data were presented with median (P25, P75) and then Mann-Whitney U test was used. The baseline characteristics between comparison groups were analyzed using the Chi-square test (χ^2) or the Fisher's Exact Test for categorical variables described as frequencies (percentages). The paired *t*-test was used to compare within a group before and after the intervention. An independent *t*-test (with a 95% confidence interval) was used to compare between-group differences after the intervention. The *t*-tests were conducted to examine the effect of the Baduanjin exercise on cognitive function, lower limb balance function, and quality of life of participants with mild cognitive impairment. P<0.05 was considered statistically significant. The pearson correlation test was used to analyze the correlation between Lower Limb Balance, changes in quality of life, and improvement of Cognitive Function.

Result

Descriptive statistics of sociodemographic information of Baduanjin exercise group and leisure walking group

A total of 60 MCI participants were in this study, and most of them were Farmer (41.66%). Men covered 51.6%. Comparing the general data of the Baduanjin exercise group and leisure walking group, the results showed no significant differences between the Baduanjin exercise group and leisure walking group in social demographic data. Included gender, age, occupation, education level, marital status, family per capita monthly income, smoking history, and drinking history (P>0.05) (Table I).

MMSE and MoCA: before and after the intervention

Before the intervention, there was no significant difference between the two groups in MMSE and MoCA (P>0.05). After the intervention,

TABLE I.—*Descriptive statistics of sociodemographic information of Baduanjin exercise group and leisure walking group (N.=60).*

Variable		BEG (N.=30)	LWG (N.=30)	P
		57.18±1.69	57.8±1.54	
Gender (M/F)	Men	15 (50%)	16 (53.3%)	0.796
	Female	15 (50%)	14 (46.7%)	
Employment status	Farmer	13 (43.3%)	12 (40%)	0.825
	Worker	6 (20%)	7 (23.3%)	
	Teacher	3 (10%)	5 (16.7%)	
	Other	8 (26.7%)	6 (20%)	
Education	Junior high school and below	19 (63.3%)	15 (50%)	0.571
	Technicalsecondary school/high school	7 (23.3%)	9 (30%)	
	College/Undergraduate	4 (13.4%)	6 (20%)	
	Postgraduate			
Marital status	Married	23 (76.7%)	20 (66.7%)	0.39
	Other	7 (23.3%)	10 (33.3%)	
Smoking status	Never	10 (33.3%)	7 (23.3%)	0.641
	Yes	9 (30%)	9 (30%)	
	Never Smoked	11 (36.7%)	14 (46.7%)	
Drinking status	Never	8 (26.7%)	6 (20%)	0.784
	Yes	13 (43.3%)	13 (43.3%)	
	Never drink	9 (30%)	11 (36.7%)	

Data was presented nuber of participants (percentage).

TABLE II.—*MMSE and MoCA: before and after intervention between the two groups (N.=60).*

Group	MMSE		MoCA	
	Before intervention	After intervention	Before intervention	After intervention
LWG(n=30)	21.56±2.06	23.83±2.11	20.61±1.86	22.79±2.17
BEG(n=30)	21.83±2.22	27.4±2.07	19.96±1.92	24.48±2.33
Between-Group Mean (95% CI)	-0.27 (-1.37 to 0.83)	-3.56 (-4.65 to -2.48)[a]	0.64 (-0.33 to 1.62)	-1.68 (-2.85 to -0.52) [a]
p	0.628	0.00	0.19	0.005

LWG: leisure walking group; BEG: Baduanjin exercise group; MMSE: Mini-mental State Examination; MoCA: Montreal cognitive assessment; P Between-group difference; [a]P<0.05.

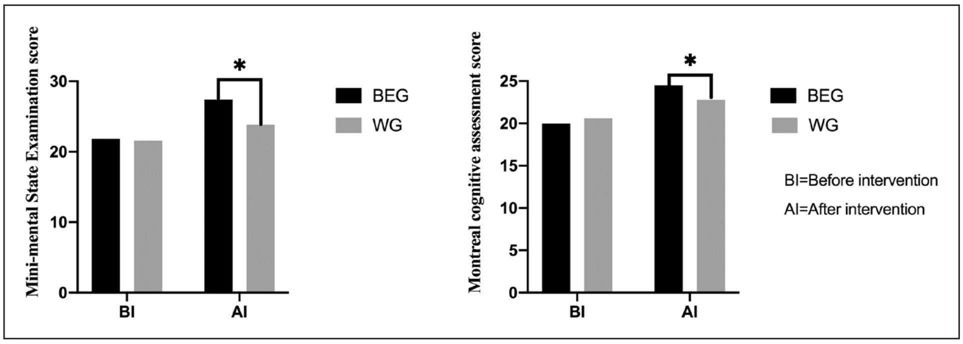

Figure 3.—MMSE and MoCA scores in the Baduanjin exercise group higher than the leisure walking group.

the scores of MMSE and MoCA in the Baduanjin exercise group and the leisure walking group were higher than before the intervention (P<0.05). Further comparing the MMSE and MoCA scores, the MMSE and MoCA scores in the Baduanjin exercise group were higher than the leisure walking group (P<0.05) (Table II, Figure 3). It showed that the effect of the Baduanjin exercise on improving MCI participants' cognitive function was better than the leisure walking group.

BBS, TUG, 10MWT: before and after intervention

Before the intervention, there was no significant difference in the BBS, TUG, and 10MWT scores between the two groups (P>0.05). After the intervention, the BBS, TUG, and 10MWT in the Baduanjin exercise group were higher than previously (P<0.05), with significant differences. Simultaneously, there was a considerable difference in the TUG and 10MWT scores in the leisure walking group (P<0.05). Experimental data showed that the Baduanjin exercise and leisure walking could play a positive role in improving the lower limb balance of MCI participants. In comparing the two groups, the BBS, TUG, and 10MWT in the Baduanjin exercise group were higher than the leisure walking group (P<0.05), with significant differences (Table III, Figure 4).

In summary, the overall effect of the Baduanjin exercise on improving the lower limb balance ability of MCI participants was better than that in the leisure walking group.

TABLE III.—*BBS, TUG, and 10MWT: before and after intervention between the two groups (N.=60).*

Group	BBS		TUG		10MWT (m/s)	
	Before intervention	After intervention	Before intervention	After intervention	Before intervention	After intervention
LWG(n=30)	47.31±1.94	47.64±2.21	9.84±0.11	9.16±0.15	0.92±0.01	1.03±0.04
BEG(n=30)	47.68±1.95	52.38±2.19	9.63±0.15	8.64±0.21	0.93±0.02	1.27±0.2
Between-Group Mean (95% CI)	-0.36 (-1.37 to 0.64)	-4.73 (-5.87 to -3.59) [a]	0.21 (0.14 to 0.28)	0.52 (0.42 to 0.61)[a]	0 (-0.01 to 0)	-0.24 (-0.31 to -0.16) [a]
P	0.471	0.00	0.169	0.00	0.195	0.00

LWG: leisure walking group; BEG: Baduanjin exercise group; BBS: Berg Balance; TUG: Timed Up and Go; 10MWT: 10-meter walk test; P Between-group difference; [a]: P<0.05.

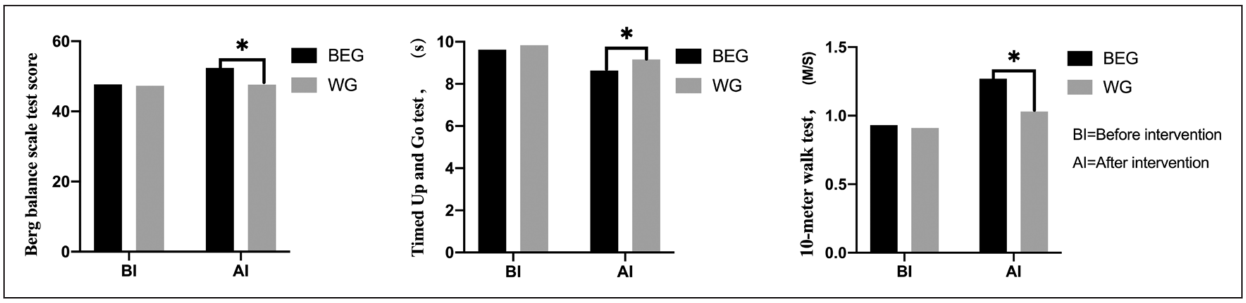

Figure 4.—The BBS, TUG, and 10MWT in the Baduanjin exercise group higher than the leisure walking group.

Quality of life (SF-12): before and after intervention

Before the intervention, there was no significant difference in SF-12 scores between the two groups (P>0.05). After the intervention, the scores on the quality of life (PCS, MCS) of the Baduanjin exercise group and the leisure walking group were both improved after the intervention (P<0.05), with a significant difference. Especially the Baduanjin exercise had a noticeable effect on improving MCI participants' quality of life. In comparison, the leisure walking group has no significant change. Furthermore, the comparative scores of quality of life (PCS, MCS) in the Baduanjin exercise group were higher than the leisure walking group after intervention (P<0.05), with a significant difference (Table IV, Figure 5).

It showed that after two kinds of intervention, the overall effect of the Baduanjin exercise in improving the quality of life of MCI participants was better than that of the leisure walking group.

Correlation between Lower Limb Balance, changes of Quality of life, and improvement of Cognitive Function

After 12 weeks of intervention, Cognitive Function, Lower Limb Balance, and Quality of life in participants in the two groups have improved than before the intervention. We use correlation analysis to analyze the correlation between Lower Limb Balance, changes in Quality of life, and improvement of Cognitive Function. The results (Table V, Figure 6) show that there is a signifi-

Table IV.—*Quality of life (SF-12): before and after intervention between the two groups (N.=60).*

Group	PCS (physical component score)		MCS (Mental component Score)	
	Before intervention	After intervention	Before intervention	After intervention
LWG(n=30)	47.33±2.06	51.84±1.69	58.11±1.66	60.74±2.04
BEG(n=30)	47.88±2.27	53.79±1.95	57.33±1.84	62.55±2.02
t	-0.98	-4.11	1.72	-3.43
Between-Group Mean (95% CI)	-0.55 (-1.67 to 0.56)	-1.94 (-2.89 to -1)[a]	0.78 (-0.12 to 1.69)	-1.8 (-2.86 to -0.75) [a]
p	0.327	0.00	0.089	0.00

LWG: leisure walking group; BEG: Baduanjin exercise group; BBS: Berg Balance; TUG: Timed Up and Go; 10MWT: 10-meter walk test; P Between-group difference; [a]: P<0.05.

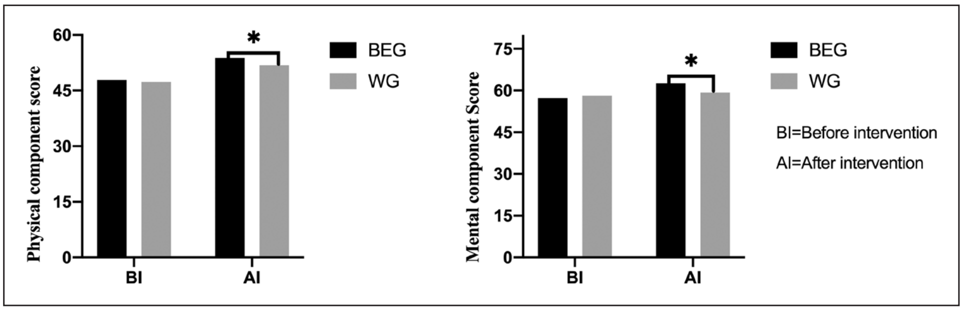

Figure 5.—Comparative scores of quality of life (PCS, MCS) in the Baduanjin exercise group higher than the leisure walking group after intervention.

TABLE V.—*Correlations between changes in Lower Limb Balance,Quality of life and Cognitive Function.*

Variable	BBS	TUG	10MWT	PCS	MCS
MMSE	0.337[a]	-0.122	0.416[a]	0.021	0.012
MoCA	-0.034	0.285	-0.148	0.041	0.525[b]

The data in the table is the correlation coefficient (r). [a]P<0.0.5; [b]P<0.01.
MMSE: Mini-mental State Examination; MoCA: Montreal Cognitive Assessment; BBS: Berg Balance Scale Test Score; TUG: Timed Up and Go; 10MWT: 10-meter Walk Test; PCS: Physical Component Score; MCS: Mental component Score.

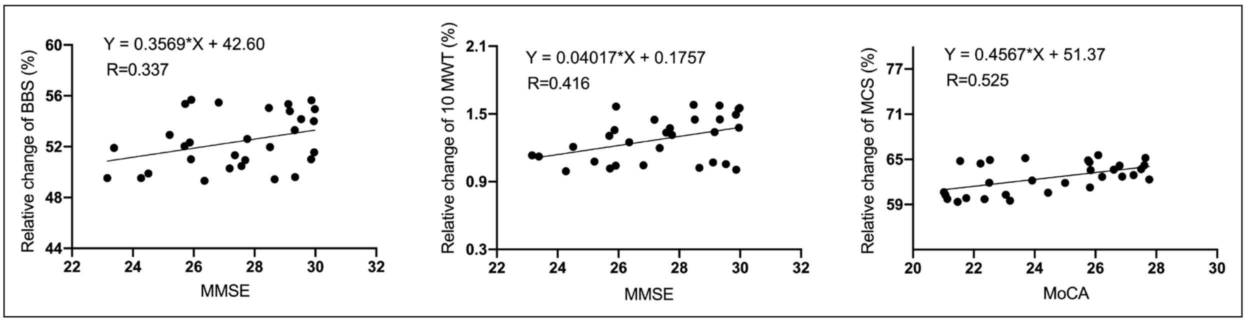

Figure 6.—Results showing a significant positive correlation between Lower Limb Balance (BBS) and the improvement of Cognitive Function (MMSE) score.

cant positive correlation between Lower Limb Balance (BBS) and the improvement of Cognitive Function (MMSE) score (r=0.337, P<0.05). Meanwhile, a significant positive correlation between Lower Limb Balance (10MWT) and the improvement of Cognitive Function (MMSE) score (r=0.416, P<0.05). In addition, the change of Quality of life (MCS) was positive correlated with Cognitive Function (MoCA)improvement (r=0.525, P<0.01). However, there is no significant correlation between Cognitive Function and Quality of life (PCS).

Discussion

The primary purpose of this study was to clarify the effects of Baduanjin on cognitive function, lower limb balance function, and quality of life of the elderly with mild cognitive impairment. The major findings were that participants with MCI intervened with 12-week Baduanjin exercise have a significant improvement in the cognitive function. In contrast, no improvement was observed in the leisure walking group. In addition, participants in the Baduanjin group also showed a concomitant improvement in lower limb balance function and quality of life. And the change of quality of life and lower limb balance ability is significantly correlated with the improvement of cognitive function.MCI participants had no adverse reactions during the whole exercise intervention, and all participants were satisfied with the exercise program.

Effect of Baduanjin exercise on cognitive function of the elderly with MCI

In our research, one of the most remarkable findings was that the experimental data after intervention in cognitive function (MMSE and MoCA) of the Baduanjin exercise group were significantly different from those of the walking group. Our results are the same as those, showing the Baduanjin exercise greatly improved participants' cognitive function.[39-45] For example, Yu, L . proposed that Baduanjin combined with traditional therapy significantly improved MCI participants' cognitive and memory functions compared with traditional therapy. In this intervention study of MCI participants, MMSE and MoCA were selected as cognitive function measurement indicators. Although the study did not add other cognitive function measurement indicators, the research results were not affected and were consistent with the research ideas and methods.[46-48]

Although the detailed mechanism by which Baduanjin improves cognitive function is not fully understood. As a comprehensive, multicomponent intervention, Baduanjin may act through many intermediate variables along the pathway to improved cognitive outcomes. Several studies have suggested that MCI is a mental disease with mild symptoms.The pathologic and molecular substrate of people diagnosed with MCI is not well established. In fact, it can be argued that neuronal degeneration initiated at different levels of the central nervous system drive cognitive decline as a final common pathway at this stage of the dementing disease process.[49] Although there is no apparent disease in the limb function of the elderly with MCI, the cognitive function is decreased and impaired, or the memory is reduced to varying degrees. Acute exercise can induce changes in pBDNF concentration, and significant associations were observed between acute exercise and cognitive memory.[50] Consistent with our studies, a study showed that Tai Chi and Baduanjin practice could modulate mental control function and the resting-state functional connectivity (RSFC) of the cognitive control network in older adults. The suggests that mind-body exercises such as Tai Chi and Baduanjin may be potential and effective methods for preventing cognitive decline in older adults.[51] Another study showed that Tai Chi and Baduanjin could significantly increase grey matter volume (GMV) in the insula, medial temporal lobe, and putamen after 12-weeks of exercise to modulate brain structure and memory function in older adults.[52] These findings might reveal the likely neurobiological mechanisms of Baduanjin exercise in improving the memory and cognition of patients.

Effect of Baduanjin exercise on lower limb balance and quality of life of the Elderly with MCI and correlation

Epidemiological investigation points out that cognitive dysfunction will reduce people's quality of life and sleep.[43] However, those investigations do not simultaneously involve the cognitive function and other health indicators affecting the real-life status of the elderly with MCI, such as physical activity, quality of life, and sleep.

Another result of our study found that besides improving cognitive function measurement, the participants in the Baduanjin Group also showed improvement in quality of life and physical performance. And the magnitude of the improvement was modest. This lower degree of improvement may be due to differences in style, duration, and intensity of the Baduanjin intervention and the characteristics of the participants. Several factors may explain the positive effects of Baduanjin training on lower limb balance function and quality of life in the elderly with MCI. First, the effect of Baduanjin on lower limb balance function among patients has been well demonstrated in our study. The present study is in keeping with these findings since, as reported elsewhere. The lower limb balance function of the Baduanjin group has been improved,[44, 45] and a significant positive correlation between Lower Limb Balance (BBS) and the improvement of Cognitive Function (MMSE) score ($r=0.337$, $P<0.05$). Meanwhile, a significant positive correlation between Lower Limb Balance (10MWT) and the improvement of Cognitive Function (MMSE) score ($r=0.416$, $P<0.05$) were observed in the present study. Second, we found that significant improvements in quality of life from Baduanjin exercise in the present study. And the improvements in quality of life are associated with improving the cognitive function of patients with MCI. This result is consistent with the research of other scholars.[53, 54] There was also a significant positive relationship between changes in cognitive function (MoCA) and quality of life (MCS) ($r=0.593$, $P<0.01$).

Limitations of the study

First, this study has only speculated the possible mechanism of the Baduanjin exercise's influence on cognitive function, lower limb ability, and quality of life through indirect indicators. Nevertheless, it did not explain the mechanism of the central nervous system and biological indicators.

Second, the indicators of lower limb balance ability used in this study are all single-task results. These result from the interaction of perception, behavior, and cognitive process. A single-task test may not fully evaluate and reflect the horizontal function of lower limbs. Multi-task state measurement combined with single-task state measurement can measure and reflect the horizontal function of lower limbs more effectively.

Additionally, the outcome indicators used in this study are subjective assessment scale (taking SF-12 health scale as an example). This is personal and limited by human factors and external influences. As an intervention means, exercise cannot be blind to the subjects.

Finally, this study lacks the follow-up process after the intervention, and cannot determine whether the Baduanjin exercise will maintain the influence on cognitive function for a long time. At present, there is no more intensive study, and the mechanism of the influence is not clear.

While this study has revelaed many new angles for further research, there are limitations to the current findings. Future research should further determine the potential function of this exercise mode through more detail the mechanism of the central nervous system and biological indicators to understand why the Baduanjin exercise can cause changes in cognitive function and lower limb balance ability and quality of life of the elderly with MCI. Since this study is a small sample of exercise intervention research, it is of reference value for the availability of new clinical intervention methods.

Conclusions

In short, this research shows that the twelve-week Baduanjin exercise can improve the cognitive function of the elderly with MCI, especially the overall cognitive function. In addition, the Baduanjin exercise can improve the balance function of lower limbs and quality of life. And the overall cognitive function improvement of the elderly with MCI affects the lower limb function and quality of life. Besides, the Baduanjin is an effective, safe, and helpful exercise, which can improve different groups' physical and mental health. In the future, more directions should focus on the intervention means of the combination of non-drugs or the lowest dose of drugs that can bring health benefits to different groups.

References

1. Gauthier S, Reisberg B, Zaudig M, Petersen RC, Ritchie K, Broich K, *et al.*; International Psychogeriatric Association Expert Conference on mild cognitive impairment. Mild cognitive impairment. Lancet 2006;367:1262–70.

2. Petersen RC. Mild cognitive impairment as a diagnostic entity. J Intern Med 2004;256:183–94.

3. Writing Goup of the D, Cognitive Society of Neurology Committee of Chinese Medical A, Alzheimer's Disease C. [Guidelines for dementia and cognitive impairment in China: the diagnosis and treatment of mild cognitive impairment]. Zhonghua Yi Xue Za Zhi 2010;90:2887–93. [Chinese].

4. Graham JE, Rockwood K, Beattie BL, Eastwood R, Gauthier S, Tuokko H, *et al.* Prevalence and severity of cognitive impairment with and without dementia in an elderly population. Lancet 1997;349:1793–6.

5. Sobów T, Flirski M, Kłoszewska I, Liberski PP. Plasma levels of alpha beta peptides are altered in amnestic mild cognitive impairment but not in sporadic Alzheimer's disease. Acta Neurobiol Exp (Warsz) 2005;65:117–24.

6. Guan Shaochen TZ, Wu X. A sampling survey on the prevalence and risk factors of mild cognitive impairment among the elderly in Beijing. Chinese Journal of Cerebrovascular Diseases 2008;5:395–8.

7. Hilal S, Ikram MK, Saini M, Tan CS, Catindig JA, Dong YH, *et al.* Prevalence of cognitive impairment in Chinese: epidemiology of dementia in Singapore study. J Neurol Neurosurg Psychiatry 2013;84:686–92.

8. Verghese J, Wang C, Lipton RB, Holtzer R, Xue X. Quantitative gait dysfunction and risk of cognitive decline and dementia. J Neurol Neurosurg Psychiatry 2007;78:929–35.

9. Holtzer R, Wang C, Lipton R, Verghese J. The protective effects of executive functions and episodic memory on gait speed decline in aging defined in the context of cognitive reserve. J Am Geriatr Soc 2012;60:2093–8.

10. Martin KL, Blizzard L, Wood AG, Srikanth V, Thomson R, Sanders LM, *et al.* Cognitive function, gait, and gait variability in older people: a population-based study. J Gerontol A Biol Sci Med Sci 2013;68:726–32.

11. Watson NL, Rosano C, Boudreau RM, Simonsick EM, Ferrucci L, Sutton-Tyrrell K, *et al.*; Health ABC Study. Executive function, memory, and gait speed decline in well-functioning older adults. J Gerontol A Biol Sci Med Sci 2010;65:1093–100.

12. Inzitari M, Newman AB, Yaffe K, Boudreau R, de Rekeneire N, Shorr R, *et al.* Gait speed predicts decline in attention and psychomotor speed in older adults: the health aging and body composition study. Neuroepidemiology 2007;29:156–62.

13. Atkinson HH, Rosano C, Simonsick EM, Williamson JD, Davis C, Ambrosius WT, *et al.*; Health ABC study. Cognitive function, gait speed decline, and comorbidities: the health, aging and body composition study. J Gerontol A Biol Sci Med Sci 2007;62:844–50.

14. Colcombe S, Kramer AF. Fitness effects on the cognitive function of older adults: a meta-analytic study. Psychol Sci 2003;14:125–30.

15. Lü J, Fu W, Liu Y. Physical activity and cognitive function among older adults in China: A systematic review. J Sport Health Sci 2016;5:287–96.

16. Sadeghi H, Shojaedin SS, Alijanpour E, Abbasi A. The Effects of Core Stability Exercises on Balance and Walking in Elderly Fallers with Mild Cognitive Impairment: A Randomized Control Trial. Journal of Research in Rehabilitation Sciences 2020;1:110–7.

17. Lv Jiaojiao LY. Exercise: an effective hand for preventing Alzheimer's disease. Sports Science 2016;36:96-7.

18. Lv Jiaojiao LY. Influence of physical activity on cognitive function of the elderly with mild cognitive impairment and its possible mechanism. Chinese Journal of Rehabilitation Medicine 2016;31:732-6.

19. C KT. Baduanjin-an ancient Chinese exercise. Am J Chin Med 2020;10:14–21.

20. Ma Q, Yang Z, Zhu F, Chen H, Yang H, Wang S. The effect of Baduanjin exercise on the quality of life in patients recovering from COVID-19: A protocol for systematic review and meta-analysis. Medicine (Baltimore) 2020;99:e22229.

21. Zhang XB, Zhang JL, Li MX, Yuan YP, Sun J. Baduanjin exercise can alleviate anxiety and depression of patients with COVID-19 in Square cabin hospital: A cross-sectional survey. Medicine (Baltimore) 2021;100:e26898.

22. Rong J, Li J, Jing F, Ren Y, Xiao Y, Pan Q, *et al.* Efficacy of Baduanjin exercise for rehabilitation after COVID-19: A protocol for systematic review and meta-analysis. Medicine (Baltimore) 2021;100:e26366.

23. Meng L. the effect of fitness baduanjin on cognitive function, emotion and quality of life of patients with chronic obstructive pulmonary disease in stable stage. Shenyang Institute of Physical Education; 2018.

24. Yunzhi ZD, Jipei M. The effect of Ba Duanjin on the quality of life and psychological state of non-dialysis patients with chronic kidney disease. Clinical Journal of Traditional Chinese Medicine 2020;99:22229.

25. Weiying F, Feng C, Lianyu Z, Yulian R, Xiaohong F. Effect of Baduanjin Exercise on Anxiety and Depression of 38 Elderly Patients with Essential Hypertension. Fujian Traditional Chinese Medicine 2021. [Epub ahead of print].

26. Yuen M, Ouyang HX, Miller T, Pang MY. Baduanjin Qigong Improves Balance, Leg Strength, and Mobility in Individuals With Chronic Stroke: A Randomized Controlled Study. Neurorehabil Neural Repair 2021;35:444–56.

27. Shijia G, Juanjuan H, Dongxue X. The influence of Ba Duan Jin of Health Qigong on cognitive function and negative emotion of patients with traumatic brain injury in rehabilitation period. The 11th National Sports Science Conference; 2019.

28. Zhang Ping WY. The effect of Ba Duan Jin with medium and high posture on anxiety, depression and quality of life of patients with ulcerative colitis. Chinese Journal of Modern Nursing 2019. [Epub ahead of print].

29. Fuxiao B. Study on the influence of Duan Jin on the balance stability of lower limbs of the elderly. Shandong Sport University; 2020.

30. Changwei T. Influence of Baduanjin of Health Qigong on the range of motion of elderly women. Shanghai Normal University. 2020.

31. Petersen RC, Smith GE, Waring SC, Ivnik RJ, Tangalos EG, Kokmen E. Mild cognitive impairment: clinical characterization and outcome. Arch Neurol 1999;56:303–8.

32. HQMCoGAoSo. Health qigong-Baduanjin. Beijing: People's Sport Publishing House of China; 2003.

33. Folstein MF, Folstein SE, McHugh PR. "Mini-mental state". A practical method for grading the cognitive state of patients for the clinician. J Psychiatr Res 1975;12:189–98.

34. Nasreddine ZS, Phillips NA, Bédirian V, Charbonneau S, Whitehead V, Collin I, *et al.* The Montreal Cognitive Assessment, MoCA: a brief screening tool for mild cognitive impairment. J Am Geriatr Soc 2005;53:695–9.

35. Bogle Thorbahn LD, Newton RA. Use of the Berg Balance Test to predict falls in elderly persons. Phys Ther 1996;76:576–83, discussion 584–5.

36. Chan PP, Si Tou JI, Tse MM, Ng SS. Reliability and Validity of the Timed Up and Go Test With a Motor Task in People With Chronic Stroke. Arch Phys Med Rehabil 2017;98:2213–20.

37. Bushnell C, Bettger JP, Cockroft KM, Cramer SC, Edelen MO, Hanley D, *et al.* Chronic Stroke Outcome Measures for Motor Function Intervention Trials: Expert Panel Recommendations. Circ Cardiovasc Qual Outcomes 2015;8(Suppl 3):S163–9.

38. Gandek B, Ware JE, Aaronson NK, Apolone G, Bjorner JB, Brazier JE, *et al.* Cross-validation of item selection and scoring for the SF-12 Health Survey in nine countries: results from the IQOLA Project. International Quality of Life Assessment. J Clin Epidemiol 1998;51:1171–8.

39. Lautenschlager NT, Cox KL, Flicker L, Foster JK, van Bockxmeer FM, Xiao J, *et al.* Effect of physical activity on cognitive function in older adults at risk for Alzheimer disease: a randomized trial. JAMA 2008;300:1027–37.

40. Zheng G, Zheng Y, Xiong Z, Ye B. Effect of Baduanjin exercise on cognitive function in patients with post-stroke cognitive impairment: a randomized controlled trial. Clin Rehabil 2020;34:1028–39.

41. Yu L, Liu F, Nie P, Shen C, Chen J, Yao L. Systematic review and meta-analysis of randomized controlled trials assessing the impact of Baduanjin exercise on cognition and memory in patients with mild cognitive impairment. Clin Rehabil 2021;35:492–505.

42. Suzuki T, Shimada H, Makizako H, Doi T, Yoshida D, Ito K, *et al.* A randomized controlled trial of multicomponent exercise in older adults with mild cognitive impairment. PLoS One 2013;8:e61483.

43. Reynolds CF 3rd, Frank E, Perel JM, Imber SD, Cornes C, Miller MD, *et al.* Nortriptyline and interpersonal psychotherapy as maintenance therapies for recurrent major depression: a randomized controlled trial in patients older than 59 years. JAMA 1999;281:39–45.

44. Xiao Y, Luo Q, Yu Y, Cao B, Wu M, Luo Y, *et al.* Effect of baduanjin on the fall and balance function in middle-aged and elderly people: A protocol for systematic review and meta-analysis. Medicine (Baltimore) 2021;100:e27250.

45. Liu XY, Gao J, Yin BX, Yang XY, Bai DX. Efficacy of Ba Duan Jin in Improving Balance: A Study in Chinese Community-Dwelling Older Adults. J Gerontol Nurs 2016;42:38–46.

46. Wei XH, Ji LL. Effect of handball training on cognitive ability in elderly with mild cognitive impairment. Neurosci Lett 2014;566:98–101.

47. Nascimento CM, Pereira JR, Pires de Andrade L, Garuffi M, Ayan C, Kerr DS, *et al.* Physical exercise improves peripheral BDNF levels and cognitive functions in mild cognitive impairment elderly with different bdnf Val66Met genotypes. J Alzheimers Dis 2015;43:81–91.

48. Varela S, Ayán C, Cancela JM, Martín V. Effects of two different intensities of aerobic exercise on elderly people with mild cognitive impairment: a randomized pilot study. Clin Rehabil 2012;26:442–50.

49. Mufson EJ, Binder L, Counts SE, DeKosky ST, de Toledo-Morrell L, Ginsberg SD, *et al.* Mild cognitive impairment: pathology and mechanisms. Acta Neuropathol 2012;123:13–30.

50. Piepmeier AT, Etnier JL. Brain-derived neurotrophic factor (BDNF) as a potential mechanism of the effects of acute exercise on cognitive performance. J Sport Health Sci 2015;4:14–23.

51. Tao J, Chen X, Egorova N, Liu J, Xue X, Wang Q, *et al.* Tai Chi Chuan and Baduanjin practice modulates functional connectivity of the cognitive control network in older adults. Sci Rep 2017;7:41581.

52. Tao J, Liu J, Liu W, Huang J, Xue X, Chen X, *et al.* Tai Chi Chuan and Baduanjin Increase Grey Matter Volume in

Older Adults: A Brain Imaging Study. J Alzheimers Dis 2017;60:389–400.

53. Uemura K, Shimada H, Makizako H, Doi T, Yoshida D, Tsutsumimoto K, *et al.* Cognitive function affects trainability for physical performance in exercise intervention among older adults with mild cognitive impairment. Clin Interv Aging 2013;8:97–102.

54. HP N. Effect of Qigong on physical and psychosocial status of Chinese COPD patients: A randomized controlled trial. The Hong Kong Polytechnic University; 2010.

Conflicts of interest.—The authors certify that there is no conflict of interest with any financial organization regarding the material discussed in the manuscript.

Authors' contributions.— Conceptualization: Keqiang Li, Mariusz Lipowski, Jakub A. Kortas, Xiaojun Lin; methodology: Keqiang Li, Mariusz Lipowski, Xiaojun Lin; software: Keqiang Li, Hongli Yu, Mariusz Lipowski, Xiaojun Lin; validation: Keqiang Li, Mariusz Lipowski, Xiaojun Lin; formal analysis: Keqiang Li, Hongli Yu, Jakub A. Kortas; investigation: Keqiang Li, Mariusz Lipowski, Jakub A. Kortas, Xiaojun Lin.; resources: Keqiang Li, Mariusz Lipowski, Xiaojun Lin; data curation: Keqiang Li, Mariusz Lipowski, Jakub Antoni Kortas, Xiaojun Lin; writing—original draft preparation: Keqiang Li, Xiaojun Lin, Hongli Yu; writing—review and editing: Keqiang Li, Xiaojun Lin, Mariusz L.; visualization: Keqiang Li, Xiaojun Lin; supervision: Keqiang Li, Mariusz Lipowski, Jakub A. Kortas, Xiaojun Lin; project administration: Keqiang Li, Mariusz Lipowski, Jakub A. Kortas, Xiaojun Lin; funding acquisition: Keqiang Li, Mariusz Lipowski, Jakub A. Kortas, Xiaojun Lin. All authors read and approved the final version of the manuscript.

History.—Manuscript accepted: April 29, 2022. - Manuscript received: March 29, 2022.

Hindawi
Evidence-Based Complementary and Alternative Medicine
Volume 2022, Article ID 8602753, 13 pages
https://doi.org/10.1155/2022/8602753

Research Article

The Effects of Er Xian Decoction Combined with Baduanjin Exercise on Bone Mineral Density, Lower Limb Balance Function, and Mental Health in Women with Postmenopausal Osteoporosis: A Randomized Controlled Trial

Keqiang Li,[1] Hongli Yu,[1] Xiaojun Lin,[2] Yuying Su,[3] Lifeng Gao,[4] Minjia Song,[5] Hongying Fan,[6] Daniel Krokosz,[1] Huixin Yang,[5] and Mariusz Lipowski[1]

[1]*Gdansk University of Physical Education and Sport, Gdańsk, Poland*
[2]*School of Public Health and Management, Wenzhou Medical University, Wenzhou, China*
[3]*Physical Education College, Bohai University, Jinzhou, China*
[4]*Henan Province Hospital of Traditional Chinese Medicine, Zhengzhou, China*
[5]*Harbin University of Physical Education, Harbin, China*
[6]*School of Psychology, Beijing Sport University, Beijing, China*

Correspondence should be addressed to Mariusz Lipowski; mariusz.lipowski@awf.gda.pl

Academic Editor: Rajeev K. Singla

Background. Postmenopausal osteoporosis (PMOP) is a common disease in older women that can severely jeopardize their health. Previous studies have demonstrated the effect of Er xian decoction (EXD) or Baduanjin exercise (BE) on PMOP. However, reports on the effect of EXD combined with BE on PMOP are limited. This study aimed to investigate the impact of EXD combined with BE on bone mineral density (BMD), lower limb balance, and mental health in women with PMOP. *Methods*. A 1 : 1 : 1 simple randomization technique was employed. Fifty participants with postmenopausal osteoporosis were allocated to three groups: the EXD group (EXD = 15); the BE group (BE = 18); and the combined group (EXD + BE = 17). After both 8 weeks and 16 weeks of intervention treatment, participants improved significantly with respect to BMD and the one-leg standing test (OLST), Berg balance scale (BBS), timed up and go (TUG) test, self-anxiety scale (SAS), and self-rating depression scale (SDS). The results were used to compare the effect of the intervention on BMD, lower limb balance function, and mental health in patients with PMOP. *Results*. Compared to the EXD and BE groups, the EXD + BE group showed the strongest effects on BMD, lower limb balance function, and mental health ($p < 0.01$). A correlation between BMD and lower limb balance and mental health was noted in the EXD + BE group. The change in mental health (SAS score) was correlated with BMD (femoral neck) improvement. *Conclusions*. The present study demonstrates that EXD combined with BE (EXD + BE) may have a therapeutic advantage over both monotherapies for treating BMD, lower limb balance function, and mental health in patients with PMOP. The feasibility of the approach for a large-scale RCT was also confirmed. Er xian decoction combined with Baduanjin exercise (EXD + BE) might offer a viable treatment alternative for participants with postmenopausal osteoporosis given its promising effects in disease control and treatment, with good efficacy and safety profiles.

1. Introduction

Osteoporosis is a systemic, multifactorial disease that causes morbidity and mortality in the elderly and is increasing in prevalence worldwide [1]. Many factors contribute to osteoporosis, such as estrogen deficiency, genetics, nutritional deficiencies, chronic diseases, and aging. Postmenopausal osteoporosis (PMOP) symptoms are mainly characterized by a decrease in bone mineral density (BMD) and changes in biochemical indicators of bone metabolism

[2], which affect the stability of the lower limbs and increase the risk of fracture. Meanwhile, the decrease in BMD, bone loss, and increased fracture risk has a strong negative impact on the mental health of postmenopausal women with osteoporosis [3–8]. Western medicine is still the primary treatment for women with PMOP. However, the long-term use of Western medicine still cannot completely cure the disease. Moreover, most Western drugs are expensive, have adverse side effects, and damage the patient's body. Examples of such medications include bisphosphonates, tibolone, calcitonin, and parathyroid hormone (PTH) therapy [9–11]. Many animal studies and clinical experiments have proved that traditional Chinese medicine has a significant effect on the prevention and treatment of postmenopausal osteoporosis (PMOP) and has fewer side effects on the body than chemically synthesized medicines [12]. Therefore, the treatment of PMOP with traditional Chinese medicine will be examined in this paper.

Er xian decoction (EXD) is a multi-herb formula composed of six herbs, namely, *Rhizome curculiginis*, *Herba epimedium*, *Radix Morinda officinalis*, *Rhizome anemarrhenae*, *Cortex Phellodendron*, and *Radix Angelica sinensis.* It has several biological and pharmacological effects [13]. It has long been used to treat osteoporosis, perimenopausal syndrome, and age-related diseases in elderly patients [14–16].

EXD can improve BMD [17], promote endocrine activity and provide antioxidants [13], and treat menopause-related symptoms [18, 19]. Moreover, studies have reported that EXD is effective and safe in reducing the frequency and severity of hot flashes and improving menopausal symptoms in perimenopausal women in Hong Kong [18]. EXD showed neuroprotective effects on corticosterone-injured PC12 cells in vitro and improved depression-like behavior in mice [20]. In OVX rats, atrophy of the uterus and reduction of BMD were suppressed by treatment with EXD (*Herba epimedium*) [17]. Additionally, studies have reported that EXD can stimulate the secretion of T from Leydig cells, P from luteal cells, and E2 from granulosa cells [15].

The effectiveness of Baduanjin as an exercise intervention has been recognized in many international studies [21]. It consists of eight independent, simple, subtle, and smooth movements and is a form of qigong. BE, an important means of Chinese traditional rehabilitation therapy [21], can improve patients' blood microcirculation, transport blood calcium to the bone, promote calcium absorption, promote bone mineral salt deposition, promote and increase the proliferation and activity of bone cells, delay bone loss with age, and increase BMD [22]. Although the potential effectiveness of each movement may be different, the overall Baduanjin exercise (BE) has been demonstrated to improve physical and psychological health [23, 24]. One study has reported that a 12-week BE program significantly prevents bone loss in middle-aged women [23]. In addition, clinical observation shows that BE improves balance and fall risk in patients with senile osteoporosis [25]. Finally, a comprehensive review shows that BE facilitates improvements in psychological health and may be a suitable choice for interventions [24]. Although several studies have demonstrated a stimulatory effect of exercise on bone tissue, it is not recommended as a substitute for medical treatment.

Few published studies have investigated the effects of combination therapy using physical exercise and drugs to treat osteoporosis. Therefore, this study aims to evaluate the effect of EXD combined with BE on patients with PMOP. After 8 weeks and 16 weeks of intervention, measurements were performed to investigate the impact of the different treatments on the BMD, lower limb balance function, and mental health of study participants.

2. Methods and Materials

2.1. Study Design and Participants

2.1.1. Experimental Design. This study enrolled 57 participants. Seven participants dropped out after the first screening for personal reasons unrelated to the study. Two had a scheduling conflict, two did not give a reason, and three could not perform the exercises. The remaining 50 eligible subjects were enrolled and randomly assigned to the BE group (BE, $n = 18$), EXD group (EXD, $n = 15$), and combined group (BE + EXD, $n = 17$). All participants completed their intervention (Figure 1).

2.1.2. Participants. From September 2021 to February 2022, 57 older citizens from six villages were randomly selected from the Lingxi Township of Wenzhou City, Zhejiang Province, China. The participants were between 50 and 70 years old, and they were required to have lived in the selected villages for more than six months in the past year. The participants completed a questionnaire survey that included the inclusion and exclusion criteria. After the screening, two participants left with no reason provided, two left the study due to scheduling conflicts, and three were excluded because their physical conditions were unsuitable. Finally, a total of 50 participants qualified for the study.

2.2. Diagnostic Criteria for Subject Recruitment

2.2.1. Inclusion Criteria. The inclusion criteria were as follows: women are aged from 50 to 79 years old and have been in natural menopause for more than one year; the BMD T score of the lumbar spine (L2–L4) or femoral shaft is −2.5 or less; the anatomical structure of the lumbar spine is suitable for dual-energy X-ray bone density measurement, and there is no severe scoliosis, trauma, or sequelae related to bones or surgery; the participant is in good health and can move outdoors for at least 30 minutes every day; the participant can understand the research process, is willing to participate in a treatment trial, and signed the informed consent form.

2.2.2. Exclusion Criteria. The exclusion criteria were as follows: the participant suffers from other severe somatic diseases or dysfunctions; the participant is unable to stand stably in place for 30 minutes; the participant has taken other anti-osteoporosis drugs (desquamate, estrogen, raloxifene)

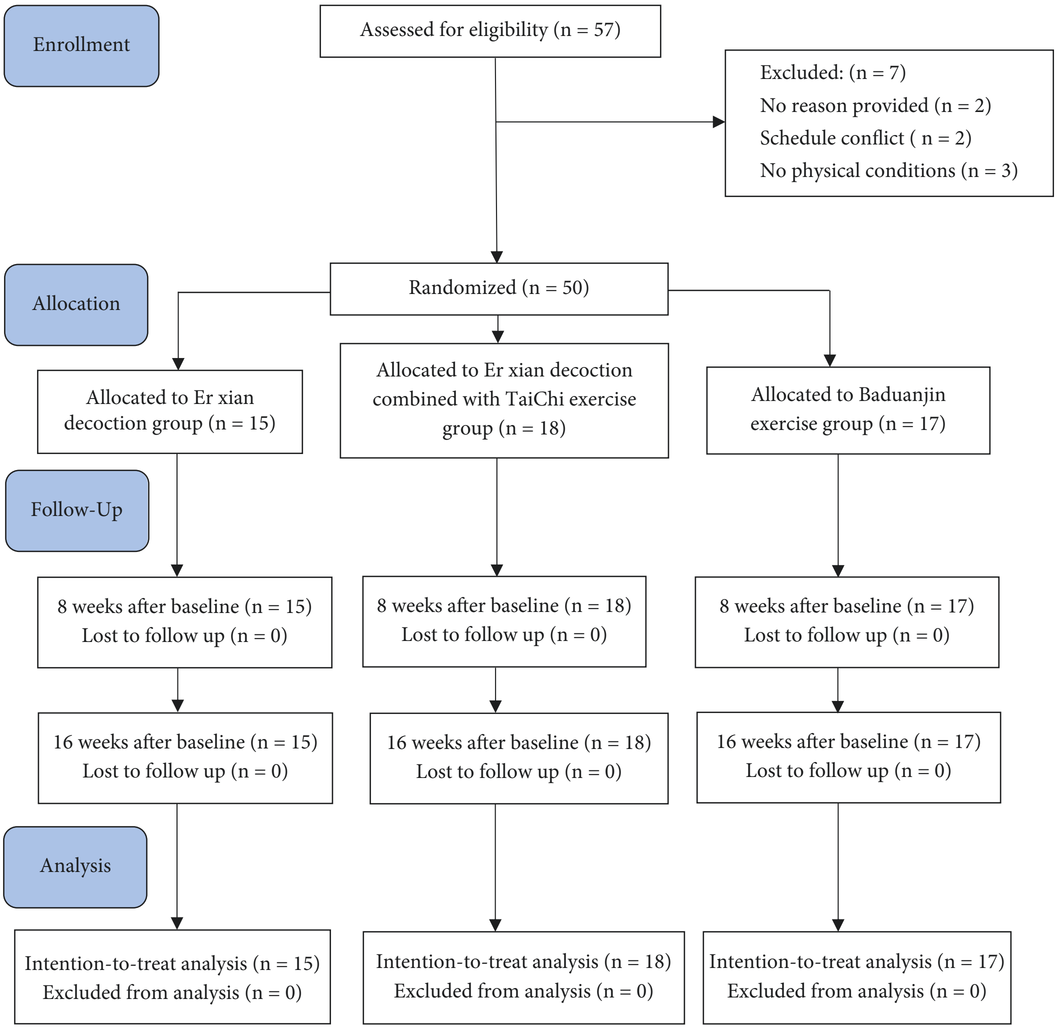

Figure 1: Study flow diagram of the progress through the phases of the experiment.

orally less than three months before entering the group; the participant suffers from mental illness or cognitive dysfunction.

2.3. Randomization and Allocation. Fifty participants who fulfilled the eligibility criteria were randomly allocated to three intervention-based groups: the BE group (BE, $n = 18$), EXD group (EXD, $n = 15$), or combined group (BE + EXD, $n = 17$). To ensure blinding, an independent researcher who was not a part of this study performed the randomized allocation. A 1 : 1 : 1 simple randomization technique was employed. A unique, random, computer-generated code was assigned to each participant via SPSS (version 26.0, Armonk, New York, USA). The allocation was concealed in sealed, opaque envelopes that were provided to researchers before applying the assigned interventions. All study personnel and participants were blinded to the treatment assignment for the duration of the trial. The experimental intervention times for the three groups were 8 weeks and 16 weeks.

2.4. Intervention. Calcium carbonate D3 tablets (Caltrate), a health supplement, can positively affect bone density. These primary drugs were given to all participants, who were asked to take two tablets once a day for 16 weeks (calcium carbonate D3 tablets (Caltrate); approval number: Sinopharm Zhunzi H10950029; manufacturer: Wyeth Pharmaceutical Co., Ltd.; specification: 600 mg).

2.4.1. Baduanjin Exercise Group (BE; $n = 17$). The participants in this group performed BE for 8 weeks and 16 weeks and continued to use their primary drugs. In the first week, they were guided by a professional Baduanjin coach. Then, they began a formal 15-week BE intervention period after mastering the moving and breathing methods. During this intervention period, the participants exercised independently. Each week, they performed the BE movements no fewer than five times, for a total duration of 45 minutes per session [26]. They prepared for exercises for 5 minutes before practice, and they practiced once a day. Follow-up was performed every two weeks by the coach who adjusted the exercise intensity according to the specific situation of the participants.

2.4.2. Er Xian Decoction Group (EXD; n = 15). Participants in this group continued to use their primary drugs and also took EXD. The medicinal components of EXD are as follows: *Rhizoma curculiginis* (15 g), *Herba epimedii* (15 g), *Radix Angelica sinensis* (10 g), *Cortex Phellodendri* (10 g), *Rhizoma anemarrhenae* (10 g), and *Radix Morinda officinalis* (10 g) [27]. The medicine was mixed with 800 ml water, decocted to 150 ml, and taken once daily. The participants consumed the EXD for 16 weeks [28].

2.4.3. Combined Group (BE + EXD; n = 18). In addition to consuming primary drugs and EXD, the participants in this group performed the BE for 8 weeks and 16 weeks. In the first week, they were guided by a professional Baduanjin coach and then began a formal 15-week intervention period of BEs after mastering the moving and breathing methods. During this intervention period, the participants exercised independently and performed the BE no fewer than five times per week for a total duration of 45 minutes per session [26]. They prepared for the exercises for 5 minutes before practice and practiced once a day. Follow-up was performed every two weeks by the coach who adjusted the exercise intensity appropriately according to the specific situation of each participant.

2.5. Measurements

2.5.1. Bone Mineral Density (BMD). A dual-energy X-ray absorptiometry (DEXA) scan is a valid and reliable tool for measuring BMD (Prodigy-GE Healthcare, Chicago, IL, USA) [29]. During a DEXA scan, participants lay supine on an open X-ray table. The participants were asked to keep still during the scan as the large scanning arm passed over their bodies. A trained radiologist scanned each participant's hip and spine regions for approximately 20 minutes. Using the information from the DEXA scans, the participants were classified into the normal bone mass density (score between −1 and 0 or higher), osteopenia (between −1.1 and −2.4), and osteoporosis (a score of −2.5 or less) [30]. We also calculated the *Z*-score, which compares the obtained bone density to the age-matched normal average bone and is often helpful in cases of severe osteoporosis [30, 31].

2.5.2. One-Leg Standing Test (OLST). An OLST was used to assess static balance. The participants were asked to close their eyes, stand on their preferred leg, lift the other leg to an approximately 90° angle at the knee, keep their arms by their sides, and maintain balance without using any assistive device. The test was completed when the stance foot shifted or when the lifted foot was replaced on the ground (whichever occurred first). Each participant had three attempts for each leg. The standing duration (in seconds) was recorded for each attempt, and the best (longest) score was selected for analysis [32]. Cronbach's α value of this test is 0.69.

2.5.3. Berg Balance Scale (BBS). The BBS includes 14 items: standing up from a sitting position; standing without support; sitting position without a backrest, but landing with both feet or putting them on a stool; sitting down from a standing position; transferring; closing eyes without support; standing with both feet together without support; stretching upper limbs and moving forward in standing position; picking up articles from the ground in a standing position; turning to look back in a standing position; turning 360 degrees; putting one foot on a step or stool in a standing position without support; and standing without support with one foot in front. The scoring standard of each item was from 0 to 4, and the total score was from 0 to 56. This range is divided into five grades: zero, poor, fair, good, and normal [33]. Cronbach's α value of this test is 0.77.

2.5.4. Timed Up and Go (TUG) Test. In the TUG test, participants sat on a straight-back chair (the chair's seat height is about 45 cm), wearing the shoes they usually wear, and then leaned against the back of the chair with their hands crossed at their chest. After the "start" instruction, the subjects immediately stood up from the chair, walked forward for 3 meters at their normal walking gait, and turned around after passing the 3-meter marker. Then, they walked back to the chair and sat down, returning to the starting position. The participants could not receive any help during the test [34]. The time was recorded (in seconds) with a stopwatch. Before the formal test, the subjects could practice once or twice to ensure that they understood the whole test process. The formal test was conducted three times, and the average value was taken. The scoring criteria are as follows: If completion time is <10 seconds, the subject can conduct free movement. If completion time is <20 seconds, the subject can move independently. If completion time is 20–29 seconds, the subject's activity is unstable, and there is a high risk of falling. If completion time is >30 seconds, there is an obstacle to activity. Cronbach's α value of this test is 0.71.

2.5.5. Self-Anxiety Scale (SAS). The SAS is used to evaluate the subjective feelings of anxiety in patients and can be used as a self-assessment tool for the clinical understanding of anxiety symptoms [35]. It consists of 20 items, and the frequency of symptoms defined by the items is evaluated according to the following scales: 1–4.1 means "given the other items, 'never or rarely' would be more natural than 'no or few'"; 2 means "sometimes"; 3 means "most of the time"; and 4 means "always." The scores of items 5, 9, 13, 17, and 19 must be calculated in reverse, and the rest can be calculated in sequence. The scores of the 20 items are added to get the rough score, and the rough score is multiplied by 1.25 to obtain the standard score. The critical standard of anxiety assessment in China is 50 points, and a score of 50 points or more indicates anxiety. Cronbach's α value of this measure is 0.62.

2.5.6. Self-Rating Depression Scale (SDS). SDS is a short-term self-rating scale compiled by Zung in 1965 [36]. It is easy to implement and can effectively reflect the symptoms of depression, together with their severity and changes. The scale consists of 20 declarative sentences and corresponding question items. Each item is equivalent to a related symptom, which is graded according to four levels: 1 is "never or rarely," 2 is "sometimes," 3 is "most of the time," and 4 is "always." Ten of the 20 items (items 2, 5, 6, 11, 12, 14, 16, 17, 18, and 20) are scored in reverse order. The scores of the 20 items are summed to obtain the rough score, and the rough score is multiplied by 1.25 to obtain the standard score. Cronbach's α value of this test is 0.85.

2.6. Sample Size. The sample size was determined based on our pilot study using G * Power 3 [37]. An a priori, repeated-measure ANOVA indicated that a total sample size of 50 was needed to achieve 95% power to detect the interaction effect size of 0.21 at a 0.05 level of significance. A total sample size of 57 participants was enrolled in the study.

2.7. Statistical Analyses. Statistical analysis was performed using SPSS (version 26.0, Armonk, New York, USA). The Shapiro–Wilk tests were performed to determine the normality of the data distribution. Normally distributed data were expressed as means with SDs, and Student's t-test was used to compare between-group differences. Non-normally distributed data were presented using the median (P25, P75), and the Mann–Whitney U test was used. The baseline characteristics between comparison groups were analyzed using the chi-square ($\chi 2$) test or Fisher's exact test for categorical variables described as frequencies (percentages). We used the paired t-test to compare the differences within the group at baseline and at 8 and 16 weeks. An ANOVA with repeated measurements with post hoc tests was used to compare the differences between different groups, as this technique is more appropriate for examining the effect of the combined treatment on BMD, lower limb balance function, and mental health of patients with PMOP. Statistical significance was defined as $p < 0.05$, and $p < 0.01$ was the standard of high statistical significance. The correlation analysis was used to analyze the correlation between lower limb balance, changes in mental health, and BMD improvement.

3. Results

3.1. Descriptive Statistics of Sociodemographic Information of the Three Groups. The study included 50 participants with PMOP, and the largest employment group was farmers (42%). Married participants comprised 84% of the sample. No significant differences were noted among the three groups in terms of social demographic data, including age, occupation, BMI, duration of menopause, duration of PMOP, and marital status. Table 1 shows the demographic data.

3.2. BMD in Three Groups at Baseline, 8 Weeks, and 16 Weeks. Before the intervention, there was no significant difference between the three groups in the BMD of the lumbar spine (L2–4) and femoral neck ($p > 0.05$). After both 8 weeks and 16 weeks of intervention, the BMD of the lumbar spine and femoral neck in the EXD + BE and EXD groups was higher than that at the baseline ($p < 0.05$). Furthermore, the BMD of the lumbar spine and femoral neck was higher in the EXD + BE group than in the BE group ($p < 0.05$). The BMD of the lumbar spine and femoral neck in the EXD + BE group was higher than that in the EXD group ($p < 0.01$; Table 2 and Figure 2).

3.3. OLST, BBS, and TUG in Three Groups at Baseline, 8 Weeks, and 16 Weeks. Before the intervention, there was no significant difference in the OLST, BBS, and TUG scores between the three groups ($p > 0.05$). After 8 weeks and 16 weeks of intervention, the OLST, BBS, and TUG scores in the EXD + BE and BE groups were higher than those at the baseline ($p < 0.05$). The OLST, BBS, and TUG scores in the EXD + BE group were higher than those in the BE group ($p < 0.05$). Meanwhile, the OLST, BBS, and TUG scores in the EXD + BE group were higher than those in the EXD group ($p < 0.01$; Table 3 and Figure 3).

3.4. Mental Health in Three Groups at Baseline, 8 Weeks, and 16 Weeks. Before the intervention, there was no significant difference between the three groups in SAS and SDS ($p > 0.05$). After 8 weeks and 16 weeks of intervention, the SAS and SDS scores in the EXD + BE, BE, and EXD groups were higher than those at the baseline ($p < 0.05$). The SAS and SDS scores in the EXD + BE group were higher than those in the BE and the EXD groups ($p < 0.05$; Table 4 and Figure 4).

3.5. Correlation between Changes in Mental Health, Lower Limb Balance Function, and Improvement of BMD. After 8 weeks and 16 weeks of intervention, the BMD, lower limb balance, and mental health of participants in all three groups improved. We used correlation analysis to analyze the correlation between lower limb balance, changes in mental health, and BMD improvement. The results (Table 5 and Figure 5) show a significant positive correlation between lower limb balance (BBS) and BMD improvement (LS L2–4; $r = 0.359$, $p < 0.05$). Moreover, the results show a significant negative correlation between lower limb balance (TUG) and BMD improvement (LS L2–4; $r = 0.521$, $p < 0.01$). However, there is no significant correlation between BMD and OLST. In addition, the change in mental health (SAS) was negatively correlated with BMD (FN) improvement ($r = -0.576$, $p < 0.01$). However, there is no significant correlation between BMD and mental health (SDS).

Table 1: Demographic data.

Variable		EXD ($n = 15$)	BE ($n = 17$)	EXD + BE ($n = 18$)	p
Age (years)		56.41 ± 1.68	57.02 ± 1.64	57.31 ± 1.48	0.317
Employment status	Worker	4 (26.6%)	5 (29.4%)	5 (27.8%)	0.578
	Manager	0	2 (11.8%)	0	
	Farmer	6 (40%)	7 (41.2%)	8 (44.4%)	
	Other	5 (33.4%)	3 (17.6%)	5 (27.8%)	
BMI (kg/m^2)		24.36 ± 2.03	24.48 ± 2.09	24.54 ± 1.99	0.486
Duration of menopause (years)		6.44 ± 1.81	6.51 ± 1.23	6.23 ± 2.21	0.37
Duration of PMOP (years)		4.66 ± 1.61	4.47 ± 1.24	4.31 ± 1.43	0.547
Marital status	Married	13 (86.7%)	14 (82.4%)	15 (83.3%)	0.942
	Other	2 (13.3%)	3 (17.6%)	3 (16.7%)	

Table 2: Changes in BMD in the three groups at baseline, 8 weeks, and 16 weeks (g/cm^3, $x \pm s$), $n = 50$.

Variable by group		Mean (SE)			From baseline to 16 weeks, mean (95% CI)	
	No.	Baseline	8 wk	16 wk	Within-group change	Between-group difference change
Lumbar spine L2–4 (g/cm^3)						
EXD	15	0.73 ± 0.01	0.78 ± 0.03	0.82 ± 0.02	0.09 (0.07 to 0.1)[a]	NA
BE	17	0.72 ± 0.02	0.67 ± 0.01	0.76 ± 0.01	0.04 (0.03 to 0.05)	NA
EXD + BE	18	0.75 ± 0.01	0.87 ± 0.01	0.98 ± 0.01	0.23 (0.22 to 0.24)[a]	NA
EXD vs. BE	NA	NA	NA	NA	NA	0.06 (0.05 to 0.07)
EXD vs. EXD + BE	NA	NA	NA	NA	NA	−0.15 (−0.16 to −0.14)[a]
BE vs. EXD + BE	NA	NA	NA	NA	NA	−0.22 (−0.23 to −0.21)[a]
Femoral neck (g/cm^3)						
EXD	15	0.75 ± 0.01	0.81 ± 0.01	0.85 ± 0.01	0.1 (0.09 to 0.11)[a]	NA
BE	17	0.75 ± 0.01	0.77 ± 0.01	0.75 ± 0.01	0 (−0.01 to 0)	NA
EXD + BE	18	0.73 ± 0.01	0.87 ± 0.01	0.97 ± 0.01	0.24 (0.23 to 0.25)[b]	NA
EXD vs. BE	NA	NA	NA	NA	NA	0.1 (−0.09 to 0.11)[a]
EXD vs. EXD + BE	NA	NA	NA	NA	NA	−0.11 (−0.12 to −0.1)[a]
BE vs. EXD + BE	NA	NA	NA	NA	NA	−0.21 (−0.22 to −0.2)[a]

Note. BE: BE group; EXD: EXD group; EXD + BE: EXD combined with BE; LS: lumbar spine L2–4; FN: femoral neck; NA: not applicable. a: $p < 0.05$, b: $p < 0.01$.

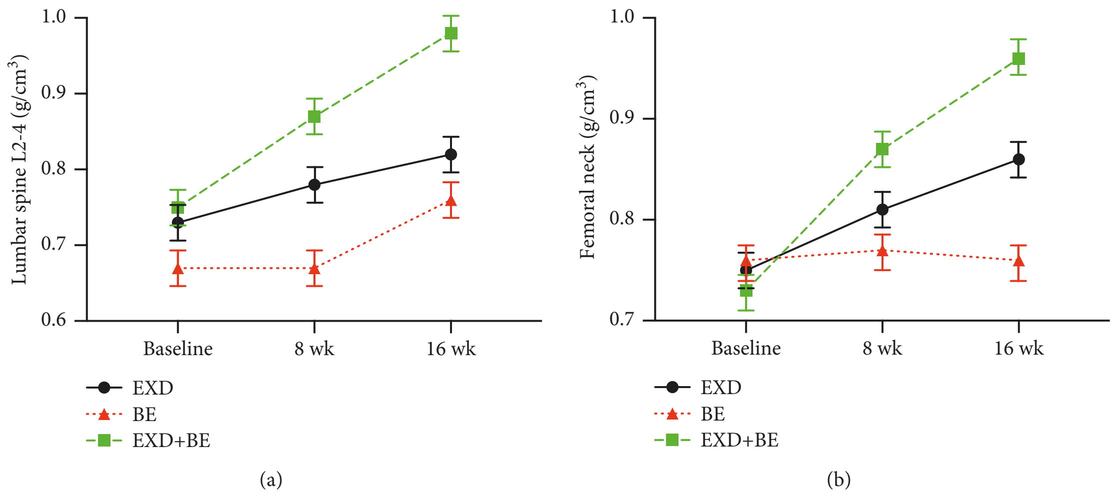

Figure 2: Changes in BMD in the three groups at baseline, 8 weeks, and 16 weeks.

Table 3: Changes in OLST, BBS, and TUG in the three groups at baseline, 8 weeks, and 16 weeks ($x \pm s$), $n = 50$.

Variable by group	Mean (SE)				From baseline to 16 wk, mean (95% CI)	
	No.	Baseline	8 wk	16 wk	Within-group change	Between-group difference change
Left leg balance (eyes closed), s						
EXD	15	3.74 ± 0.17	4.11 ± 0.15	4.83 ± 0.18	1.09 (0.956 to 1.22)[a]	NA
BE	17	3.66 ± 0.22	8.76 ± 0.25	8.82 ± 0.18	5.16 (5 to 5.31)[b]	NA
EXD + BE	18	3.81 ± 0.17	9.12 ± 0.13	9.21 ± 0.17	5.4 (5.26 to 5.53)[b]	NA
EXD vs. BE	NA	NA	NA	NA	NA	−3.98 (−4.11 to −3.85)[b]
EXD vs. EXD + BE	NA	NA	NA	NA	NA	−4.38 (−4.51 to −4.25)[b]
BE vs. EXD + BE	NA	NA	NA	NA	NA	−0.39 (−0.52 to −0.27)
Right leg balance (eyes closed), s						
EXD	15	3.55 ± 0.07	3.54 ± 0.06	3.66 ± 0.19	0.11 (−0.02 to 0.24)	NA
BE	17	3.74 ± 0.15	7.71 ± 0.18	7.23 ± 0.18	3.48 (3.36 to 3.61)[b]	NA
EXD + BE	18	3.88 ± 0.22	7.21 ± 0.18	7.30 ± 0.19	3.41 (3.26 to 3.57)[b]	NA
EXD vs. BE	NA	NA	NA	NA	NA	−3.56 (−3.7 to −3.42)[b]
EXD vs. EXD + BE	NA	NA	NA	NA	NA	−3.63 (−3.77 to −3.5)[b]
BE vs. EXD + BE	NA	NA	NA	NA	NA	−0.07 (−0.2 to 0.05)
TUG, s						
EXD	15	7.33 ± 0.18	7.31 ± 0.16	7.53 ± 0.24	0.19 (−0.01 to 0.38)	NA
BE	17	7.48 ± 0.23	7.28 ± 0.17	7.14 ± 0.18	−0.34 (−0.49 to −0.19)[a]	NA
EXD + BE	18	7.23 ± 0.14	6.67 ± 0.16	6.54 ± 0.19	−0.68 (−0.77 to −0.59)[b]	NA
EXD vs. BE	NA	NA	NA	NA	NA	0.38 (0.24 to 0.52)
EXD vs. EXD + BE	NA	NA	NA	NA	NA	0.98 (0.85 to 1.12)[c]
BE vs. EXD + BE	NA	NA	NA	NA	NA	0.6 (0.47 to 0.73)[b]
BBS						
EXD	15	38.36 ± 2.08	36.33 ± 1.15	39.24 ± 1.38	0.87 (−0.43 to 2.18)	NA
BE	17	38.33 ± 1.57	39.33 ± 1.78	41.39 ± 2.16	3.06 (1.78 to 4.33)[a]	NA
EXD + BE	18	39.31 ± 1.26	44.27 ± 1.58	45.23 ± 1.02	5.92 (5.12 to 6.72)[b]	NA
EXD vs. BE	NA	NA	NA	NA	NA	−2.15 (−3.29 to −1.01)[a]
EXD vs. EXD + BE	NA	NA	NA	NA	NA	−5.99 (−7.11 to −4.86)[c]
BE vs. EXD + BE	NA	NA	NA	NA	NA	−3.84 (−4.92 to −2.75)[b]

Note. BE: BE group; EXD: EXD group; EXD + BE: EXD combined with BE; OLST: one-leg standing test; BBS: Berg balance scale test score; TUG: timed up and go test; NA: not applicable. a: $p < 0.05$, b: $p < 0.01$, c: $p < 0.001$.

4. Discussion

This study aimed to evaluate the effectiveness of the combination of EXD and BE on the BMD, lower limb balance function, and mental health of patients with PMOP. The research reflected the practical need to find a harmless, non-pharmaceutical intervention with minimal side effects, and the results support the feasibility and acceptability of EXD combined with BE in clinical trials. Our main finding is the significant increase of BMD in patients with PMOP in the EXD + BE group. In contrast, no significant improvement was observed in the EXD group or the BE group. Furthermore, participants in the EXD + BE group also showed a simultaneous improvement in lower limb balance function and mental health. In addition, these changes in lower limb balance function and mental health are significantly correlated with the improvement of BMD. The participants had no adverse reactions during the intervention, and all the participants were satisfied with the intervention program.

4.1. The Effects of EXD Combined with BE on BMD in Women with PMOP. One of our most remarkable findings is that the overall effect of the EXD + BE intervention on BMD is significantly higher than that of the BE or EXD groups. This is notable given that most studies, including both population and experimental studies, have confirmed that EXD or exercise can improve BMD [12, 14, 23, 38–42].

In addition to medication, exercise can improve BMD. Exercise has attracted much clinical attention because of its convenience, affordability, and safety, and it has been recommended by many guidelines for the prevention and treatment of osteoporosis [43, 44]. It has been proven that exercise can effectively intervene in the symptoms of PMOP [45–48].

The effect of exercise on estrogen levels may explain its therapeutic effect. Estrogen deficiency and bone resorption of osteoclasts are important causes of PMOP. Moreover, estrogen plays a very important role in the mechanism of female bone metabolism. Studies have shown that exercise can promote a slight increase in estrogen concentration [45]. Estrogen inhibits the secretion of thyroid hormone, which, in turn, reduces bone absorption, promotes the secretion of calcitonin, and reduces bone resorption. Estrogen receptors secrete factors that can effectively improve the proliferation of osteoblasts and promote bone-transforming growth factor β. Furthermore, the production of bone collagen molecules indirectly reduces the activity of osteoblasts, increases kidney 25-hydroxyl α-hydroxylase activity, and increases the production of 1, 25-(OH) 2D3 to increase the calcium absorption rate of the small intestine [48].

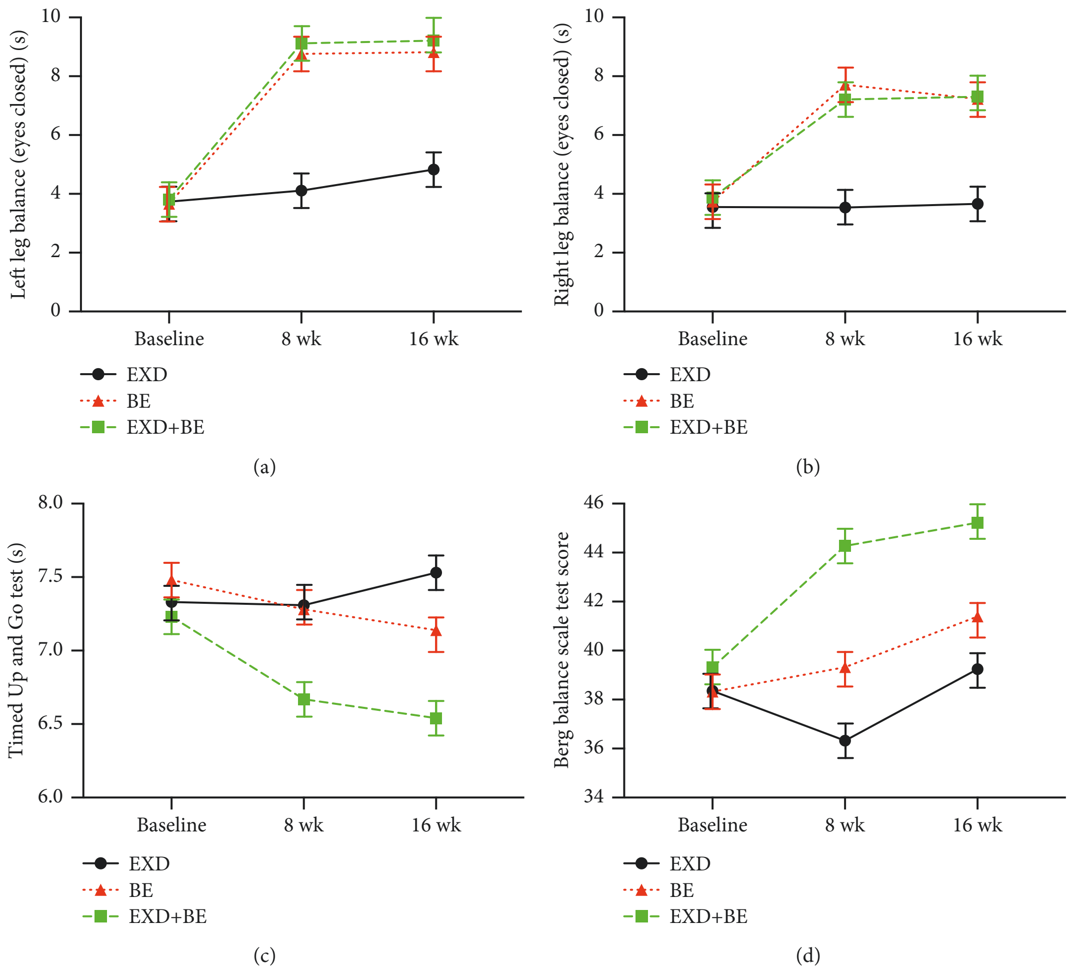

Figure 3: Changes in OLST, BBS, and TUG in the three groups at baseline, 8 weeks, and 16 weeks.

Table 4: Change in mental health (SDS, SAS) in the three groups at baseline, 8 weeks, and 16 weeks ($n = 50$).

Variable by group		Mean (SE)			From baseline to 16 weeks, mean (95% CI)	
	No.	Baseline	8 weeks	16 weeks	Within-group change	Between-group difference change
SDS						
EXD	15	51.22 ± 1.74	49.63 ± 1.72	47.07 ± 2.19	−4.14 (−5.33 to −2.95)[b]	NA
BE	17	50.03 ± 1.85	49.51 ± 1.38	47.06 ± 1.81	−2.96 (−4.45 to −1.47)[a]	NA
EXD + BE	18	50.71 ± 2.04	47.53 ± 2.01	46.06 ± 2.26	−4.64 (−6.13 to −3.16)[b]	NA
EXD vs. BE	NA	NA	NA	NA	NA	0.01 (−1.48 to 1.5)
EXD vs. EXD + BE	NA	NA	NA	NA	NA	1.01 (−0.46 to 2.49)[a]
BE vs. EXD + BE	NA	NA	NA	NA	NA	1 (−0.42 to 2.43)[a]
SAS						
EXD	15	53.45 ± 1.94	51.39 ± 2.11	50.55 ± 2.06	−2.89 (−4.67 to −1.12)[a]	NA
BE	17	50.84 ± 1.83	49.83 ± 1.82	46.65 ± 2.28	−4.18 (−5.38 to −2.98)[b]	NA
EXD + BE	18	53.37 ± 1.83	49.58 ± 1.31	46.02 ± 1.23	−7.34 (−8.56 to −6.13)[c]	NA
EXD vs. BE	NA	NA	NA	NA	NA	3.89 (2.54 to 5.24)[b]
EXD vs. EXD + BE	NA	NA	NA	NA	NA	4.52 (3.19 to 5.86)[b]
BE vs. EXD + BE	NA	NA	NA	NA	NA	0.63 (−0.65 to 1.92)

Note. BE: BE group; EXD: EXD group; EXD + BE: EXD combined with BE; SAS: self-anxiety scale; SDS: self-rating depression scales; NA: not applicable. a: $p < 0.05$, b: $p < 0.01$, c: $p < 0.001$.

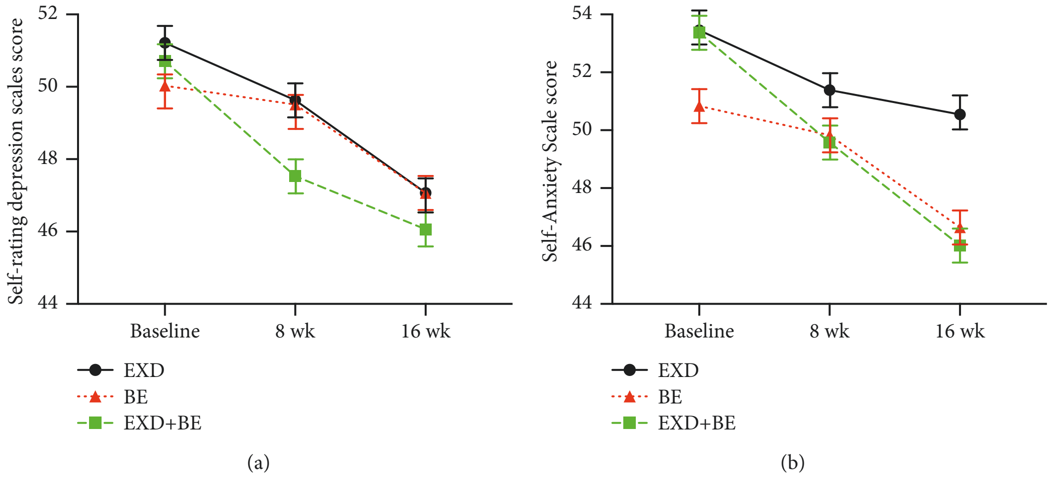

Figure 4: Change in mental health (SDS, SAS) in the three groups at baseline, 8 weeks, and 16 weeks.

Table 5: Correlations between changes in lower limb balance, mental health, and BMD.

Variable	BBS	TUG	OLST	SAS	SDS
LS L2–4	0.359[a]	−0.521[b]	−0.041	0.353	0.063
FN	−0.089	0.096	0.116	−0.576[b]	−0.266

Note. The data in the table are the correlation coefficient (r). a: $p < 0.05$; b: $p < 0.01$. LSL2–4: lumbar spine L2–4; FN: femoral neck; OLST: one-leg standing test; BBS: Berg balance scale test score; TUG: timed up and go; SAS: self-anxiety scale; SDS: self-rating depression scales.

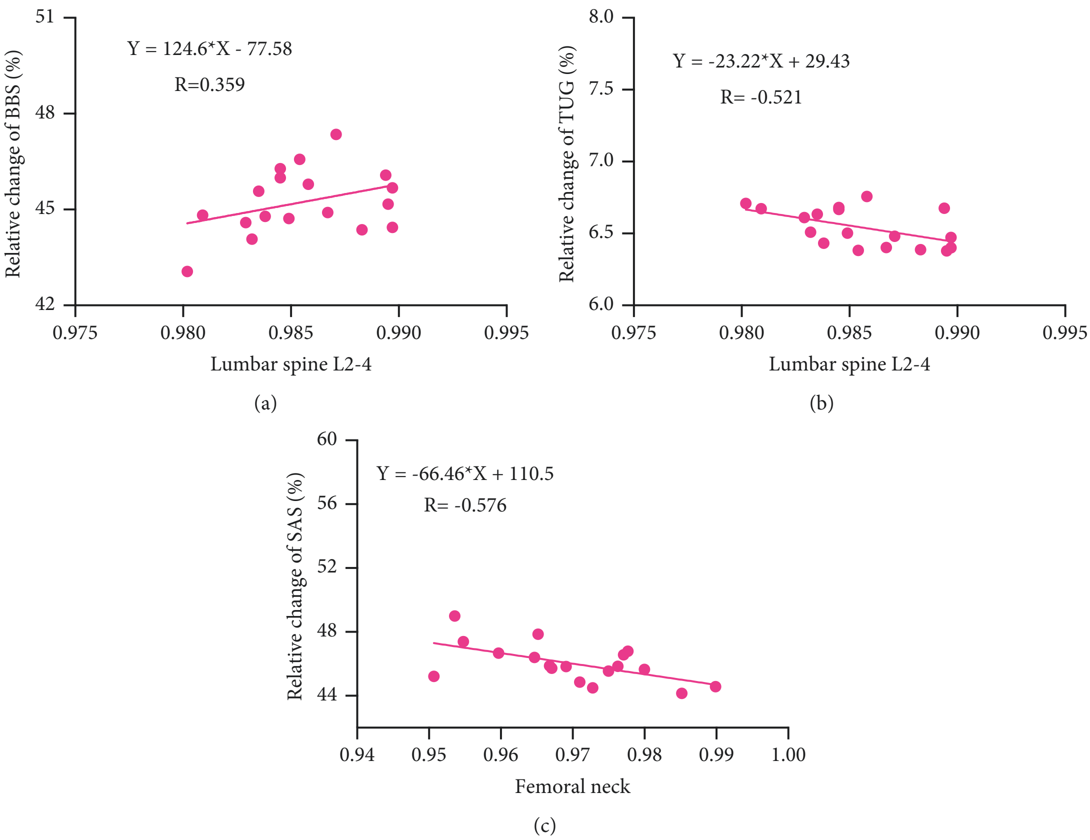

Figure 5: Correlations between changes in lower limb balance, mental health, and BMD.

Meanwhile, BE can fully stretch the muscles of the spine, neck, waist, and hip; increase the flexibility of neck and waist movement and muscle strength; and stimulate the bone cells of corresponding segments to strengthen tendons and bones.

We found that combining EXD with BE (EXD + BE) had more advantageous effects on the prevention of bone loss and the improvement of BMD in patients with PMOP than either intervention on its own. However, this study shows only that exercise combined with medicine may have a therapeutic advantage over each monotherapy in improving BMD; the detailed mechanism is not completely clear as to whether this is merely an additive benefit or whether there is some synergistic effect between the two mechanisms. At present, there is no literature about the mechanism by which EXD combined with BE improves BMD. Thus, a longer-term trial would be required to evaluate the effects of EXD combined with BE on BMD.

4.2. The Effects of EXD Combined with BE on Lower Limb Balance Function and Mental Health in Women with PMOP. Our study also demonstrated that the participants in the EXD + BE group showed significant improvement in lower limb balance. The present study supports previous studies showing the improvement of lower limb balance function from EXD and BE [17, 21, 40, 49–51]. In addition, there is a significant positive correlation between lower limb balance (BBS test score) and BMD improvement (lumbar spine L2–4; $r = 0.402$, $p < 0.05$). Meanwhile, we observed a significant negative correlation between lower limb balance (TUG test score) and BMD improvement (femoral neck; $r = 0.661$, $p < 0.01$). However, there was no significant correlation between BMD and lower limb balance (OLST). These findings were consistent with results reported in other studies [52, 53].

Second, we observed significant improvements in mental health from EXD combined with BE. These improvements are related to improving BMD in patients with PMOP, and this result is consistent with the research of other scholars [13, 54–59]. In addition, the change in mental health (self-anxiety score) was negatively correlated with BMD improvement (lumbar spine L2–4; $r = -0.625$, $p < 0.01$). However, we observed no significant correlation between BMD and mental health (self-rating depression score). These findings are in line with other studies [60].

In summary, positive effects of EXD combined with BE were observed on lower limb balance and mental health in women with PMOP, but the detailed mechanisms need further study.

5. Limitations of the Study

This study has several limitations. First, the study has a small sample size for exercise intervention research. As a result, its reference value for new clinical intervention methods is limited.

Second, our study did not add clinical data for auxiliary measurement, which led to an increase in the deviation of the research results. The patients with PMOP in the EXD + BE group experienced interference and influence on indexes related to the investigation, especially on mental health. This is due to an increase in group communication and the Hawthorne effect.

Finally, as this study lacks a follow-up process after the intervention, it cannot determine whether EXD combined with BE will maintain the influence on BMD in the long term. At present, there is no more intensive study on the combination of EXD and BE, and the mechanism of the influence remains unclear.

6. Conclusion

The 16-week intervention of EXD combined with BE improved the BMD of patients with PMOP, especially the density of the lumbar spine (L2–4) and femoral neck. We also found that EXD combined with BE can improve balance and mental health in patients with PMOP. In addition, our study shows that BE is an effective, safe, and helpful exercise that can improve the physical and mental health of women with PMOP. In the future, research should focus on interventions involving combinations of non-pharmaceutical treatments or the lowest dose of drugs that can provide health benefits to different groups.

Data Availability

The data used to support the findings of this study are available from the corresponding author upon request.

Conflicts of Interest

The authors declare that they have no conflicts of interest.

Authors' Contributions

Keqiang Li, Hongli Yu, Xiaojun Lin, Yuying Su, Lifeng Gao, Minjia Song, and Mariusz Lipowski contributed to methodology. Keqiang Li, Hongli Yu, Mariusz Lipowski, and Xiaojun Lin worked on software, validation, and resources. Keqiang Li, Hongli Yu, Lifeng Gao, and Daniel Krokosz carried out formal analysis. Keqiang Li, Mariusz Lipowski, Huixin Yang, and Xiaojun Lin conducted investigation. Keqiang Li, Hongli Yu, Mariusz Lipowski, Lifeng Gao, Daniel Krokosz, Xiaojun Lin, and Huixin Yang performed data curation. Keqiang Li, Xiaojun Lin, and Hongli Yu prepared the original draft. Keqiang Li, Xiaojun Lin, and Mariusz Lipowski revised and edited the manuscript. Keqiang Li and Xiaojun Lin helped with visualization. Keqiang Li, Mariusz Lipowski, Lifeng Gao, Daniel Krokosz, Xiaojun Lin, and Huixin Yang were responsible for project administration. Keqiang Li and Mariusz Lipowski participated in funding acquisition. All authors were involved in conceptualization and supervision and read and approved the final version of the manuscript.

References

[1] J. Y. Reginster and N. Burlet, "Osteoporosis: a still increasing prevalence," *Bone*, vol. 38, pp. S4–S9, 2006.

[2] R. Pacifici, "Estrogen, cytokines, and pathogenesis of postmenopausal osteoporosis," *Journal of Bone and Mineral Research*, vol. 11, no. 8, pp. 1043–1051, 2009.

[3] H. B. Erez, A. Weller, N. Vaisman, and S. Kreitler, "The relationship of depression, anxiety and stress with low bone mineral density in post-menopausal women," *Arch Osteoporos*, vol. 7, pp. 247–255, 2012.

[4] D. Michelson, C. Stratakis, L. Hill et al., "Bone mineral density in women with depression," *New England Journal of Medicine*, vol. 335, no. 16, pp. 1176–1181, 1996.

[5] B. Jahelka, T. Dorner, R. Terkula, M. Quittan, H. Broll, and L. Erlacher, "Health-related quality of life in patients with osteopenia or osteoporosis with and without fractures in a geriatric rehabilitation department," *Wiener Medizinische Wochenschrift*, vol. 159, no. 9-10, pp. 235–240, 2009.

[6] D. T. Gold, "The nonskeletal consequences of osteoporotic fractures. psychologic and social outcomes," *Rheumatic Disease Clinics of North America*, vol. 27, no. 1, pp. 255–262, 2001.

[7] D. Gold, "Physical and psychosocial consequences of osteoporotic vertebral fracture (Part 2). identifying and managing the non-skeletal consequences of osteoporosis," *Advances in Osteoporotic Fracture Management*, vol. 1, no. 3, pp. 74–79, 2002.

[8] A. Seven, B. Yuksel, G. Yavuz, M. Polat, B. Unlu, and N. Keskin, "The evaluation of hormonal and psychological parameters that affect bone mineral density in postmenopausal women," *European Review for Medical and Pharmacological Sciences*, vol. 20, 2016.

[9] P. D. Delmas, "Treatment of postmenopausal osteoporosis," *The Lancet*, vol. 359, no. 9322, pp. 2018–2026, 2002.

[10] P. Barrionuevo, E. Kapoor, N. Asi et al., "Efficacy of pharmacological therapies for the prevention of fractures in postmenopausal women: a network meta-analysis," *Journal of Clinical Endocrinology & Metabolism*, vol. 104, no. 5, pp. 1623–1630, 2019.

[11] R. Eastell, C. J. Rosen, D. M. Black, A. M. Cheung, M. H. Murad, and D. Shoback, "Pharmacological management of osteoporosis in postmenopausal women: an endocrine society ∗ clinical practice guideline," *Journal of Clinical Endocrinology & Metabolism*, vol. 104, no. 5, pp. 1595–1622, 2019.

[12] E. Mukwaya, F. Xu, M. S. Wong, and Y. Zhang, "Chinese herbal medicine for bone health," *Pharmaceutical Biology*, vol. 52, no. 9, pp. 1223–1228, 2014.

[13] S. C. W. Sze, Y. Tong, Y. B. Zhang et al., "A novel mechanism: Erxian decoction, a Chinese medicine formula, for relieving menopausal syndrome," *Journal of Ethnopharmacology*, vol. 123, no. 1, pp. 27–33, 2009.

[14] C. Wang, Z. Zhang, and J. Ma, "Treatment of 50 cases of osteoporosis with Er-Xian decoction," *Shan Xi Zhong Yi*, vol. 19, pp. 205-206, 1998.

[15] Q. Liu, J. R. Shi, Y. Yang, Z. Q. Fang, S. H. Liang, and R. X. Guo, "Effects on secretory function of rat gonad by Erxian decoction and its disassembled prescriptions," *Zhongguo Zhong Yao Za Zhi = Zhongguo Zhongyao Zazhi= China Journal of Chinese Materia Medica*, vol. 30, no. 13, pp. 1023–1026, 2005.

[16] X. H. Shen, Z. Q. Fang, and D. X. Wu, "Effect of Er-xian decoction and its disassembled prescription on enzyme activities and their gene expression of antioxidant enzymes in aging rat," *Zhongguo Zhong Xi Yi Jie He Za Zhi Zhongguo Zhongxiyi Jiehe Zazhi = Chinese Journal of Integrated Traditional and Western Medicine*, vol. 15, no. 11, pp. 672–674, 1995.

[17] H. Nian, L. P. Qin, Q. Y. Zhang, H. C. Zheng, Y. Yu, and B. K. Huang, "Antiosteoporotic activity of Er-Xian decoction, a traditional Chinese herbal formula, in ovariectomized rats," *Journal of Ethnopharmacology*, vol. 108, no. 1, pp. 96–102, 2006.

[18] S. F. Fu, Y. Q. Zhao, M. Ren et al., "A randomized, double-blind, placebo-controlled trial of Chinese herbal medicine granules for the treatment of menopausal symptoms by stages," *Menopause*, vol. 23, no. 3, pp. 311–323, 2016.

[19] L. L. D. Zhong, Y. Tong, G. W. K. Tang et al., "A randomized, double-blind, controlled trial of a Chinese herbal formula (Er-Xian decoction) for menopausal symptoms in Hong Kong perimenopausal women," *Menopause*, vol. 20, no. 7, pp. 767–776, 2013.

[20] L. Zhang, Y. Yang, L. Di, J. L. Li, and N. Li, "Erxian decoction, a famous Chinese medicine formula, antagonizes corticosterone-induced injury in PC12 cells, and improves depression-like behaviours in mice," *Pharmaceutical Biology*, vol. 58, no. 1, pp. 498–509, 2020.

[21] C. Wang, J. Liang, Y. Si, Z. Li, and A. Lu, "The effectiveness of traditional Chinese medicine-based exercise on physical performance, balance and muscle strength among older adults: a systematic review with meta-analysis," *Aging Clinical and Experimental Research*, vol. 34, no. 4, pp. 725–740, 2022.

[22] K. L. Hertel and M. G. Trahiotis, "Exercise in the prevention and treatment of osteoporosis: the role of physical therapy and nursing," *Nursing Clinics of North America*, vol. 36, no. 3, pp. 441–453, 2001.

[23] H. H. Chen, M. L. Yeh, and F. Y. Lee, "The effects of Baduanjin Qigong in the prevention of bone loss for middle-aged women," *The American Journal of Chinese Medicine*, vol. 34, no. 5, pp. 741–747, 2006.

[24] F. K. Cheng, "Effects of Baduanjin on mental health: a comprehensive review," *Journal of Bodywork and Movement Therapies*, vol. 19, no. 1, pp. 138–149, 2015.

[25] Z. F. Li Qd, Y. J. Zhang, R. Peng, J. Li, W. Chen, and H. Xu, "Clinical observation on eight-section brocade in improving balance ability and fall risk of senile osteoporosis," *Western Journal of Traditional Chinese Medicine*, vol. 9, pp. 62–65, 2019.

[26] M. Li, Q. Fang, J. Li et al., "The effect of Chinese traditional exercise-Baduanjin on physical and psychological well-being of college students: a randomized controlled trial," *PLoS One*, vol. 10, no. 7, Article ID e0130544, 2015.

[27] M. Zhenglai, *Practical Dictionary of Pharmacology of Traditional Chinese Medicine Formulae*, JiangSu Press of Scientific Technology, Wuxi Shi, China, 1989.

[28] N. Wu, "The efficacy of Erxian decoction on menopausal osteoporosis in 60 women," *Yun-Nan Journal of Traditional Chinese Medicine*, vol. 27, no. 6, p. 18, 2006.

[29] A. E. Smith-Ryan, M. G. Mock, E. D. Ryan, G. R. Gerstner, E. T. Trexler, and K. R. Hirsch, "Validity and reliability of a 4-compartment body composition model using dual energy X-ray absorptiometry-derived body volume," *Clinical Nutrition*, vol. 36, no. 3, pp. 825–830, 2017.

[30] J. A. Kanis and J. A. Kanis, “Assessment of fracture risk and its application to screening for postmenopausal osteoporosis: synopsis of a WHO report. WHO study group,” *Osteoporosis International: A Journal Established as Result of Cooperation Between the European Foundation for Osteoporosis and the National Osteoporosis Foundation of the USA*, vol. 4, no. 6, pp. 368–381, 1994.

[31] G. M. Blake and I. Fogelman, “The role of DXA bone density scans in the diagnosis and treatment of osteoporosis,” *Postgraduate Medical Journal*, vol. 83, no. 982, pp. 509–517, 2007.

[32] T. Michikawa, Y. Nishiwaki, T. Takebayashi, and Y. Toyama, “One-leg standing test for elderly populations,” *Journal of Orthopaedic Science: Official Journal of the Japanese Orthopaedic Association*, vol. 14, no. 5, pp. 675–685, 2009.

[33] K. O. Berg, S. L. Wood-Dauphinee, J. I. Williams, and B. Maki, “Measuring balance in the elderly: validation of an instrument,” *Canadian Journal of Public Health*, vol. 83, no. Suppl 2, pp. S7–S11, 1992.

[34] D. Podsiadlo and S. Richardson, “The timed “up & go”: a test of basic functional mobility for frail elderly persons,” *Journal of the American Geriatrics Society*, vol. 39, no. 2, pp. 142–148, 1991.

[35] W. W. Zung, “A rating instrument for anxiety disorders,” *Psychosomatics*, vol. 12, no. 6, pp. 371–379, 1971.

[36] W. W. K. Zung, “A self-rating depression scale,” *Archives of General Psychiatry*, vol. 12, p. 63, 1965.

[37] F. Faul, E. Erdfelder, A.-G. Lang, and A. G. Buchner, “G∗Power 3: a flexible statistical power analysis program for the social, behavioral, and biomedical sciences,” *Behavior Research Methods*, vol. 39, no. 2, pp. 175–191, 2007.

[38] J. Y. Li, Y. S. Jia, L. M. Chai et al., “Effects of Chinese herbal formula Erxian decoction for treating osteoporosis: a systematic review,” *Clinical Interventions in Aging*, vol. 12, pp. 45–53, 2017.

[39] S. Liu, J. Huang, J. Wang et al., “Er-xian decoction stimulates osteoblastic differentiation of bone mesenchymal stem cells in ovariectomized mice and its gene profile analysis,” *Stem Cells International*, vol. 2016, Article ID 4079210, 10 pages, 2016.

[40] J. Zou, F. Lin, and L. Zhang, “Effect of long time taijiquan training on bone density and balance function in postmenopause women,” *Chinese Rehabilitation Theory and Practice*, vol. 1, 2011.

[41] Y.-J. Li, X.-R. Niu, and S. Hu, “Efficacy evaluation of different forms of traditional Chinese health-preservation exercises for osteoporosis: a network meta-analysis,” *Journal of Acupuncture and Tuina Science*, vol. 19, no. 4, pp. 258–270, 2021.

[42] L. Ruanyingdi, “Effect of healthy Qigong on the related indicators of bone metabolism and serum NO, NOS in postmenopausal women,” Master thesis, Shenyang Sport University, Shenyang, China, 2011.

[43] J. A. Kanis, C. Cooper, R. Rizzoli, and J. Y. Reginster, “Executive summary of European guidance for the diagnosis and management of osteoporosis in postmenopausal women,” *Aging Clinical and Experimental Research*, vol. 31, no. 1, pp. 15–17, 2019.

[44] P. Makras, A. D. Anastasilakis, G. Antypas et al., “The 2018 Guidelines for the diagnosis and treatment of osteoporosis in Greece,” *Arch Osteoporos*, vol. 14, no. 1, p. 39, 2019.

[45] D. Saintier, V. Khanine, B. Uzan, H. K. Ea, M. C. de Vernejoul, and M. E. Cohen-Solal, “Estradiol inhibits adhesion and promotes apoptosis in murine osteoclasts in vitro,” *The Journal of Steroid Biochemistry and Molecular Biology*, vol. 99, no. 4-5, pp. 165–173, 2006.

[46] W. T. S. J. He, “Tai Ji Chuan and the sub-cattle progress of primary osteoporosis,” *Chinese Journal of Osteoporosis*, vol. 14, no. 8, pp. 587–600, 2008.

[47] Y. Q. J. X. Shen, “Effects of exercise on bone mineral density of children and adolescents,” *Journal of Wuhan Institute of Physical Education*, vol. 38, no. 5, pp. 55–57, 2004.

[48] J. C. Gallagher, B. L. Riggs, J. Eisman, A. Hamstra, S. B. Arnaud, and H. F. DeLuca, “Intestinal calcium absorption and serum vitamin D metabolites in normal subjects and osteoporotic patients: effect of age and dietary calcium,” *Journal of Clinical Investigation*, vol. 64, no. 3, pp. 729–736, 1979.

[49] T. Tian, Y. Cai, J. Zhou et al., “Effect of eight-section brocade on bone mineral density in middle age and elderly people: protocol for a systematic review and meta-analysis of randomised controlled trials,” *Medicine (Baltimore)*, vol. 99, no. 1, Article ID e18549, 2020.

[50] L. Qin, T. Han, Q. Zhang et al., “Antiosteoporotic chemical constituents from Er-Xian decoction, a traditional Chinese herbal formula,” *Journal of Ethnopharmacology*, vol. 118, no. 2, pp. 271–279, 2008.

[51] L. Zhu, W. Wu, M. Chen et al., “Corrigendum to “effects of nonpharmacological interventions on balance function in patients with osteoporosis or osteopenia: a network meta-analysis of randomized controlled trials,” *Evidence-Based Complementary and Alternative Medicine*, vol. 2021, Article ID 9892786, 1 page, 2021.

[52] B. A. M. Larsson, L. Johansson, D. Mellstrom et al., “One leg standing time predicts fracture risk in older women independent of clinical risk factors and BMD,” *Osteoporosis International*, vol. 33, pp. 185–194, 2021.

[53] L. H. Fan Lu, X. Chen, and X. Zhu, “Correlation between bone mineral density and balance function in the elderly Chinese,” *Journal of Osteoporosis and Bone Mineral Salt Diseases*, vol. 7, no. 4, pp. 298–307, 2014.

[54] I. Acimovic, “The influence of health qigong on the subjectively expressed psychophysical state of patients with rheumatoid arthritis, rheum, osteoporosis, osteopenia,” *Chinese Medicine and Culture*, vol. 1, no. 3, p. 150, 2018.

[55] J. Zhou, Y. Yu, B. Cao et al., “Characteristic of clinical studies on Baduanjin during 2000-2019: a comprehensive review,” *Evidence-Based Complementary and Alternative Medicine*, vol. 2020, Article ID 4783915, 9 pages, 2020.

[56] L. Jing, Y. Jin, X. Zhang, F. Wang, Y. Song, and F. Xing, “The effect of Baduanjin Qigong combined with CBT on physical fitness and psychological health of elderly housebound,” *Medicine (Baltimore)*, vol. 97, no. 51, Article ID e13654, 2018.

[57] J. S. M. Chan, R. T. H. Ho, K. F. Chung et al., “Qigong exercise alleviates fatigue, anxiety, and depressive symptoms, improves sleep quality, and shortens sleep latency in persons with chronic fatigue syndrome-like illness,” *Evidence-Based Complementary and Alternative Medicine*, vol. 2014, Article ID 106048, 10 pages, 2014.

[58] C.-W. Wang, C. H. Chan, R. T. Ho, J. S. Chan, S.-M. Ng, and C. L. Chan, "Managing stress and anxiety through Qigong exercise in healthy adults: a systematic review and meta-analysis of randomized controlled trials," *BMC Complementary and Alternative Medicine*, vol. 14, no. 1, p. 8, 2014.
[59] H. Y. Chen, T. W. Kao, J. W. Huang, T. J. Tsai, and K. D. Wu, "Treatment of menopausal symptoms with Er-xian decoction: a systematic review," *Clinical Nephrology*, vol. 70, no. 3, pp. 233–239, 2008.
[60] F. Yang, Y. Liu, S. Chen et al., "A GABAergic neural circuit in the ventromedial hypothalamus mediates chronic stress-induced bone loss," *The Journal of Clinical Investigation*, vol. 130, no. 12, pp. 6539–6554, 2020.