Research on Exercise Intervention for Elderly People Based on Cognitive Function Improvement

Xinqi Lin [1*]

[1] Fuzhou Sunshine Experimental School, Fuzhou, China

Abstract. Against the backdrop of the increasingly significant global aging trend, the problem of cognitive decline in the elderly has received widespread attention from all sectors of society. This article first systematically reviews the relevant concepts of cognitive decline in the elderly, including its definition, main manifestations, and epidemiological characteristics, and deeply analyzes the various impacts of cognitive decline on the daily lives of the elderly. On this basis, the article focuses on exploring the theoretical basis, empirical research results, and mechanism of action of exercise intervention as a non-pharmacological treatment method for improving cognitive function in the elderly. Through a comprehensive evaluation of existing research, this article further proposes design principles and implementation strategies for elderly exercise intervention programs. It demonstrates the effectiveness and feasibility of exercise intervention in delaying cognitive decline in the elderly through specific case analysis. The article also proposes suggestions for future research directions, emphasizing the need to strengthen interdisciplinary cooperation, deeply explore the long-term effects of exercise intervention on cognitive function in the elderly, and optimize intervention plans to achieve more personalized and accurate health management services, providing scientific basis and practical guidance for addressing global aging challenges.

1 Introduction

With the continuous advancement of medical technology and significant improvement in living standards, human life expectancy has been unprecedentedly extended, making an aging society an undeniable trend worldwide. However, the impact of aging goes far beyond changes in population structure. It is accompanied by a series of complex and severe health problems, among which the decline of cognitive function in the elderly is particularly concerning. Cognitive decline is a gradual process that quietly erodes the memory, thinking, judgment, and daily decision-making abilities of elderly people, profoundly impacting their quality of life. More seriously, this decline concerns individuals and affects families and society, increasing the burden of care and posing challenges to the existing medical and social service systems.[1]

In this context, it is particularly important and urgent to explore and practice effective intervention measures to delay the decline of cognitive function in the elderly. In recent years, exercise intervention as a non-pharmacological treatment has shown encouraging application prospects in improving cognitive function in the elderly. Exercise can not only promote the physical health of the elderly and improve their cardiovascular function and muscle strength but more importantly, it can also help activate the cognitive function of the brain and enhance memory and attention. Research has shown that older adults who regularly participate in aerobic exercise, strength training, or balance exercises often perform better on cognitive tests than their sedentary peers. Exercise seems to stimulate the connections of brain neurons, promote blood flow in brain regions, and provide necessary nutrition and support for cognitive function.

2 Overview of Cognitive Decline in the Elderly

2.1 Definition and Manifestations of Cognitive Decline

Cognitive decline is a concept closely related to aging, which describes the gradual decline in an individual's cognitive abilities in areas such as memory, attention, executive function, language comprehension, and application. This decline is an important aspect of physiological and psychological changes in older adults, which is not just a simple memory loss problem but encompasses complex changes in multiple cognitive dimensions. Specifically, there are various manifestations of cognitive decline. Memory loss is one of the most common symptoms, and elderly people may find it increasingly difficult to remember new information and even forget some important daily tasks. At the same time, their reaction speed may also slow down, and their processing and response time to things may be prolonged. Lack of concentration is another significant manifestation, as older adults may find it

* Corresponding author: linxinqi2006@126.com

difficult to focus on a task or activity for extended periods of time. The decline in decision-making ability is also an important sign, as elderly people may feel confused and uncertain when facing choices.[2]

These changes in cognitive functions have a profound impact on the daily lives of elderly people. They may find it difficult to complete some daily tasks, such as managing finances, cooking, or even simple household chores. This sense of powerlessness may lead them to reduce social activities, further exacerbating the decline of social functioning. Meanwhile, cognitive decline may also trigger a series of emotional problems such as anxiety, depression, and an inferiority complex, further affecting their quality of life.

2.2 The Impact of Cognitive Decline on the Lives of Elderly People

The decline of cognitive function has a wide and profound impact on the lives of elderly people. In daily life, this decline first manifests as a significant decrease in memory. Older people may frequently forget important matters, such as medication schedules and appointment arrangements with family and friends, which undoubtedly brings many inconveniences to their daily lives. Meanwhile, as executive function declines, elderly people often feel powerless when faced with the need to plan or execute complex tasks, making it difficult to develop reasonable plans or effectively complete tasks.[3]

In terms of social activities, cognitive decline has also brought significant changes. Communication barriers are an important reason for the decrease in social participation among elderly people. They may find it difficult to express their thoughts accurately or understand others' words, and this communication difficulty often leads to a gradual decrease in their participation in social activities. The decrease in social interaction may further trigger feelings of loneliness and depression, posing a threat to the mental health of the elderly. Cognitive decline may also pose a threat to the safety of the elderly. For example, due to the decline in memory and attention, elderly people may be more prone to accidents such as falls. At the same time, they may also accidentally take medication due to forgetting or confusing the type and dosage of drugs, which undoubtedly increases their health risks.

2.3 Epidemiological Survey on Cognitive Decline

Epidemiological research has revealed the prevalence and development trend of cognitive decline in the elderly population. Survey data shows that this phenomenon intensifies with age and poses a significant threat to the quality of life of the elderly. It is worth noting that the prevalence and severity of cognitive decline vary among different countries and regions due to differences in multiple factors such as population structure, lifestyle, and allocation of medical resources. However, regardless of the country or region, cognitive decline has been recognized as one of the important challenges facing the global health system. Its wide-ranging impact not only concerns individual health but also involves the overall well-being of families and society. The in-depth research on cognitive decline and the development of effective intervention strategies have become major issues that urgently need to be addressed in the global health field. In the future, we need to use cross-border cooperation and interdisciplinary research methods to gain a more comprehensive understanding of the epidemiological characteristics of cognitive decline in order to provide a more accurate scientific basis for its prevention and treatment.[4]

3 The Impact of Exercise Intervention on Cognitive Function in the Elderly

3.1 Theoretical Basis for the Improvement of Cognitive Function Through Exercise Intervention

The theoretical basis for the improvement of cognitive function in elderly people through exercise intervention is mainly rooted in the two core theories of neural plasticity and brain functional reserve. The theory of neuroplasticity suggests that the brain is not static and has a certain degree of adaptability and remodeling ability. External stimuli, such as regular movements, can effectively promote the connection and reconstruction between neurons, thereby opening up new possibilities for the improvement of cognitive function. The theory of brain functional reserve further emphasizes that individuals are able to mobilize more brain resources to cope with cognitive challenges. Exercise, as an active lifestyle, can significantly increase brain functional reserves, making the brain more adept at facing cognitive tasks, thereby improving the stability and persistence of cognitive function. These two theories together form a solid theoretical foundation for exercise intervention to improve cognitive function in the elderly.[5]

3.2 Empirical Study on the Improvement of Cognitive Function through Exercise Intervention

Numerous empirical studies support the improvement effect of exercise intervention on cognitive function in the elderly. For example, research has found that long-term aerobic exercise can delay the atrophy of the elderly human hippocampus and improve memory and executive function. Resistance training can enhance muscle strength and improve body balance, indirectly promoting cognitive function. Physical and mental exercises such as Tai Chi and square dancing have also been proven to have a positive impact on cognitive function in the elderly. These research results indicate that different types of exercise interventions can improve cognitive function in elderly people to a certain extent.[6]

3.3 Mechanism Exploration of Exercise Intervention on Cognitive Function Improvement

The mechanism by which exercise intervention improves cognitive function in elderly people may involve multiple aspects. Exercise can promote blood circulation and metabolism, providing the brain with more oxygen and nutrients. Exercise can stimulate the release of neurotransmitters and synaptic plasticity changes, enhancing the connections and communication between neurons. Exercise can also alleviate psychological stress and depression, improve the mental health level of the elderly, and indirectly promote the improvement of cognitive function.

4 Design and Implementation of Exercise Intervention Program for the Elderly

4.1 Design Principles of Exercise Intervention Plan

When designing exercise intervention programs for the elderly, the following principles should be followed: first, the principle of safety should be followed to ensure that the intensity and method of exercise are suitable for the physical condition of the elderly; The second is the principle of personalization, which involves developing personalized exercise plans based on factors such as the age, gender, and health status of the elderly; The third is the principle of comprehensiveness, which comprehensively considers various forms of exercise such as aerobic exercise, resistance training, flexibility exercises, etc.; The fourth principle is sustainability, encouraging elderly people to persist in long-term exercise to achieve the best results. As shown in Figure 1:

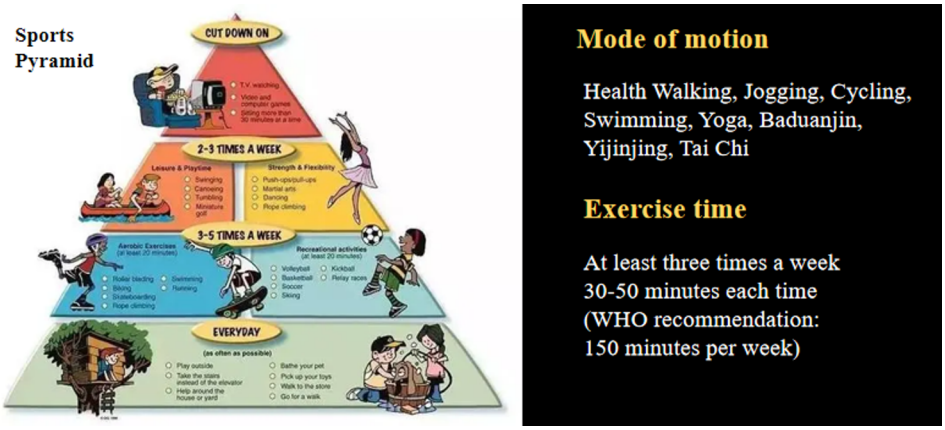

Fig. 1. Design scheme of exercise intervention plan

4.2 Implementation Strategy of Exercise Intervention Plan

Numerous empirical studies strongly support the improvement effect of exercise intervention on cognitive function in the elderly. Specifically, long-term aerobic exercise has been shown to significantly delay the atrophy process of the elderly human hippocampus, thereby improving their memory and executive function. At the same time, resistance training indirectly promotes cognitive function by enhancing muscle strength and body balance. In addition, physical and mental exercises that balance both body and mind, such as Tai Chi and square dancing, have also been proven to have a significant positive impact on the cognitive function of the elderly. Based on these research results, we can clearly see that regardless of the type of exercise intervention, it can improve the cognitive function of the elderly to a certain extent, bringing them a healthier and more fulfilling later life. This discovery undoubtedly provides new ideas and directions for the maintenance and improvement of cognitive function in the elderly.[7]

4.3 Effectiveness Evaluation of Exercise Intervention Plan

An 8-week exercise intervention program was designed and implemented to address the issue of cognitive decline in the elderly. Through the data presented in Table 1, we can clearly see the positive impact of exercise intervention on cognitive function improvement in the elderly. In the early stage of intervention (4 weeks), the overall cognitive function, refresh function, and inhibition function of the elderly showed a significant improvement trend, indicating that exercise intervention can effectively promote cognitive function in a short time. It is worth noting that the conversion function has not shown significant changes and may require longer interventions to show results.[8]

With the extension of the intervention period to 8 weeks, the improvement effect of cognitive function in the elderly is further consolidated and expanded. The overall cognitive function continues to improve, with a more significant improvement in refresh function compared to 4 weeks, and inhibition function also shows a continuous improvement trend. It is particularly important that the conversion function has also been significantly improved at this time, which fully

demonstrates the positive effect of long-term exercise intervention on the comprehensive cognitive function improvement of the elderly. In summary, the exercise intervention program in this study significantly improves cognitive function in elderly people and is worthy of wider promotion and application. As shown in Table 1:

Table 1. Evaluation of the Effect of Exercise Intervention for Elderly People Based on Cognitive Function Improvement

Intervention cycle	Cognitive function improvement indicators	Improvement effect
Four weeks	Overall cognitive function	Significant improvement
	Refresh function	Significant improvement
	Inhibition function	Significant improvement
	Conversion function	No significant changes
Eight weeks	Overall cognitive function	Significant improvement
	Refresh function	Significantly better than four weeks
	Inhibition function	Significant improvement
	Conversion function	Significant improvement

5 Case Analysis of Exercise Intervention for the Elderly

5.1 Case Selection and Background Introduction

The 2024 National Elderly Taijiquan Fitness Campaign (Mount Taishan Branch Venue) ended successfully in Wuyue Square, Tai'an, on May 18 of the same year. As a part of the national campaign, the branch venue gathered 600 senior Taijiquan enthusiasts in Mount Taishan District, demonstrating the profound connotation of Taijiquan with professionalism and high participation. The core content of the event focuses on the concentrated display of Dongyue Tai Chi. Through a systematic arrangement of performances, it scientifically showcases the unique rhythm of Tai Chi, which combines hardness and softness and the combination of fast and slow movements and has gained widespread professional recognition and audience praise. Under the careful planning of the Mount Taishan Elderly Sports Association and its special committee, this activity not only strengthened the status of Taijiquan as the preferred way for the elderly to keep fit but effectively promoted the physical and mental health and quality of life of participants, but also built a platform integrating skills exchange, cultural inheritance, and community integration, which is of great significance for promoting the sustainable development of regional elderly sports and the modernization of Chinese excellent traditional culture, becoming a model case of the combination of elderly sports and cultural activities nationwide.

5.2 Specific Implementation of Exercise Intervention Plan

In order to ensure the effective implementation and expected results of the Tai Chi exercise intervention program, we have carefully developed personalized Tai Chi exercise plans based on the physical condition and interests of the elderly. This plan fully considers the physical characteristics of the elderly, focusing on gentle and soothing movements to avoid sports injuries. Specifically, we have arranged three Tai Chi exercises per week, each lasting 60 minutes. This frequency and duration ensure that elderly people have sufficient exercise time without causing any burden on their bodies due to excessive exercise. In terms of practice content, we cover the basic footwork, boxing techniques, and routine exercises of Tai Chi, ensuring that elderly people can learn Tai Chi comprehensively and systematically.

In order to enhance the learning effectiveness and experience of the elderly, we have also specially invited professional Tai Chi coaches to provide on-site guidance and correct movements for them. Coaches not only have rich teaching experience but also can provide personalized guidance based on the actual situation of the elderly, helping them better master the techniques and essence of Tai Chi. In addition to daily exercises and guidance, we also regularly organize communication, sharing, and achievement display activities for the elderly. These activities provide a platform for the elderly to showcase their learning achievements while also giving them the opportunity to exchange experiences and share insights with other Tai Chi enthusiasts. Through such activities, the enthusiasm of the elderly for participation has been greatly stimulated, and they are more actively engaged in learning and practicing Tai Chi.

5.3 Evaluation and Analysis of the Effect of Exercise Intervention

After a year of Tai Chi exercise intervention, we conducted a comprehensive and detailed evaluation of the effectiveness of the project. The evaluation results showed that elderly people who participated in Tai Chi exercise showed significant improvements in multiple aspects. Their cognitive abilities, such as memory and attention, have been improved, and their physical balance has also been significantly enhanced. Tai Chi exercise has also had a positive impact on the mental health of the elderly, effectively alleviating their depression and improving their sleep quality. These

positive changes fully demonstrate that Tai Chi exercise intervention has a significant promoting effect on the cognitive function and physical health of the elderly. We can confidently say that Tai Chi is a very suitable fitness method for the elderly. It can not only improve their physical fitness but also enhance their mental health and quality of life. As shown in Table 2:

Table 2. Evaluation data of the effect of Tai Chi exercise intervention on elderly people

Evaluation dimensions	Pre-intervention state	Post-intervention status	Improvement effect
Memory	average score 60	Average score of 80	Significant improvement
Attention	average score 70	Average score of 90	Significant improvement
Body balance ability	Moderate risk of falling	Low risk of falling	Significant improvement
Depressive mood (scale score)	Average 20 (high)	Average 10 (low)	Effectively alleviate
Sleep quality (subjective evaluation)	Average 3/5	Average 4.5/5	Significant improvement
Overall quality of life (self-assessment)	Average 6/10	Average 8/10	Significant improvement

6 Conclusion and Prospect

As a non-pharmacological approach, exercise intervention has shown promising application prospects in improving cognitive function in the elderly. Future research should further explore the specific mechanisms by which different types of exercise improve cognitive function in the elderly, as well as issues such as optimal exercise intensity and frequency. At the same time, interdisciplinary cooperation and empirical research should be strengthened to promote the widespread application and promotion of exercise intervention in the field of cognitive function improvement in the elderly. In addition, with the development of technology and the popularization of smart elderly care concepts, the future can explore the application of modern technological means, such as smart wearable devices in the elderly's exercise intervention process to achieve more accurate and personalized health management services.

References

1. Park H, Park J H, Na H R, et al. Combined intervention of physical activity, aerobic exercise, and cognitive exercise intervention to prevent cognitive decline for patients with mild cognitive impairment: A randomized controlled clinical study[J]. Journal of clinical medicine, 2019, 8(7): 940.
2. Whitty E, Mansour H, Aguirre E, et al. Efficacy of lifestyle and psychosocial interventions in reducing cognitive decline in older people: Systematic review[J]. Ageing research reviews, 2020, 62: 101113.
3. Mendes L, Oliveira J, Barbosa F, et al. A conceptual view of cognitive intervention in older adults with and without cognitive decline—a systemic review[J]. Frontiers in Aging, 2022, 3: 844725.
4. Law L L F, Barnett F, Yau M K, et al. Effects of combined cognitive and exercise interventions on cognition in older adults with and without cognitive impairment: a systematic review[J]. Ageing research reviews, 2014, 15: 61-75.
5. Van Uffelen J G Z, Paw M J M C A, Hopman-Rock M, et al. The effects of exercise on cognition in older adults with and without cognitive decline: a systematic review[J]. Clinical Journal of Sport Medicine, 2008, 18(6): 486-500.
6. Tseng C N, Gau B S, Lou M F. The effectiveness of exercise on improving cognitive function in older people: a systematic review[J]. Journal of Nursing Research, 2011, 19(2): 119-131.
7. Zhou X L, Wang L N, Wang J, et al. Effects of exercise interventions for specific cognitive domains in old adults with mild cognitive impairment: A meta-analysis and subgroup analysis of randomized controlled trials[J]. Medicine, 2020, 99(31): e20105.
8. Liu T, Li N, Hou Z, et al. Nutrition and exercise interventions could ameliorate age-related cognitive decline: a meta-analysis of randomized controlled trials[J]. Aging Clinical and Experimental Research, 2021, 33: 1799-1809.