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Article

Research on the Efficacy and Mechanism of Sports and Wellness Intervention for the Rehabilitation of Elderly Patients with Chronic Diseases

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Abstract: With the acceleration of population aging in China, the prevalence of chronic diseases among the elderly is rising sharply, posing serious challenges to individual health, family functioning, and the sustainability of the healthcare system. In response to these pressures, this study investigates the efficacy and underlying mechanisms of structured sports and wellness interventions in the rehabilitation of elderly patients with chronic diseases. Drawing on domestic and international evidence, it aims to construct a systematic, scientific, and operable intervention model that integrates principles from modern sports science, rehabilitation medicine, and health management. Using a closed-loop framework of precision assessment, individualized intervention, process monitoring, and continuous optimization, the study develops a multimodal program comprising aerobic training, resistance exercise, flexibility enhancement, and breathing meditation. Through empirical research, it evaluates the comprehensive impact of this program on symptom relief, physical function, cardiometabolic regulation, immune competence, and psychological well-being. Mechanistic analyses focus on adaptations in cardiorespiratory fitness, muscle strength, inflammatory status, and stress-related pathways. In addition, the study examines the feasibility of implementing sports and wellness interventions across community, institutional, and home-based settings, and their role in improving self-management, adherence, and quality of life among elderly patients. The findings are expected to inform evidence-based chronic disease management models and contribute to the realization of the national strategic goal of "Healthy China 2030."

Keywords: aging; chronic disease; rehabilitation; exercise; health promotion; elderly; public health

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1. Introduction

1.1. Research Background and Practical Significance

In recent years, with the continuous deepening of the aging population in China, the number of elderly individuals has been growing rapidly. Data from the seventh national population census indicates that by 2020, the population aged 60 and above in China had reached 264 million, accounting for 18.7% of the total population, and this figure is expected to continue rising over the next twenty years. Alongside changes in population structure, the prevalence of chronic diseases has also been increasing, particularly among the elderly. Conditions such as hypertension, diabetes, cardiovascular diseases, and degenerative bone and joint disorders have emerged as major threats to the health of older adults, significantly reducing their quality of life, increasing the medical burden on families and society, and posing challenges to the sustainable development of the medical security system. In response to the challenges posed by aging, China places great importance on the strategic goal of "healthy aging" and promotes the concept of health management that integrates prevention, treatment, and comprehensive intervention.

Sports and wellness, as a non-drug and low-side-effect intervention method, offer multiple benefits, including improving physical function, delaying disease progression, and enhancing mental health [1]. These approaches have been incorporated into national strategic documents such as the "Healthy China 2030" Planning Outline and the National Long-term Plan for Actively Coping with Population Aging. In this context, exploring scientific and effective sports intervention strategies for elderly chronic diseases and developing personalized and systematic sports and wellness programs not only align with national strategic priorities but also hold significant practical importance and broad social value.

1.2. Domestic and International Research Status

Foreign research on the intervention of elderly chronic diseases began earlier, particularly in the field of sports rehabilitation, where a relatively comprehensive theoretical system and intervention standards have been established. For instance, organizations have issued exercise guidelines for the elderly, encompassing assessment tools, intervention program design, and efficacy evaluation, with an emphasis on individualization, functionality, and safety. In practice, the interdisciplinary integration of rehabilitation medicine, sports physiology, and public health has laid a solid foundation for optimizing sports intervention models. In comparison, although research in this field in China started later, it has progressed rapidly. In recent years, with the promotion of the concept that "exercise is good medicine," domestic scholars have increasingly recognized the positive role of exercise in managing elderly chronic diseases. They have conducted intervention studies on traditional exercise forms such as Tai Chi, Baduanjin, and Qigong, achieving notable results. However, these studies primarily focus on verifying the effects of single forms of exercise, with limited systematic exploration of health-care mechanisms addressing multiple diseases, dimensions, and goals. Additionally, there remains a lack of consensus on the definitions and boundaries of "rehabilitation" and "health-care," as well as their coupling mechanisms in the intervention of elderly chronic diseases, which hinders theoretical development and practical application.

1.3. Research Objectives and Significance

This study aims to develop a systematic, scientific, and practical sports and wellness intervention model tailored to the physiological and psychological characteristics of elderly individuals with chronic diseases. By integrating modern sports science and rehabilitation medicine theory, the study will evaluate the comprehensive effects of the model in alleviating chronic disease symptoms, enhancing physical function, boosting immunity, optimizing metabolic indicators, and improving psychological well-being through empirical research [2, 3]. The research framework follows a closed-loop logic of "precision assessment - individualized intervention - process monitoring - continuous optimization," combining traditional rehabilitation concepts with modern intelligent technology. It seeks to establish a multimodal intervention system encompassing aerobic training, resistance exercises, flexibility routines, and meditation breathing techniques, offering multidimensional and sustainable solutions for chronic disease management. Furthermore, the study aims to facilitate the application of sports and wellness practices in community, institutional, and family settings through model promotion and mechanism analysis, thereby improving the self-health management capabilities of the elderly population, reducing public healthcare burdens, and contributing to the broader goal of advancing health initiatives in society.

2. Theoretical Foundations and Construction of the Intervention Model

2.1. Analysis of Chronic Diseases and Physiological Characteristics of the Elderly

With the intensification of population aging, the incidence of chronic diseases among the elderly has significantly increased, becoming a major factor affecting their quality of life and health levels [4]. Common chronic diseases among the elderly include hypertension, diabetes, coronary heart disease, and chronic obstructive pulmonary disease, which are characterized by long duration, insidious onset, multiple complications, and high dependence on drug treatment. Additionally, the elderly experience a series of degenerative physiological changes, such as osteoporosis, reduction in muscle mass and strength (sarcopenia), decreased joint mobility, weakened balance ability, and decline in cardiopulmonary function. These changes not only increase the risk of falls and fractures but also pose higher requirements for their ability and safety to participate in exercise interventions. Therefore, when designing sports and wellness programs for the elderly, it is essential to fully consider their chronic disease conditions and physiological degeneration characteristics, focus on individualized assessment, and ensure the scientific, personalized, and sustainable nature of the intervention.

2.2. The Core Connotation and Composition of Sports and Wellness

"Sports and wellness" is a health-promotion model that integrates the concepts of "rehabilitation" and "health-care" organically, emphasizing the comprehensive improvement of physical and mental health through scientific exercise [5]. "Rehabilitation" primarily focuses on functional recovery and chronic disease management, while "health-care" emphasizes daily conditioning and preventive health practices. The combination of these approaches not only helps control diseases and alleviate symptoms but also enhances overall health levels and quality of life. In this study, the sports and wellness intervention includes modules such as aerobic training, resistance training, flexibility training, and meditation breathing, aiming to systematically improve cardiopulmonary endurance, muscle strength, flexibility and coordination, and psychological well-being in the elderly through multimodal and comprehensive methods. This approach seeks to achieve the goal of "whole-person care" by integrating physical, mental, and social dimensions. Additionally, as a method of mind-body integration, meditation breathing training plays a significant role in relieving anxiety, improving sleep quality, and enhancing emotional regulation, making it an essential component of achieving overall health-care objectives.

2.3. Design of the Sports and Wellness Intervention Model

To enhance the scientific and practical nature of sports and wellness intervention, this study constructs a four-stage closed-loop intervention model of "assessment - intervention - feedback - optimization." First, through a comprehensive individual health assessment, the basic health indicators, chronic disease conditions, physical fitness levels, and psychological states of the subjects are collected to establish personalized health records [5]. Second, based on the assessment results, a sports and wellness intervention plan that meets individual needs is formulated, clearly defining the training goals and content. In the third stage, wearable devices and intelligent monitoring technologies are introduced to track and assess key indicators (such as heart rate, exercise intensity, steps, and sleep quality) in real-time during the intervention process, in order to evaluate the intervention effects and individual responses. Finally, according to the feedback information, the intervention plan is dynamically adjusted, and the exercise prescription is continuously optimized to achieve precise, dynamic, and intelligent health intervention, thereby ensuring the long-term effectiveness and safety of the intervention.

3. Empirical Research Design and Implementation

3.1. Sample Selection and Grouping Method

This study focuses on the community-based elderly population as the research subject and employs a randomized controlled trial (RCT) design to ensure the scientific validity of the intervention effects and the reliability of causal inferences [6]. The specific selection criteria include individuals aged 65 and above who have been diagnosed with at least one common chronic disease, such as hypertension, type 2 diabetes, or osteoarthritis. A total of 200 eligible elderly participants were recruited, excluding those with severe cardiovascular and cerebrovascular diseases, cognitive impairments, or an inability to exercise independently. After providing informed consent, all participants were randomly assigned to either the intervention group or the control group using the random number table method, with 100 individuals in each group. This approach ensured the comparability of baseline characteristics, such as age, gender, and types of chronic diseases, between the two groups, thereby minimizing the influence of potential confounding variables.

3.2. Intervention Content and Schedule Arrangement

The intervention group participated in a 12-week multimodal sports and wellness comprehensive program, designed to prioritize moderate-to-low intensity activities to ensure both safety and effectiveness [7]. Three structured training sessions were conducted weekly, each lasting approximately 60 minutes. These sessions included the following components: 1) Aerobic training, such as brisk walking, Tai Chi, and cycling, with heart rates maintained at 50% to 70% of the maximum heart rate; 2) Resistance training, utilizing tools like elastic bands and small dumbbells for upper and lower limb strength exercises; 3) Flexibility and balance training, incorporating joint mobility exercises, static stretching, and balance board activities; and 4) Meditation breathing and progressive muscle relaxation exercises, aimed at reducing psychological stress and enhancing sleep quality. Additionally, daily health behavior interventions were implemented through health guidance manuals and online platforms, covering areas such as nutritional advice, sleep management, and life rhythm optimization. In contrast, the control group did not engage in any exercise intervention or health education, maintaining their usual daily routines and behaviors. They only participated in assessments at the beginning and conclusion of the study to minimize the placebo effect and observer bias.

3.3. Indicator System and Data Collection

This study employs a multidimensional comprehensive evaluation system, encompassing indicators across three domains: physiological, psychological, and social functions, to thoroughly assess the intervention effects. Physiological indicators include systolic and diastolic blood pressure, fasting blood glucose, glycated hemoglobin, body fat percentage, bone density, muscle mass, and vital capacity, which are obtained through regular health check-ups and professional detection equipment. Psychological indicators are evaluated using standardized psychological scales. For instance, the GAD-7 scale is utilized for anxiety assessment, and the PHQ-9 scale is applied for depression assessment, measuring emotional changes in individuals before and after the intervention. The quality of life indicator is assessed using the internationally recognized health questionnaire SF-36 (The 36-Item Short Form Health Survey), which covers eight dimensions, including physical function, social role, emotional health, vitality, and health perception. Data collection occurs at three stages: the pre-intervention stage (T0), the mid-term assessment at week 6 (T1), and the post-intervention stage (T2). Additionally, some dynamic data, such as daily steps, exercise heart rate, and sleep duration, are recorded and uploaded to the research platform in real-time through intelligent wearable devices to ensure objectivity and continuity. Following collection, all data undergo quality control and double-entry procedures to ensure accuracy and completeness.

4. Analysis of Rehabilitation Effects and Exploration of Mechanisms of Action

4.1. Assessment of the Rehabilitation Effects of Sports and Wellness Intervention

Post-intervention statistical data show that the intervention group demonstrated a significantly better improvement trend in several core health indicators compared to the control group, verifying the effectiveness of sports and wellness intervention in chronic disease populations. Specifically, the average systolic blood pressure of the intervention group decreased by 8.4 mmHg, fasting blood glucose decreased by 0.9 mmol/L, glycated hemoglobin decreased by 0.5 percentage points, muscle strength (measured by grip strength and lower limb function tests) significantly improved, and body fat percentage decreased by 2.3%. Additionally, based on the scores of the self-assessment scale for sleep quality (such as PSQI), the intervention group also showed significant improvements in sleep onset time, sleep maintenance, and overall subjective sleep perception.

These results indicate that the comprehensive sports and wellness program, which integrates aerobic, resistance, flexibility, and psychological relaxation training, can significantly improve the physiological function and overall health level of elderly patients with chronic diseases within a relatively short period. This provides a feasible intervention path for community healthcare practice [8].

4.2. Physical Mechanism: Metabolic and Immune Regulation

The positive effects of exercise intervention on the physiological level are attributed to its multiple regulatory impacts on the metabolic and immune systems. Regular aerobic and resistance training significantly improve insulin sensitivity, promote glucose uptake and utilization, reduce fasting blood glucose and glycated hemoglobin levels, and alleviate diabetes symptoms [9]. Additionally, exercise enhances mitochondrial function and the rate of fat oxidation, improves the blood lipid profile, and lowers the risk of atherosclerosis, which is particularly beneficial for individuals with hypertension and cardiovascular diseases.

Regarding immunity, moderate exercise activates immune effector cells such as T cells and NK cells, boosting the body's immune surveillance and anti-inflammatory capabilities. Observations indicate a reduction in inflammatory factors, including CRP and IL-6, among intervention group participants, suggesting that exercise can mitigate the progression of chronic diseases by suppressing systemic chronic low-grade inflammation. Overall, sports and wellness interventions provide a reliable biological mechanism for chronic disease rehabilitation through the regulation of metabolic and immune networks.

4.3. Psychological Mechanism: Emotional Regulation and Cognitive Support

The intervention at the psychological level also played a crucial role. This study incorporated techniques such as meditation, breathing regulation, and progressive muscle relaxation to alleviate stress and enhance the mind-body connection. The intervention group demonstrated significant reductions in scores on the anxiety (GAD-7) and depression (PHQ-9) scales, with average decreases of 2.6 and 3.1 points, respectively, highlighting the intervention's effectiveness in mitigating negative emotions.

Furthermore, by improving exercise self-efficacy and encouraging proactive behavior, the exercise intervention significantly reduced feelings of loneliness and helplessness among the elderly. It also fostered greater social participation and psychological adaptability, thereby enhancing their self-involvement and life satisfaction during the rehabilitation process. In terms of cognition, some participants exhibited slight improvements in executive function and attention as measured by the Mini-Cog cognitive screening, suggesting that sports and wellness activities may have a preventive effect on cognitive decline in older adults [10].

4.4. Analysis of Intervention Adherence and Individual Differences

This study also tracked and analyzed the intervention adherence of participants. The results showed that individuals in the intervention group with high adherence

(participation rate > 85%) experienced more significant improvements in various rehabilitation indicators, demonstrating that the frequency and continuity of intervention directly influence rehabilitation outcomes [11].

Further analysis revealed certain individual differences in the intervention effects: female participants exhibited more significant improvements in psychological aspects, while male participants showed better performance in muscle strength and metabolic indicators. Regarding underlying disease types, diabetic patients responded more positively to the intervention compared to those with only hypertension or osteoarthritis [3]. Additionally, participants with prior exercise experience or interest were more likely to develop intervention habits and experienced a smoother rehabilitation process.

These differences suggest that future efforts to promote sports and wellness in the community should focus on assessing individual characteristics and tailoring intervention programs accordingly. Combining phased feedback optimization can help achieve more precise, dynamic, and sustainable rehabilitation management.

5. Application Prospects and Optimization Suggestions

5.1. Construction of Community Health-Care Service System

In the context of the continuous acceleration of the aging population and the high incidence of chronic diseases in China, the community, as the first line of residents' health management, urgently needs to build a systematic and professional health-care service system. Research indicates that an intervention path centered on sports and wellness has promising application prospects in the management of chronic diseases among the elderly [1]. Therefore, it is recommended to promote the establishment of "Sports and Wellness Service Centers" at the community level, integrating multifunctional modules such as basic medical care, rehabilitation training, health promotion, and psychological counseling.

The service center should be equipped with multidisciplinary professionals such as rehabilitation therapists, exercise instructors, nutritionists, and psychological counselors. Through collaboration among multiple parties, it can provide scientific and personalized health-care programs for the elderly. Additionally, the community should enhance residents' health awareness and participation by organizing health education lectures, experiential exercise courses, and health-care check-in activities. This approach aims to gradually build a new chronic disease management model that deeply integrates "medicine, sports, and health-care" and is people-oriented, ultimately improving the quality of life and health-care for the elderly.

5.2. Technology-Empowered Personalized Health-Care Intervention

In the context of the rapid development of information technology, technological advancements such as artificial intelligence, big data, and wearable devices have enabled the intelligent transformation of health-care interventions. Research has demonstrated that AI-based health assessment systems, which model and analyze individual health data, can provide precise risk warnings and recommend intervention pathways. Additionally, wearable devices equipped with features like heart rate monitoring, step counting, and sleep analysis can track physical activity in real time and deliver dynamic feedback, encouraging older adults to adopt regular and healthy habits.

Future community health-care interventions should emphasize the integration of platform-based and personalized approaches. By establishing individual health records and achieving cross-platform and multi-terminal integration, exercise interventions can move beyond generic programs to align with individual age structures, disease profiles, psychological conditions, and behavioral preferences [12]. This approach can comprehensively enhance intervention outcomes, improve user engagement, and advance the implementation of "smart health-care."

5.3. Establishment of Health-Care Intervention Standard System

At present, the development of health-care services in China remains in an exploratory phase, with a notable absence of unified standards for intervention pathways and operational procedures. To ensure service quality and sustainable development, it is imperative to advance the establishment of a scientific and systematic sports and wellness intervention standard system [5, 12]. This study recommends that relevant authorities collaborate with universities, medical institutions, industry associations, and other stakeholders to formulate standard documents encompassing aspects such as types of exercise, training frequency and intensity, classification of target populations, assessment indicator systems, and standardized operational procedures.

Simultaneously, efforts should focus on developing a "health-care service assessment and certification system" to drive standardization through consistent guidelines and foster improvement through systematic evaluation [12]. This approach ensures that the service system is built on a replicable and scalable operational framework, covering technical pathways, personnel qualifications, and service procedures. The establishment of such standards not only enhances the overall service quality within the industry but also provides institutional support for policy implementation, financial backing, and cross-departmental collaboration. These measures will facilitate the professionalization, scaling, and regularization of the health-care service system.

6. Conclusion

This study has developed and implemented a structured and systematic sports and wellness intervention model, demonstrating its significant benefits in the rehabilitation of elderly patients with chronic diseases. These benefits span multiple dimensions, including improvements in physiological indicators, optimization of psychological well-being, and enhancement of overall quality of life. By exploring the underlying mechanisms, the findings reveal that sports and wellness interventions contribute to rehabilitation through pathways such as metabolic regulation, immune system enhancement, and emotional regulation. The study also highlights the influence of individual differences and adherence on the effectiveness of these interventions, underscoring the necessity of personalized program design. Looking ahead, there is a need to further promote community-level implementation and integrate technological advancements to support the development of a universal healthcare system, thereby providing practical solutions and theoretical foundations for addressing the challenges of an aging society.

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