GEORGE BROWN PRESS
JOURNALS, BOOKS & PROCEEDINGS

Journal of Computer, Signal, and System Research

Article

Intervention Research and Optimization Strategies for Neuromuscular Function Degeneration in the Context of Aging

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Abstract: With the aging of the population in China, neuromuscular function degradation has become one of the most important problems affecting the health level and quality of life of the elderly. The degradation process of this neuromuscular function involves a decrease in nerve conduction velocity, muscle strength, coordination, and balance, which seriously affects the daily activity and self-care abilities of the elderly. This article is based on the perspectives of sports science and physical therapy, and elaborates on the physiological mechanisms of neuromuscular degeneration. It summarizes the mainstream intervention paths of aerobic exercise, resistance training, and proprioceptive training, and proposes suggestions and improvement plans for functional evaluation, personalized training, multidisciplinary integration, and information-based assistance to improve neuromuscular degeneration. The aim is to provide theoretical basis and practical reference for the development of a scientific and effective neuromuscular function intervention system for the elderly.

Keywords: aging population; neuromuscular degeneration; sports training

Received: 09 November 2025
Revised: 25 November 2025
Accepted: 02 December 2025
Published: 09 December 2025

1. Introduction

With the increase of the elderly population in China, neuromuscular dysfunction has become the main factor affecting the quality of life and social function activities of the elderly. The degeneration of this function is manifested as a decrease in nerve conduction velocity, weakened muscle strength, and impaired balance and coordination, greatly increasing the risk of falls, fractures, and disabilities. Conventional rehabilitation therapy lacks personalized response and inaccurate evaluation in terms of intervention effectiveness. This article systematically studies the causes and characteristics of neuromuscular functional degradation from the perspectives of kinematics and physical therapy. Combining mainstream intervention methods such as aerobic exercise, resistance training, and proprioceptive training, it explores the integration of evaluation technology and intelligent assistance to improve treatment effectiveness, providing a basic theory and method for achieving healthy aging.

2. Mechanism Analysis of Neuromuscular Dysfunction in Elderly People

2.1. The Impact of Aging on the Nervous System

As age increases, the human nervous system undergoes a series of structural and functional degradations, mainly manifested as a decrease in neurons, reduced synthesis of neurotransmitters, demyelination, and slowed nerve conduction velocity. Research has shown that the cerebral cortex of elderly people gradually becomes thinner, and the density of white matter decreases, especially in areas that control movement such as the motor cortex, cerebellum, and basal ganglia, where degeneration is significant. These changes directly affect the central nervous system's ability to transmit instructions for muscle movement, leading to prolonged muscle response time and decreased accuracy of movements. In addition, peripheral nerves are also affected, manifested as smaller axons, prolonged latency of sensory nerve conduction, and decreased excitability of motor nerves, leading to a decline in proprioceptive and dynamic posture control functions. Due to reduced neural plasticity, older adults may have a weaker response to training, resulting in a longer rehabilitation process. In summary, the widespread impact of aging on the nervous system lays the foundation for the degeneration of neuromuscular function, emphasizing the importance of early assessment and intervention for the nervous system (As shown in Table 1).

Table 1. Comparison of the main impacts of aging on the structure and function of the nervous system.

project	Youth population (20-30 years old)	Elderly population (over 65 years old)	Impact performance
Number of neurons	Relatively stable, active	Significant reduction (especially in the cerebral cortex and cerebellum)	Slow down of information processing speed
Neurotransmitter levels	Normal level, efficient signal transmission	Reduced synthesis of dopamine, acetylcholine, and other substances	Motion control and memory decline
Myelin integrity	Complete myelin sheath structure and fast conduction speed	Loss or damage of myelin sheath, decreased conduction velocity	Slow muscle response and decreased coordination
nerve conduction velocity	Rapid conduction (>60 m/s)	Significantly slowed down (<45 m/s)	Action delay and longer reaction time
Central nervous system plasticity	Strong and adaptable	Weakness, decreased ability to reshape	Poor adaptability to rehabilitation training
Peripheral nerve excitability	High, fine muscle control	Decreased excitability and delayed perceptual feedback	Degradation of proprioceptive perception and decreased balance ability

2.2. Physiological Basis of Muscle System Decline

As age increases, the human muscular system will face significant structural and functional changes, known as "sarcopenia". At first, the cross-sectional area of skeletal muscles gradually decreases, and the atrophy of fast muscle fibers (type II) becomes more pronounced, leading to a decrease in explosive power and reaction speed. Subsequently, the synthesis rate of muscle proteins gradually slows down, and metabolic capacity gradually decreases, which is not conducive to the repair and reconstruction of muscles in the body. In addition, muscle tissue steatosis and fibrosis are further exacerbated, which is not conducive to muscle elasticity, flexibility, and strength output. The decrease in the number of exercise units and the reduction in the transmission efficiency of neuromuscular junctions result in impaired motor response ability of the human muscular system. Research has found that the muscle mass of elderly people aged 65 and above will decrease at a rate of 8% -10% within 10 years [1]. If not treated properly, it will cause significant obstacles to individual motor function. The degradation of the muscle system not only affects daily activities such as walking and climbing stairs, but also significantly increases the risk of falls and fractures, which is an important physiological basis for disability and dependence in the elderly (As shown in Table 2).

Table 2. Comparison of Muscle System Structure and Function in Different Age Groups.

Index	Youth population (20-30 years old)	Elderly population (over 65 years old)	Change impact
Muscle cross-sectional area	Maximum, structurally complete	Significant shrinkage, decreased organizational density	Decreased muscle strength and weakened athletic ability
Proportion of fast muscle fibers (type II)	High proportion, strong explosive power	Significantly reduced, slow contraction speed	Slow action response and lack of instantaneous explosive power
Protein synthesis ability	High, with vigorous metabolism	Decrease, slow synthesis rate	Poor muscle repair ability and easy atrophy
intramuscular fat	Low, less fat infiltration	Significant increase, fat replacing muscle tissue	Decreased muscle mass and weakened power output efficiency
Muscle elasticity and tension	Good, supporting high-intensity activities	Poor elasticity and insufficient tension	Easy to fatigue, reduced joint stability
Motor unit neural control	Large quantity, precise control	Quantity reduction leads to decreased efficiency of neuromuscular junctions	Poor coordination, prone to unstable posture

2.3. Comprehensive Manifestations of Decline in Motor Function

Against the backdrop of synchronous degeneration of the nervous and muscular systems, the motor abilities of elderly individuals exhibit a characteristic of multiple functional impairments. Firstly, a decrease in muscle strength is the most intuitive manifestation, manifested as weakened grip strength, slower gait, and difficulty climbing up and down stairs, directly affecting daily independence. Secondly, there is a significant decrease in balance and coordination abilities, such as unstable standing and slow turning, which increases the risk of falls. A survey shows that over 30% of elderly people aged 65 and above fall at least once a year, and falls have become one of the important causes of disability and death among the elderly. Thirdly, the decrease in flexibility and joint range of motion affects the body's ability to move in different directions, exacerbating the elderly's difficulty and discomfort in movement. Fourthly, the decrease in proprioceptive perception and reaction speed leads to delayed response to environmental changes, reducing the ability to defend oneself. Long term decline in motor function can also trigger psychological problems such as exercise anxiety and social avoidance, forming a vicious cycle. In summary, the decline in exercise ability is not the result of a single physiological mechanism, but a common result of neurological muscular system disorders, and comprehensive interventions should be implemented (As shown in Table 3).

Table 3. Comprehensive manifestations and influencing factors of motor function decline in elderly people.

Performance of motor function	Main physiological reasons	Typical external manifestations	Potential risks and impacts
Decreased muscle strength	Muscle fiber atrophy and reduction in motor units	Weak grip strength, difficulty lifting objects, and difficulty climbing up and down stairs	Decreased self-care ability and increased risk of falls
Weakened balance ability	Vestibular dysfunction and decreased proprioception	Unstable standing and prone to falling	Fracture, fear of daily life, restricted mobility
Lack of joint flexibility	Degenerative joint changes and poor tendon elasticity	Reduced range of motion and slow turning	Poor spatial adaptability, prone to falls and injuries
Poor coordination	Decreased nerve conduction velocity and sensory motor dysfunction	Stiff movements and unstable gait	Increased frequency of falls and increased cognitive burden
Slow reaction speed	Reduced neurotransmitters and delayed response at the neuromuscular interface	Slow start and poor obstacle avoidance ability	Unable to respond promptly to unexpected situations, traffic or home hazards
Limited social participation	Reduced physical ability leads to psychological avoidance	Staying indoors and experiencing an increase in negative emotions	Increased loneliness and simultaneous decline in physical and mental health

3. Current Mainstream Intervention Methods and Physical Therapy Pathways

3.1. Aerobic Exercise Training and Neural Function Activation Pathway

Aerobic exercise is a form of exercise characterized by low-intensity, continuous exercise, which has a significant activating effect on the nervous system of elderly people. Research has shown that reasonable aerobic exercise can increase cerebral blood flow, improve oxygen supply and metabolic efficiency in the central nervous system of the brain, and help delay the process of neurodegeneration. Specifically, aerobic exercise can induce the secretion of nerve growth factors (such as BDNF), enhance neural plasticity, improve synaptic connections, and enhance the central nervous system's ability to regulate movement. The main forms of exercise, such as brisk walking, cycling, and slow running in the water, can significantly improve reaction speed and attention, and enhance the body's perceptual ability. Aerobic exercise also has beneficial effects on memory and thinking ability, and to some extent, can prevent the occurrence of Alzheimer's disease. For neuromuscular control, aerobic exercise also helps to strengthen the communication rate of information between the central nervous system and muscle tissue, improving the coordination and rhythm control of limb movements. The overall intervention mechanism of aerobic exercise on neural function activation is illustrated in Figure 1. For the optimal intervention effect of aerobic exercise, the physical condition of the elderly should be comprehensively considered, and the frequency (3-5 times/week), intensity (moderate or mild), and duration (30-45 minutes) of aerobic exercise should be appropriately planned to achieve the synergistic promotion of neural function activation and healthy aging goals [2].

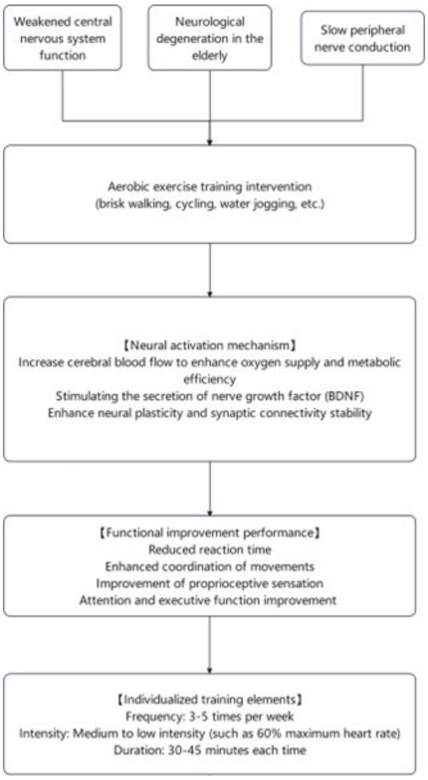

Figure 1. Intervention pathway framework for activating neural function through aerobic exercise.

3.2. Resistance Training and Muscle Mass Reconstruction Mechanism

Resistance training is considered the most effective measure to improve muscle strength and quality in the elderly. Mainly by applying external loads to skeletal muscles, it stimulates muscle protein synthesis, fiber remodeling, and enhances muscle nerve control ability. Common sarcopenia in the elderly includes muscle fiber atrophy, decreased muscle strength output, and decreased activation of motor units. Resistance training can improve muscle atrophy. Numerous studies have shown that regular resistance training can significantly increase the cross-sectional area of type II muscle fibers, improve muscle strength and explosiveness, and thus enhance the exercise ability of elderly people in daily life, such as standing, carrying, and climbing stairs. For training, a moderate resistance plan (60% -70% 1RM) should be chosen, combined with a training frequency of 2-3 repetitions per week, 8-12 repetitions per session, to maximize muscle synthesis and reduce the risk of sports injuries [3]. In addition, resistance training can also enhance bone density and joint stability, thereby improving body balance and establishing muscle mass recovery [4].

3.3. Path of Proprioceptive Training and Balance Training

Ontological perception refers to an individual's ability to perceive body posture, muscle tone, and joint position, playing a central role in maintaining dynamic balance and posture control [5]. The proprioception of elderly people may decrease with age, which may lead to a decrease in center of gravity control, slow posture adjustment, and loss of balance, increasing the risk of falls. Ontological training helps improve the body's ability to perceive spatial position by activating deep sensory receptors and strengthening the neuromuscular response chain. Common methods include standing with closed eyes, balance board training, single foot support, and training with elastic bands, which can effectively improve leg stability and joint control ability. Combining dynamic balance training (such as walking "s" shaped routes and practicing dynamic turns) to better enhance posture adjustment ability. Research has shown that conducting proprioceptive training for more than 6 weeks can effectively improve the lower limb balance control ability of elderly people and reduce the incidence of falls. Training should be designed in layers based on individual functional levels, increasing the challenge of exercise from shallow to deep, and implementing protective measures during the process to ensure the effectiveness and compliance of interventions. This is an important way to ensure exercise ability and prevent accidental injuries [6].

4. Current Mainstream Intervention Methods and Optimization Strategies for Physical Therapy

4.1. Neural Function Assessment and Precise Pathway Construction for Aerobic Training

In order to improve the intervention effectiveness of aerobic training on the nervous system of elderly people, precise neurological function assessment should be conducted before intervention, and personalized training plans should be developed based on this assessment. This assessment project includes reaction time testing (simple audio-visual response testing), measurement of attention and executive ability (such as Stroop test and TrailMakingTest), and measurement of brain functional activity (such as using near-infrared spectroscopy or electroencephalography (EEG)). By combining physiological indicators and behavioral performance, determine the specific dimensions of neurological dysfunction. Based on the evaluation results, develop a personalized aerobic exercise plan, including the calculation of individual maximum heart rate (i.e. 220 age), expected training heart rate range (i.e. 50% to 70% HRmax), exercise selection (such as walking, cycling, or water aerobic exercise), etc., to achieve dynamic matching of intensity and tolerance [7]. Real time monitoring of training data can also be achieved through wearable heart rate recorders, wearable pedometers, etc., in order to adjust training plans. Forming a cycle of "evaluation training feedback" significantly improves the effectiveness of intervention and provides lasting motivation for the maintenance of neurological function in elderly patients [8].

In 2024, a rehabilitation center in Guangzhou conducted a personalized aerobic training intervention study based on neurological function assessment on 40 elderly people aged 65 and above. After passing the MMSE cognitive screening, all subjects underwent monitoring of brain functional area oxygen metabolism and executive function testing, and were grouped according to the evaluation results to develop training prescriptions. The experimental group underwent brisk walking and cross stepping training for 40 minutes three times a week, with intensity maintained at 50% -65% HRmax; The control group used uniform intensity regular brisk walking.

The training period was 8 weeks, and the results showed that the experimental group's Stroop execution reaction time decreased from an average of 1230ms to 950ms, with $P<0.01$; The average increase in frontal lobe blood oxygen response amplitude recorded by NIRS was 12.3%; There was no significant change in the control group. In addition, the experimental group's TUG (standing up walking test) time decreased from 11.2 seconds to 9.1 seconds, indicating a significant improvement in their neural response and posture coordination ability.

To enhance monitoring effectiveness, wearable heart rate monitors and pace recorders were introduced to provide real-time feedback on exercise load and physiological changes, achieving a closed-loop mechanism of "evaluation training feedback". This mechanism effectively improves training compliance and reduces the risk of falls, providing a feasible paradigm for personalized neuro-rehabilitation interventions (As shown in Table 4).

Table 4. Comparison results of neurological function intervention between experimental group and control group of elderly people before and after intervention (n=40).

Indicator Name	Testing tools/methods	Before intervention (experimental group)	After intervention (experimental group)	Before intervention (control group)	After intervention (control group)	Significant difference between groups (P value)
Stroop task response time (ms)	Cognitive executive function test	1230 ± 95	950 ± 80	1215 ± 90	1180 ± 85	<0.01
TUG standing and walking time (s)	Timing test	11.2 ± 1.5	9.1 ± 1.2	11.0 ± 1.4	10.8 ± 1.3	<0.05
Frontal lobe oxygen response amplitude (% Δ HbO2)	NIRS near-infrared spectrometer	+4.5 ± 1.8	+12.3 ± 2.5	+4.8 ± 1.7	+5.3 ± 2.0	<0.01
Training compliance score (0-10)	Self evaluation questionnaire+recording device rating	-	8.7 ± 1.1	-	6.2 ± 1.6	<0.05
Wearable heart rate compliance rate (%)	Intelligent heart rate recorder	-	89.5%	-	71.4%	<0.05

4.2. Muscle Function Evaluation and Resistance Training Prescription Optimization Mechanism

Building a scientific resistance training system requires developing personalized training prescriptions based on accurate muscle function assessment results. Common evaluation indicators include grip strength measurement (reflecting overall muscle strength), lower limb sitting and standing frequency test (30s chair standing test), isokinetic muscle strength test, etc., which comprehensively present the muscle mass and muscle strength output ability of elderly people. The training intensity is usually calculated based on one maximum repeated load (1RM), using the following estimation formula:

$$1RM = \frac{W}{1.0278 - 0.0278 \times R} \quad (1)$$

Among them, W: current training weight (kg); R: The maximum number of repetitions completed under this weight; 1RM: Estimated maximum force output value. For elderly people, the intensity of resistance training should be controlled at 60% to 70% 1RM, with 8-12 movements per movement, and 2-3 groups should be recommended as much as possible. This can ensure safety and achieve sufficient muscle stimulation. If the strength is small, a weekly linear increase plan (such as increasing training intensity by 5% per week) can be used to enhance the body's adaptability. The principle of cyclic training and the arrangement of recovery period can effectively promote the recovery of type II muscle fiber activity and muscle protein synthesis, which is an important strategy for muscle function reconstruction.

In 2023, a medical and elderly care integrated rehabilitation institution in Shenzhen launched a pilot intervention project of "functional assessment + personalized resistance training" for 60 elderly people aged 70 and above. The subjects first underwent baseline assessments using a muscle strength grip tester and a chair standing test. They were then divided into a weak muscle group and a moderate muscle group based on the assessment results. Resistance prescriptions with 60% and 70% 1RM training intensity were designed, respectively. The training frequency was 3 times a week, 45 minutes each time, for 12 weeks.

The results showed that after 12 weeks, the experimental group (personalized resistance) had an average increase in 30 second chair standing times from 10.5 to 16.3 times, grip strength from 22.4kg to 28.6kg, and muscle strength growth rate of 27.7%, which was significantly better than the control group (unified strength intervention, improvement rate of 12.9%); The electromyographic activity (EMG RMS) of type II muscle fibers increased by an average of 18.2%; In addition, the subjects reported a significant improvement in lower limb stability and heavy lifting ability, with a satisfaction score of 9.1/10.

To achieve training safety and quantitative monitoring, the project is equipped with electronic resistance equipment and muscle feedback system, which can record the weight, frequency, completion quality of each movement and adjust the load level in a timely manner. The integration of the strategy of "gradual cycle target tracking load adjustment" into intervention design effectively improves the scientificity and training compliance of muscle strength recovery in elderly people (As shown in Table 5).

Table 5. Comparison of muscle function changes in elderly people before and after resistance training intervention (n=60).

Evaluation indicators	measuring method	Before intervention (experimental group)	After intervention (experimental group)	Before intervention (control group)	After intervention (control group)	Significant difference between groups (P value)
30 second chair standing times (times)	Chair standing function test	10.5 ± 2.1	16.3 ± 2.4	10.3 ± 2.0	13.1 ± 2.3	<0.01
Grip strength (kg)	Hand grip strength tester	22.4 ± 3.5	28.6 ± 3.2	22.1 ± 3.3	25.0 ± 3.0	<0.01
EMG RMS (μV) of type II muscle fibers in lower limbs	Electromyography (Isometric Contraction Test)	42.6 ± 6.8	50.4 ± 7.2	43.0 ± 6.5	45.2 ± 6.4	<0.05
Training compliance score (0-10)	Training attendance rate+self-assessment questionnaire	-	9.1 ± 0.8	-	7.5 ± 1.0	<0.05
Subjective stability	Self-evaluation questionnaire on the ability to	-	8.6 ± 0.9	-	6.9 ± 1.1	<0.05

improvement score (0-10)	stand up and lift objects

4.3. Intelligent Upgrade of Balance Ability Recognition and Proprioceptive Training

The decline of balance function in elderly people has high individual differences, and before conducting proprioceptive training, it is necessary to conduct objective quantitative analysis and evaluation. Among them, commonly used assessment tools such as Berg Balance Scale (BBS), TimeUp and GoTest (TUG), and Dynamic Posture Control Test (DGI) can comprehensively reflect one's balance control ability in both static and dynamic aspects. The wearable sensing device (inertial measurement unit IMU) can obtain real-time data on the amplitude of human center of gravity swing, gait rhythm, and muscle response, which is beneficial for improving the level of balance control and the objective grasp of accuracy. When implementing training, intelligent auxiliary platforms (such as balance feedback devices and virtual reality VR training platforms) can be used to provide visual feedback and scenario simulation training to enhance the fun and initiative of training. By using visual vestibular proprioceptive multisensory fusion stimulation, the sensory feedback pathway can be activated to adjust the posture control ability of elderly people. Adjust the training intensity in a timely manner based on the evaluation results, gradually guiding the completion of challenging tasks such as closed eyes, soft cushions, and irregular surfaces from simple to complex. Through an intelligent training loop of "evaluation feedback adaptation adjustment", an individualized self perception training program led by a technology innovation assisted system is established to improve treatment effectiveness and reduce the risk of falls.

In 2023, a tertiary rehabilitation hospital in Wuhan conducted an 8-week proprioceptive intervention experiment using the "intelligent evaluation + VR fusion training" model for 30 elderly people with mild balance disorders. The experimental group is equipped with IMU and VR training platform for multi scene dynamic posture control training, such as virtual bridge walking, closed eye stability testing, standing on irregular terrain, etc; The control group received traditional balance board and manual dynamic training.

The intervention results showed that the Berg Balance Scale score in the experimental group increased from 42.1 to 50.3, and the TUG testing time was shortened from 13.8 seconds to 10.2 seconds; In contrast, the control group showed a smaller improvement and did not meet the significance criteria. In the IMU data collection, the amplitude of the center of gravity deviation before and after the experimental group decreased from an average of 3.4cm to 1.9cm, and the fluctuation of ankle joint angular velocity decreased by 21.5%. The subjective fear of falling score (FES-I) decreased by 18.7%, indicating a significant improvement in exercise confidence among the elderly.

This project has formed an intelligent closed-loop training mechanism of "evaluation classification training feedback", combined with virtual reality technology, multimodal perception input and individual response data analysis, significantly improving the targeting and compliance of training, and providing a scalable engineering path for maintaining the balance ability of the elderly (As shown in Table 6).

Table 6. Comparison results of evaluation indicators before and after intelligent proprioceptive training (n=30).

Evaluation indicators	Testing tools/equipment	Before intervention (experimental group)	After intervention (experimental group)	Before intervention (control group)	After intervention (control group)	Significant difference (P-value)
Berg Balance Scale (total	Standard scale+physical	42.1 ± 4.5	50.3 ± 3.8	42.4 ± 4.1	45.8 ± 3.9	<0.01

score/56 points)	therapist evaluation					
TUG testing time (seconds)	Stand up walking standard timing device	13.8 ± 1.7	10.2 ± 1.4	13.5 ± 1.8	12.4 ± 1.6	<0.05
Deviation amplitude of center of gravity (cm)	IMU+Foot Pressure Sensing Pad	3.4 ± 0.9	1.9 ± 0.6	3.3 ± 0.8	2.8 ± 0.7	<0.01
Coefficient of variation of ankle joint angular velocity (°/s)	IMU three-axis gyroscope	7.8 ± 2.0	6.1 ± 1.5	7.6 ± 1.8	7.0 ± 1.7	<0.05
Fall Fear Score (FES-I, total score 28)	International Falling Efficiency Energy Meter (Chinese Version)	22.5 ± 2.3	18.3 ± 2.1	22.2 ± 2.5	20.6 ± 2.2	<0.05

5. Conclusion

With the intensification of population aging, the decline of neuromuscular function has become an important factor affecting the quality of life and independence of elderly people. This article reviews mainstream intervention pathways such as aerobic exercise, resistance training, and proprioceptive training, starting from the mechanisms of neural and muscle degeneration. Combining evaluation tools, training formulas, and intelligent technologies, it proposes precise and multidimensional optimization strategies. For the construction of future rehabilitation treatment systems, attention should be paid to the integration of scientific research evaluation, personalized prescriptions, and intelligent assisted training, promoting the coordinated development of rehabilitation and sports science to a higher level, which will help improve the effectiveness and sustainability of rehabilitation treatment. Constructing an elderly fitness intervention model with functional reconstruction as the goal and technology promoting treatment as the feature will provide important support for achieving the goal of healthy aging.

References

1. M. Timraz, M. G. Wyss, T. J. Quinn, E. Combet, C. Celis-Morales, and S. R. Gray, "The association of n-3 fatty acid intake with muscle mass and strength in older adults: A cross-sectional analysis of the UK biobank data," *The Journal of nutrition, health and aging*, vol. 29, no. 9, p. 100622, 2025. doi: 10.1016/j.jnha.2025.100622
2. N. S. Luthra, N. Mehta, M. J. Munoz, G. Fantuzzi, G. Lamotte, J. M. Haus, and D. M. Corcos, "Aerobic exercise-induced changes in fluid biomarkers in Parkinson's disease," *npj Parkinson's Disease*, vol. 11, no. 1, p. 190, 2025. doi: 10.1038/s41531-025-01042-8
3. A. Verschueren, C. Palminha, E. Delmont, and S. Attarian, "Changes in neuromuscular function in elders: Novel techniques for assessment of motor unit loss and motor unit remodeling with aging," *Revue Neurologique*, vol. 178, no. 8, pp. 780-787, 2022. doi: 10.1016/j.neurol.2022.03.019
4. S. McMillan, S. J. Kim, H. Yulico, R. Li, M. Allison, D. Bascombe, and B. K. Grodzicki, "Common cancers among the aging population: What NPs need to know," *The Nurse Practitioner*, vol. 50, no. 6, pp. 39-47, 2025.
5. H. Dou, C. Wang, G. Cheng, X. Lei, and S. Xu, "The vision of younger-seniors-based elderly care in rural China: based on population aging predictions from 2020 to 2050," *Humanities and Social Sciences Communications*, vol. 12, no. 1, pp. 1-12, 2025. doi: 10.1057/s41599-025-04994-7
6. S. B. Na, S. Y. Choi, D. B. Jeon, S. J. Moon, and J. K. Kim, "Estimating the Impact of Aging on Visual Function Using Useful Field of View (UFOV) with a Focus on the Population of Gangwon-do in Korea," *Brain Sciences*, vol. 15, no. 1, p. 29, 2024.

7. Q. Liu, M. Jia, G. Chai, and D. Yang, "Research on the main methods of core strength training in sprinters," *Revista Brasileira de Medicina do Esporte*, vol. 29, p. e2022_0229, 2022. doi: 10.1590/1517-8692202329012022_0229
8. J. Burtscher, A. Raberin, F. Brocherie, D. Malatesta, G. Manferdelli, T. Citherlet, and G. P. Millet, "Recommendations for women in mountain sports and hypoxia training/conditioning," *Sports Medicine*, vol. 54, no. 4, pp. 795-811, 2024. doi: 10.1007/s40279-023-01970-6