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Research Article

THE INFLUENCE AND TREATMENT OF TAI CHI WATER RESISTANCE BALL REHABILITATION TRAINING COMBINED WITH MUSIC ON MENTAL PATIENTS

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Abstract

This study explores the synergistic intervention effect of the integration of Tai Chi water resistance ball training and music therapy on patients with mental illness. By enhancing limb control ability through the resistance characteristics of water and combining it with the gentle rhythm of Tai Chi movements, the patient's motor coordination and neural plasticity can be significantly improved. The intervention of musical elements further regulates the autonomic nervous system through the auditory-motor coupling mechanism, reduces anxiety levels and improves treatment compliance. Clinical observations have shown that this therapy has multi-dimensional advantages in emotional expression (releasing suppressed emotions through the motion-music co-frequency effect), social function reconstruction (music promoting non-verbal interaction in group training), and cognitive function improvement (compound attention distribution training). In the future, it is necessary to optimize the design of personalized plans by integrating digital assessment tools, providing a new paradigm of non-pharmaceutical intervention for mental rehabilitation.

Keywords: Tai Chi water resistance ball training Music fusion therapy Mental rehabilitation Multimodal intervention Non-pharmaceutical therapy; Mind-body synergy effect

INTRODUCTION

Mental patients generally have core symptoms such as motor dysfunction, abnormal emotion regulation and decreased social adaptability. Although traditional drug treatment can alleviate some positive symptoms, its improvement effect on negative symptoms and functional recovery is limited, and it is often accompanied by side effects such as metabolic syndrome. In recent years, non-pharmaceutical intervention methods such as exercise therapy and music therapy have gradually become research hotspots due to their advantages of high safety and good compliance. Tai Chi water resistance ball training enhances limb control ability through the resistance characteristics of water. Its movement design integrates the principle of "relaxed but not unremitting" in Tai Chi philosophy, which can effectively improve patients' balance function and neuromuscular coordination. When synchronized with music therapy, rhythmic auditory stimulation can activate the brain's mirror neuron system, forming a "audience-motor" dual-channel intervention model, significantly enhancing the fluency of movement execution and the efficiency of emotional expression. Clinical observations have shown that this somatosensory and auditory cross-modal intervention can reduce patients' anxiety levels by 34.7% and enhance their willingness to interact socially in group therapy. This study aims to systematically explore the integration mechanism of Tai Chi water resistance balls and music therapy, with a focus on analyzing their multi-dimensional impacts on the physiological functions, emotional states, and social cognition of patients with mental illness, providing an innovative intervention paradigm for the field of mental rehabilitation.

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1.1 Synergistic intervention at the physiological and neural mechanism level

Exercise rehabilitation and regulation of neural plasticity

1.1.1 Neural Remodeling Mechanisms in Sports Rehabilitation

Tai Chi water resistance ball training enhances muscle strength and joint stability through the dynamic resistance characteristics of water. Its movement design follows the principle of "softness, slowness and continuity" of Tai Chi, which can optimize proprioceptive input, activate the cerebellar - basal ganglia - cortical motor circuit, and promote the plasticity and functional reorganization of neural synapses. Studies have shown that water resistance training can promote the secretion of brain-derived neurotrophic factor (BDNF) through mechanical stress stimulation and accelerate the repair of functional connections between the motor cortex and the striatum.

1.1.2 Neural Synergistic Effects of Musical Rhythms

Music therapy forms a "auditory-movement" synchronous coupling through rhythmic auditory stimulation (such as a soothing rhythm of 60-80 BPM) and exercise training. Enhanced functional connectivity between the auditory cortex and the premotor area can improve the accuracy and fluency of movement execution, while activating the mirror neuron system to promote motor learning and memory consolidation. For instance, low-frequency music vibrations can directly act on the vestibular nucleus through bone conduction, regulating the integration of neural signals related to motor coordination.

1.1.3 Synergistic Mechanism of Bimodal Intervention

Neural circuit integration: The somatosensory input of water resistance training combined with the auditory input of musical rhythms enhances the efficiency of movement planning and execution through the thalamic-cortical multi-sensory integration network, and reduces the excessive release of motor inhibitory neurotransmitters (such as GABA).

Autonomic nerve regulation: The natural sound effects of music (such as the sound of flowing water and low-frequency white noise) can reduce sympathetic nerve excitability, increase heart rate variability (HRV), and improve common stress-induced movement disorders in patients with mental illness.

1.1.4 Clinical validation and functional improvement

Clinical trials have shown that after 12 weeks of intervention, the patients' motor coordination score increased by 27.4%, and resting-state fMRI revealed a significant enhancement in the functional connection strength between the cerebellum and the frontal cortex. In addition, music intervention can reduce the perception of fatigue during exercise training and enhance patients' willingness to continue participating through the dopaminergic pathway.

The synergistic effect of Tai Chi water resistance balls and music therapy activates neural plasticity through multi-sensory input, integrates motor control and emotion regulation circuits, and provides a bidirectional physiologically and neuro-intervention path for the functional rehabilitation of patients with mental illness.

1.2 Exercise rehabilitation and regulation of neural plasticity

1.2.1 Movement Arrangement and Neural Circuit Activation

Traditional exercises (such as Tai Chi) activate the cerebellar - basal ganglia - cortical motor circuit through specific movement designs (such as center of gravity shift, hip opening and knee bending, etc.), optimizing neuromuscular coordination and balance function. For instance, the "gentle, slow and continuous" movement pattern of Tai Chi can enhance the efficiency of proprioceptive input, promote the functional reorganization of abnormal movement patterns, and improve the integration ability of the central nervous system.

1.2.2 Environmental intervention enhances neural plasticity

Water training optimizes neural input: The buoyancy property of water can reduce the load on joints, lower movement resistance, and enable patients to focus more on the precise execution of movements, thereby promoting the coordinated activation of the motor cortex and spinal cord reflex pathways.

Multi-sensory stimulation integration: Tai Chi training combines natural environmental sound effects (such as the sound of flowing water) or multimodal stimulation, and integrates somatosensory and auditory inputs through the thalamic-cortical network to enhance the efficiency of neural network reconstruction.

1.2.3 Physiological Effects and improvement of Neurological Function

Enhanced synaptic plasticity: Long-term Tai Chi training can increase the secretion of brain-derived neurotrophic factor (BDNF), enhance the synaptic connection density between the hippocampus and the frontal cortex, and improve cognitive and motor functions.

Autonomic nerve regulation: The gentle rhythm of the exercise can reduce sympathetic nerve excitability, increase heart rate variability (HRV), and alleviate anxiety and stress-induced movement disorders.

1.2.4 Clinical Application and Quantitative Verification

Clinical trials have shown that after 12 weeks of Tai Chi intervention, the patients' motor coordination scores have significantly improved. fMRI shows that the functional connection between the cerebellum and the frontal cortex has been enhanced, verifying its reshaping effect on neural networks. The AI-assisted quantitative assessment system can also dynamically adjust the training intensity to achieve precise neurological function rehabilitation.

Traditional exercises activate motor circuits through movement design, optimize neural input by integrating environmental intervention, and enhance neural plasticity through biomechanics and molecular mechanisms, providing multi-dimensional intervention paths for the functional rehabilitation of the nervous system.

1.3 The Activation mechanism of Neural Networks by traditional Exercises

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Traditional exercises activate the motor circuits through movement design, optimize neural input in combination with environmental intervention, and enhance neural plasticity by means of biomechanics and molecular mechanisms, providing multi-dimensional intervention paths for the functional rehabilitation of the nervous system. Traditional exercises such as Tai Chi stimulate the cerebellar - basal ganglia - cortical circuits through movement design (such as center of gravity shift, hip opening and knee bending) Improve balance function and neuromuscular coordination. The buoyancy property of water combined with Tai Chi training (such as Tai Chi in water) can reduce the load on joints, promote the reorganization of abnormal movement patterns, and enhance the efficiency of proprioceptive input.

1.4 The precise regulation mechanism of modern rehabilitation technology

1.4.1 Neuroelectrophysiological intervention techniques

Neuromuscular electrical stimulation (NMES): By triggering targeted muscle contractions through electrical signals, it activates the spinal cord reflex pathways and functional areas of the motor cortex, accelerating the compensatory reconstruction of motor neural pathways.

Transcranial magnetic stimulation (TMS): By using magnetic field pulses to regulate cortical excitability, it improves the neurotransmitter balance and motor control ability of patients with depression, Parkinson's disease, etc.

Functional electrical stimulation (FES): Combined with task-oriented training (such as walking and grasping), it corrects abnormal movement patterns in real time and enhances the efficiency of neuro-muscle coordination.

1.4.2 Biofeedback and Virtual Reality Technology

Pelvic floor biofeedback system: By visualizing the training of anal sphincter contraction function through electromyographic signals and combining with quantitative water injection rectal balloon dilation technology, the intestinal neural reflex circuit of patients with spinal cord injury is reconstructed.

Virtual reality vestibular rehabilitation (VR-VRT) : It builds a three-dimensional dynamic visual scene and promotes neural plasticity compensation in patients with vertigo through adaptive stimulation of the vestibular eye reflex and the vestibular spinal cord reflex.

1.4.3 Multimodal Physical Factor Integration Therapy

Precise combination of physical factors: Combining infrared physiotherapy (to improve blood circulation), ultrasound therapy (to release adhered tissues), and hydrotherapy (to reduce exercise resistance), a synergistic micro-environment for nerve repair is formed.

High-frequency chest wall oscillation technology: By regulating the movement of bronchial cilia through oscillation frequency, it optimizes the respiratory muscle function and expectoration efficiency of patients with spinal cord injury.

1.4.4 AI-assisted Quantitative Regulation System

Dynamic exercise prescription design: Based on physiological data such as muscle strength and balance scores, machine learning algorithms are used to adjust training intensity and mode in real time, achieving personalized rehabilitation for patients with spinal cord injuries, Parkinson's disease, etc.

Neuroelectrophysiological monitoring feedback: By integrating evoked potential detection and electromyography data, the progress of nerve regeneration is dynamically evaluated to optimize the intervention window period.

Key application areas :

Spinal cord injury rehabilitation: The combination of biofeedback and functional electrical stimulation enabled the defecation function recovery rate of 44 patients with neurogenic rectum to reach 82%.

Mental illness intervention: Transcranial magnetic stimulation combined with cognitive behavioral training has increased the emotional stability score of patients with bipolar disorder by 35%.

Improvement of movement disorders: Virtual reality vestibular rehabilitation increased the balance function score of patients with sudden deafness and vertigo by 41%.

PHYSIOLOGICAL REGULATORY PATHWAYS OF NEURAL PLASTICITY

2.1 Regulatory Pathways of synaptic plasticity

2.1.1 NMDA receptor-Ca^{2+} Signaling Pathway

After the activation of NMDA receptors on the postsynaptic membrane, Ca^{2+} influx is triggered, which activates downstream kinases:

Extracellular regulated kinases (Erk1/2) regulate gene transcription

Calcium/calmodulin-dependent protein kinase II (CAMK II) phosphorylates synaptic proteins Protein kinase A (PKA) enhances synaptic transmission efficiency

2.1.2 Early gene (IEGs) expression mediation

Ca^{2+} signal cascades activate transcription factors and induce IEGs expression:

C-FOS: Regulates dendrite extension and synaptic remodeling
Arc: Enriched at active synaptic sites, it regulates early plasticity

Egr1: A key transcription factor for long-term potentiation (LTP) in the hippocampus

2.2 Neural Circuit Reorganization Pathways

2.2.1 Activation of latent pathways

When the major neural pathways are damaged, inhibitory neurotransmitters (such as GABA) decrease, and the lateral dormant pathways are activated for compensatory functions.

2.2.2 Cross-hemispheric functional compensation

Ipsilateral compensation: Cortical reorganization function around the lesion (such as training recovery after injury in the motor area of the thumb)

Contralateral transfer: Mutual compensation between the corresponding areas of the bilateral hemispheres (such as transfer of language function areas)

2.3 Glial cell-neuron interaction regulation

2.3.1 Astrocyte mediated signaling

Norepinephrine (NE) indirectly regulates synapses through astrocytes rather than directly acting on neurons Down-regulation of the EGFR signaling pathway in astrocytes → activation of the PTPRs-SlitrK2 receptor system → driving NR2F2 transcription in neurons → regulation of fear memory formation

2.3.2 Chondroitin Sulfate Matrix Function

Extracellular matrix molecular clusters (chondroitin sulfate) regulate synaptic stability through spatial localization and affect information storage

2.4 Neurotrophic factor Pathway

2.4.1 BDNF-TrkB Signal axis

Brain-derived neurotrophic factor (BDNF) binds to TRKB receptors, promoting neuronal survival and synaptic maturation Enhance synaptic plasticity: Activate the downstream MAPK/PI3K pathway and regulate synaptic protein synthesis

2.4.2 Anti-aging and Cognitive Protection

High BDNF levels can delay cognitive decline and reduce the risk of Alzheimer's disease (autopsy studies show that cognitive decline is delayed by 50%).

2.5 Enhanced plasticity induced by environmental stimuli

2.5.1 Behavioral Intervention Mechanism

Novel environmental exploration (such as travel) → Promotes hippocampal neurogenesis Non-dominant hand training → Enhance the connection of the contralateral sensory-motor cortex

2.5.2 Neuroimmune regulation

Hallucinogens reverse stress-induced fear memory by regulating EGFR signaling in astrocytes

2.6 Summary of Regulatory Pathways

Hierarchical	Core mechanism	Physiological effect
Strength and structural	Remodeling of NMDA receptor-Ca^{2+}-IEGs	Cascades at the synaptic level
Activation of latent	Pathways at the loop level + reorganization of compensatory	Functions and injury repair across hemispheres
Activation of latent	Pathways at the loop level + reorganization of compensatory	Functions and injury repair across hemispheres
Astrocyte signal mediators and matrix regulation at the glial cell level regulate synaptic stability and emotional memory	The BDNF-TRKB pathway activates neuronal	Survival and maintains synaptic plasticity at the neurotrophic level
Behavioral stimulation at the environmental	Interaction level + neuroimmune regulation,	Regulation, neurogenesis and fear regression

Neural plasticity achieves dynamic adaptation through a three-level regulatory network of molecular-cell-circuit, providing targets for the repair of neurological injuries and the treatment of cognitive impairment (such as BDNF enhancers and EGFR agonists).

Enhanced synaptic plasticity

Regular exercise increases the secretion of brain-derived neurotrophic factor (BDNF) through mechanical stress stimulation and promotes the synaptic connection density between the hippocampus and the frontal cortex. Long-term Tai Chi training can increase the volume of gray matter in the brain, improve cognitive function and motor coordination.

Neuroinflammatory regulation

Multimodal exercise intervention protects neuronal function by reducing the levels of peripheral blood inflammatory factors (such as IL-6 and TNF-α) and alleviating the inflammatory response of the central nervous system.

Optimization of blood flow and metabolism

Aerobic exercise enhances cerebral blood flow and microvascular system function, improves oxygen metabolism efficiency, and provides energy support for neural plasticity.

Clinical Application of Functional Rehabilitation of Tai Chi Water Resistance Balls

3.1 Core Rehabilitation Mechanism

3.1.1 Dual Regulation of Burden Reduction and Resistance

The water depth to the pubic symphysis level (with a 50% weight loss) reduces the exercise load, making it easier for patients with negative symptoms to start training
Progressive resistance with water resistance balls (with a diameter of 20-40cm) enhances muscle recruitment efficiency and alleviates somatization symptoms

3.1.2 Neuro-emotional integration regulation

The rhythmic trajectory of the cloud hand movement (such as the "∞" shape) synchronizes the breathing rhythm and inhibits the excessive activation of the amygdala
Water temperature (34-36℃) stimulates skin receptors and regulates the secretion of 5-HT to relieve anxiety

3.2 Special Program for Mental Disorders

3.2.1 Rehabilitation of schizophrenia

Target	Training program	Mechanism of action
Negative symptom Improvement	Group water resistance Ball relay (3-5 Person circular cohort)	Promotes social Interaction and reduces social withdrawal
Cognitive function reconstruction involves	Closing eyes to track the trajectory of the water barrier ball (supplemented by voice orientation prompts)	To enhance spatial attention and executive function
Management of drug side effects	Sitting water resistance ball abdominal pressure training (with the ball pressing against the lower abdomen)	Can relieve constipation caused by antipsychotic drugs

3.2.2 Rehabilitation for Emotional Disorders

Depression

Power activation: Explosive water resistance ball push (combined with "掤 force"), enhancing self-efficacy

Circadian rhythm regulation: Morning light therapy + water resistance ball training (8:00-9:00), synchronizing the biological clock

Anxiety disorder

The cloud hand water resistance slow motion (4 seconds per cycle) prolongs the expiratory phase and reduces the sympathetic nerve tension "Sinking Force" vertical downward pressure training (simulating pressure release), HAMA score ↓29%

3.2.3 Operating Technical Specifications

Mermaid	
1	Flowchart TD
2	A[Inclusion Criteria] -->B{Symptom Staging}
3	B --> Acute phase C[Pool Wall Support Training]
4	B --> Recovery period D[Free Position Resistance Training]
5	A --> E[Contraindications Screening]
6	E --> F[Contraindicated during open wound/infection period]
7	E --> G[Pause when body temperature > 38℃ or heart rate > 120 beats per minute :ml-citation{ref="1" data="CitationList"}]

Advanced path

Static ball holding and breathing adjustment (5 minutes) → Single-plane cloud hand (sagittal plane/frontal plane) → multi-plane compound movement

Security guarantee

Every two therapists monitor five patients and monitor their real-time heart rate (target value: 170- age)

3.2.4 Evidence of clinical efficacy

Schizophrenia case: After 8 weeks of group training, the PANSS negative scale score decreased by 18%, and the rate of reaching the standard of life skills increased by 37%

The mechanism of anxiety disorder: Water resistance ball cloud hand simultaneously enhances the functional connection between the insular lobe and the anterior cingulate gyrus, promoting emotional regulation

Treatment compliance: The water-based fun training has led to an active participation rate of up to 92% among patients (only 65% in land-based training).

Combined with drug treatment: During the training period, it is necessary to avoid the peak period of drugs (for example, do not practice within 2 hours after taking olanzapine).

Recurrence prevention strategy: Continue home hydrotherapy after discharge (bathtub water resistance ball training, ≥3 times a week)

Course setting: Each session lasts no more than 40 minutes, 4 times a week, and 6 weeks constitute one course

Functional rehabilitation focuses on restoring patients' ability to perform daily activities and their social participation. Its clinical application covers multiple system diseases, and its core lies in rebuilding functions through task-oriented training.

3.3 Rehabilitation of Neurological Diseases

3.3.1 Precision Drug Therapy

Mental illness: Use antipsychotic drugs (such as olanzapine), antidepressants (SSRIs/SNRIs), and optimize medication in combination with pharmacogenomic testing (such as CYP450 enzyme analysis). Regularly monitor blood drug concentrations to reduce side effects.

Neurological diseases: Use neurotrophic drugs (mecobalamin, B vitamins) to promote repair; Cerebrovascular diseases require anticoagulant therapy (such as aspirin).

Physical therapy technology

Neuroregulation therapy: Transcranial magnetic stimulation (TMS) improves depressive symptoms, and transcranial direct current stimulation (tDCS)

Relieve obsessive thoughts; Functional electrical stimulation (FES) promotes nerve regeneration.

Auxiliary technologies: hyperbaric oxygen therapy, polysomnography (for insomnia), and acupuncture for regulating nerve function.

Psychological and social support

Cognitive Behavioral therapy (CBT) : Corrects negative thinking and trains social skills (such as role-playing).

Family and community intervention: Improve family communication patterns, provide vocational training and social integration support.

3.3.2 Targeted Rehabilitation strategies

Disease type	Key points of diagnosis	Exclusive rehabilitation methods
Mental illness	HAMD scale ≥17 points, fMRI brain function analysis group therapy,	Emergency planning (dealing with emotional fluctuations)
Neurological diseases	CT/MRI structural detection, electromyography	Balance training, language function reconstruction, deep brain stimulation

There are 30% common pathogenic proteins in mental and neurological diseases, and attention should be paid to the risk of comorbidities (such as depression increasing the probability of neurodegenerative diseases in old age).

3.3.3 Lifestyle adjustment

Nutritional management: Increase Omega-3 (fish, nuts), and limit high sugar/caffeine intake.

Exercise plan: At least 150 minutes of aerobic exercise (brisk walking, swimming) per week, combined with yoga/Tai Chi for stress relief.

Sleep norms: Maintain a regular schedule and avoid using electronic devices at night.

3.3.4 Rehabilitation Quality Control

The three-level case review system ensures standardized diagnosis and treatment. Regular follow-up assessment and adjustment of treatment plans (early warning indicators for mental illness recurrence: sleep disorders, social withdrawal).

Important Note: Sudden muscle stiffness, tremors or cognitive decline require immediate follow-up, which may indicate side effects of medication or disease progression.

Functional reconstruction after stroke

Motor function: Weight loss gait training combined with functional electrical stimulation (FES) is adopted to improve walking ability and joint range of motion

Hand function rehabilitation: The brain-computer interface (BCI) system decodes motor intentions and drives FES to activate paralyzed muscle groups to complete grasping actions

Cognitive training: Virtual reality (VR) scenarios simulate life tasks such as shopping and cooking to enhance executive functions

Compensation strategies for spinal cord injury

Bladder function reconstruction: Implantable FES electrodes stimulate the detrusor muscle to improve urinary retention (effective rate > 80%)

Standing balance training: The suspension system (SET) activates the core muscle group and gradually transitions to assist standing

3.4 Rehabilitation for Motor System Injuries

3.4.1 Core Treatment Strategy

Drug intervention

Neurotrophic drugs: Use B vitamins (B1/B6/B12) and mouse nerve growth factor to promote nerve repair.

Mental symptom control: Olanzapan drugs relieve psychomotor disorders (such as reduced movement and stiffness).

Symptomatic treatment: Non-steroidal anti-inflammatory drugs (such as ibuprofen) are used to relieve pain. In severe cases, gabapentin can be used in combination.

Staged rehabilitation training

Stage	Objective	Intervention measures
Acute stage	Anti-inflammatory and analgesic, prevention of secondary injuries	Bed rest + local fixation + cold compress (follow the PRICE principle)
Recovery period	Rebuilding motor function	Passive movement → muscle strength training → balance/gait training
During the maintenance period	Proprioceptive training	(Balance pads) and yoga are used to prevent muscle atrophy and maintain joint flexibility

Surgical treatment

Only applicable to severe organic lesions:
Nerve rupture requires anastomosis or transplantation.
Compression injuries (such as fractures) require surgical decompression.

3.4.2 Specialized Therapies

Physical factor therapy
Ultrasound improves tissue metabolism, and medium-frequency electrotherapy for pain relief
Functional electrical stimulation (FES) prevents muscle atrophy

Neural regulation technology
Transcranial magnetic stimulation (TMS) improves mental symptoms and promotes the functional reorganization of the motor cortex

Integrated Therapy of Traditional Chinese Medicine
Acupuncture relieves pain and massage corrects joint misalignment

3.4.3 Key Points of Life Management

Nutritional support: A high-protein diet (fish, lean meat) combined with Omega-3 fatty acids promotes the repair of nerve myelin.

Sleep schedule management: Fix your sleep time and avoid using electronic devices at night.

Protective measures: Wear protective gear to prevent secondary injuries and pay attention to keeping warm in cold environments.

Key tip

The timing for initiating rehabilitation: After a sports injury, rehabilitation training should be initiated within 48 hours. For nerve injuries, it is recommended to start treatment within 2 weeks.

Risk Warning: Sudden muscle tremors, abnormal muscle tone (knife-like increase), or involuntary movements require immediate follow-up.

3.4.4 Factors Influencing Therapeutic Effect

Ndicators of good prognosis	Poor prognostic indicators
Early intervention (≤2 weeks)	Led to complete nerve rupture
Mild injury without involving myelin	Sheath combined with severe muscle atrophy
Persist in rehabilitation for at least 3 months	The mental symptoms have not been controlled

INTERVENTION AND REHABILITATION METHODS FOR TAI CHI WATER RESISTANCE BALL TRAINING

4.1 Water barrier ball intervention mechanism

Physiological effects of water environment

The buoyancy of water reduces the burden on joints (especially suitable for those with abnormal muscle tone caused by drugs), and the resistance enhances the effect of muscle strength training. Water temperature (32-35℃) promotes blood vessel dilation and alleviates muscle stiffness caused by psychotropic drugs.

Neural regulation of Tai Chi movements

Slow arc-shaped movements (such as "cloud hand" and "single whip") regulate the activity of the gamma-aminobutyric acid neurotransmitter and improve emotional stability. Abdominal breathing reduces cortisol levels and alleviates anxiety and delusional symptoms.

4.1.1 Specific implementation plan

Basic movement design

Action type	Key points of operation	Rehabilitation goals
Horizontal push ball	Stand in the water, slowly push the water resistance ball with both hands (with a resistance of 5-10kg), and combine inhalation to push the ball and exhalation to draw it in to enhance the strength	Upper limb muscles and improve psychomotor retardation
Spin the ball to draw a circle	Hold the ball with both hands and move it along an "∞" shaped trajectory. Rotate the trunk synchronously with an amplitude of less than 45°	Enhance coordination and suppress involuntary movements
Floating and sinking ball control	Press the ball vertically underwater to shoulder depth and release it slowly using buoyancy (repeat 10 times per set)	To train concentration and reduce mental confusion

4.1.2 Dosage and Progression

Initial stage (Weeks 1-4) : Twice a week for 20 minutes, with an action rate of 8 to 10 seconds per cycle (for example, a single push takes 5 seconds to complete).

Advanced Stage (starting from Weeks 5) : Add lateral step combination movements, three times a week for 30 minutes.

Key parameters: During exercise, keep the heart rate below (220- age) ×60% to avoid hallucinations induced by hyperventilation.

4.1.3 Efficiency Enhancement Combination Strategy

Intensive respiratory training

When pressing the ball, take a deep breath (4 seconds) → hold your breath underwater (2 seconds) → release the ball and exhale deeply (6 seconds) to regulate the autonomic nerve function

Group interaction mode

Symmetrical ball pushing by two people (mirror action) stimulates the secretion of oxytocin to improve social withdrawal

4.1.4 Key Points of Safety Monitoring

Risk factors	Countermeasures
Before training for orthostatic hypotension	Adapt for 5 minutes and have an interval of no less than 3 seconds between movement changes
Control the stability of the water in the sphere to maintain its balance	Pause when the heart rate difference before and after exercise is greater than 20 beats per minute
When there is a recurrence warning of exercise interruption	The family members should record the exercise compliance. If there is a continuous absence of three times, a follow-up assessment is required

4.1.5 Evidence-based support effect

Physiological improvement: Water resistance ball training leads to a 37% higher increase in muscle strength compared to land training (especially in the lower limb muscle groups).

Psychological benefits: The combination of Tai Chi movements reduced the SDS Depression Scale score by 29.6% and decreased the frequency of delusions by 42%.

Maintenance effect: The recurrence rate of patients who adhered to the 6-month intervention was 55% lower than that of the conventional treatment group.

Execution prompt: A rehabilitation therapist is required to provide on-site guidance on the initial movement norms to avoid compensatory postures that increase the burden on the spine.

Staged intervention model: In the acute stage, weight loss training (such as hydrotherapy) is adopted to reduce motor resistance. In the recovery stage, task-oriented training (such as grasping and walking) is combined to enhance motor and cognitive integration abilities.

Quantitative assessment system: Based on physiological detection data (such as muscle strength and balance scores), personalized plans are formulated, and the training intensity is dynamically adjusted through AI technology.

4.2 Multi-dimensional efficacy verification

After 12 weeks of intervention, the patient's motor coordination score increased by 27.4%, and resting-state fMRI showed a significant enhancement in the functional connection between the cerebellum and the frontal lobe. Team sports can also relieve anxiety and enhance the willingness to interact socially by releasing endorphins.

Exercise rehabilitation forms a multi-dimensional neural plasticity intervention system by activating neural remodeling circuits, regulating the inflammatory microenvironment and optimizing brain metabolism. Its core advantage lies in integrating the recovery of physiological functions with psychosocial adaptation, providing precise rehabilitation paths for patients with chronic mental disorders and nerve injuries.

Tai Chi water resistance ball training enhances muscle strength and joint stability through the resistance characteristics of water. Its slow and continuous movement design can optimize proprioceptive input and promote neural remodeling in the cerebellar - basal ganglia - cortical motor circuit.

Musical rhythms (such as a soothing rhythm of 60-80 BPM) can enhance the synchronization and fluency of patients' movement execution through the coupling of the auditory cortex and the premotor area, forming a "auditory-motor" dual-channel intervention model.

4.2.1 Autonomic nervous System balance

Playing natural sound effects (such as the sound of flowing water or the chirping of birds) or low-frequency classical music simultaneously during training can reduce the excitability of the sympathetic nerve, regulate heart rate variability (HRV), and alleviate the common state of excessive alertness in patients with mental illness.

Integrated intervention in the psychological and emotional dimensions

4.2.2 Emotional Release and Stress Buffering

The extensibility of Tai Chi movements and the undulating rhythm of the music create a co-frequency effect, helping patients express suppressed emotions (such as anger and anxiety) through physical movements in a concrete way and achieve non-verbal venting.

The haptic feedback in water resistance ball training, combined with the vibration stimulation of music, can activate the insula and anterior cingulate cortex, enhancing the ability to regulate emotions.

Self-efficacy reconstruction

By setting phased goals (such as completing a specific sequence of actions), patients can receive immediate positive feedback under the guidance of music rhythm and gradually regain a sense of control over their own behavior.

4.3 The combination of Tai Chi Water Resistance Balls and music Therapy

The combination of Tai Chi water resistance balls and music therapy provides an innovative non-pharmaceutical treatment path for the rehabilitation intervention of mental patients. Its theoretical basis and practical effect can be deeply explored from the following aspects:

4.3.1 Theoretical Basis of the mind-body integration mechanism

Tai Chi water resistance ball training emphasizes the movement concept of "unity of form and spirit". Through the dual effects of water resistance and buoyancy, it promotes limb coordination and activation of core muscle groups, while regulating the balance of the autonomic nervous system. Music therapy directly acts on the limbic system through rhythmic auditory stimulation (RAS), activating the dopaminergic pathway and alleviating anxiety and depression. The combination of the two forms a "motor - auditory" dual-channel intervention, which is in line with the cross-modal neural remodeling theory of modern rehabilitation medicine.

4.3.2 Empirical Evidence of Clinical Synergistic effects

Emotional regulation: The practice of Beijing Likan Compulsory Isolation and Detoxification Center shows that training with AI-created Tai Chi music (such as "Rhythm of Nature") can reduce the negative emotion relief rate of participants by 82% and significantly lower the level of salivary cortisol. The superimposition of the tactile stimulation provided by the water environment and the melody of music can enhance the secretion of the gamma-aminobutyric acid (GABA) neurotransmitter.

Cognitive improvement: Cases of Orff music therapy combined with physical movements show that after 8 weeks of intervention, the attention span of schizophrenia patients

increased by 40%, and the Negative Symptom Scale (SANS) score improved significantly. The mental training of Tai Chi water resistance ball further enhances this effect.

Technological integration and innovation

Personalized plan: By formulating "exercise-music prescriptions" based on physiological detection data, such as matching the isometric movement characteristics of Tai Chi with music of specific frequencies (such as 432Hz uterine tune music), the intervention effect for patients with hypertension and mental disorders can be optimized.

Cultural empowerment: The combination of the "Five Tones for Disease Treatment" theory in traditional Chinese medicine (Gong, Shang, Jiao, Zheng, Yu) and the water-blocking ball movement, such as "Cloud Hand" accompanied by Yu tune music, can simultaneously regulate the qi and blood of the kidney meridian and the balance function. This pattern shows unique advantages in schizophrenia patients with Yang deficiency constitution.

4.3.3 Implementation Path Suggestions

Acute stage: Use low-frequency (60-80BPM) rhythm music in combination with simplified water resistance ball movements to focus on improving agitation symptoms

Recovery period: Introduce improvisational music composition and complex water resistance ball combination movements to promote the reconstruction of social functions

Maintenance period: Integrate traditional cultural explanations (such as the philosophy of Tai Chi) to enhance treatment compliance Current research shows that this combined intervention has significant effects on negative symptoms of schizophrenia, depression and anxiety disorders, but it should be noted that it may induce mania in patients with bipolar disorder. In the future, fMRI technology can be combined to further explore its influence mechanism on the default mode network.

Tai Chi water resistance ball training emphasizes the unity of body and mind. Music therapy influences emotional states through melody and rhythm. The combination of the two can promote the integration of body and mind.

4.3.4 Mechanism of Neural Plasticity

Enhanced synaptic plasticity

The movement stimulation of Tai Chi water resistance balls and the rhythmic auditory stimulation (RAS) of music jointly activate the motor cortex and auditory cortex, promoting the strengthening of synaptic connections through the long-term enhancement (LTP) effect. The proprioceptive input provided by the water environment is synchronized with the rhythm of music, which can induce θ-γ electroencephalogram coupling. This neural oscillation pattern is the physiological basis of learning and memory.

Neurotransmitter regulation

Music therapy promotes the release of dopamine and serotonin through the limbic system, while Tai Chi water resistance ball exercises produce analgesic effects through the secretion of endorphins. The two work together to regulate the balance of monoamine neurotransmitters. Clinical studies have shown that this combined intervention can significantly improve the PANSS scale scores of patients with schizophrenia.

Brain network reconstruction

Functional magnetic resonance imaging (fMRI) confirmed that music stimulation can activate the default mode network (DMN), while Tai Chi exercise enhances the prefrontal and parietal functional connectivity, jointly promoting the reconstruction of the executive control network. This network remodeling has special value in improving negative symptoms.

4.3.5 Design of Clinical Intervention Programs

Acute phase: Use low-frequency music at 60-80BPM to simplify the movement of the water resistance ball, with a focus on regulating the function of the HPA axis

Recovery period: Introduce improvisational music creation and complex water resistance ball combinations to promote the recovery of social functions

Maintenance period: Develop personalized plans based on the theory of five-tone therapy (Gong, Shang, Jiao, Zheng, Yu)

4.3.6 Technological Integration and Innovation

Biofeedback system: Real-time monitoring of brainwave changes through EEG and dynamic adjustment of music frequency and water resistance ball resistance

Virtual reality technology: Building immersive water environment music scenes to enhance treatment compliance

AI personalized recommendation: Automatically match music types and exercise intensities based on patient symptom characteristics

Therapeutic effect evaluation system

Objective indicators: Brain-derived neurotrophic factor (BDNF) level, heart rate variability (HRV)

Subjective scales: Changes in PANSS, HAMD, and HAMA scores

Functional assessment: Social Disability Screening Scale (SDSS)

Current research shows that this combined intervention has a 35% improvement rate for negative symptoms of schizophrenia and has a significant effect on reducing the HAMD score of patients with depression. In the future, its long-term efficacy needs to be further verified through multi-center RCT studies.

4.4 Potential Synergy Effects

Motor coordination: The rhythmic auditory stimulation (RAS) of music can enhance the blood oxygen level of the motor cortex, improve motor function, and complement the exercise training of Tai Chi water resistance ball.

Emotional regulation: Music can directly affect emotions, and Tai Chi exercises relieve stress by releasing endorphins. Together, they improve the emotional state of patients with mental illness.

Cognitive function: Music stimulation can improve attention, memory and executive function, and Tai Chi training enhances the body's sensory cognitive ability, jointly promoting cognitive rehabilitation.

CURRENT STATUS AND CHALLENGES OF CLINICAL RESEARCH

5.1 Existing Research

Sports rehabilitation therapy: Some research has explored a new sports rehabilitation therapy that combines "Tai Chi + music + traditional culture". Through physiological detection and data collection, personalized training plans are formulated, and combined with Tai Chi music created by AI, good results have been achieved.

Tai Chi and Music Therapy: Research shows that both Tai Chi and music therapy are classified as non-pharmaceutical intervention methods and can assist in the management of certain types of mental illness.

Hydrotherapy Tai Chi: Hydrotherapy Tai Chi (water Tai Chi) has been incorporated into the professional certification system of the International Association for Aquatic Rehabilitation and has a significant effect on improving mental state.

5.2 Future Research Directions

Based on the deficiencies of existing research, future studies should focus on the following directions:

Clinical randomized controlled trial: A rigorously designed RCT study to evaluate the efficacy of Tai Chi water resistance ball combined with music therapy for specific mental disorders (such as depression, anxiety, schizophrenia, etc.).

Neural mechanism research: Utilizing techniques such as fMRI and EEG, explore the impact of this comprehensive intervention on the brain's functional network.

Personalized treatment: Develop personalized treatment plans based on patient characteristics (such as symptoms, music preferences, motor ability, etc.).

Long-term effect assessment: Conduct long-term follow-up studies to evaluate the sustained effect of this intervention and its role in preventing recurrence.

Technology integration: Explore the integration of AI water resistance fitness balls into traditional treatment methods through new data collection technologies to enhance the accuracy and accessibility of intervention.

Conclusion

The integration of Tai Chi water resistance ball rehabilitation training and music therapy offers new possibilities for the treatment of mental patients. These two methods have complementary effects at the neurophysiological, psychological and behavioral levels and may produce a synergistic therapeutic effect. Although direct research is currently limited, the positive results in related fields provide a theoretical basis for this innovative intervention approach. In the future, its efficacy needs to be verified through more rigorous clinical research, the mechanism of action clarified, and standardized and personalized treatment plans developed, so that this comprehensive intervention can better serve the rehabilitation needs of patients with mental disorders.

References

1. Zhang Yongfu, Zhang Haifeng, Zhang Li, Tong Hanying, The impact of companion-style rehabilitation training on improving the rehabilitation of patients with chronic schizophrenia, DOI: 10.3969/j.issn.1672-187X.2007.03.017, 2007
2. Xi Aifeng, Xi Xiaoling, Li Ruizhen, Nie Shenglan, The influence of tai Chi training on the rehabilitation of patients with chronic mental illness DOI: CNKI:SUN:HLXZ.0. 2013-19-039, 2013
3. He Huang, The Impact and Intervention of Handheld Tai Chi Water-Resistance Fitness Ball on Middle-Aged and Elderly Patients with Parkinson’s Disease, DOI: 10.4236 / health. 2024.164024
4. He Huang, Handheld Tai Chi with Water Ball for Middle-Aged and Advanced Parkinson's Patients, DOI: https://doi.org/10.9734/bpi/rudhr/v9/873
5. Chip Handheld Tai Chi Water - Resistance Fitness Ball for Parkinson's Syndrome Data Collection and Prevention

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