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Research on the Influence of Physical Training on Sensory Integration Rehabilitation of Autistic Children

--A Case Study of yibin Special Education School

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Abstract

Research Objective: This paper mainly studies the influence of physical training on sensory integration rehabilitation of autistic children in yibin Special Education School. Surveys indicate that autistic children frequently suffer from sensory integration dysfunction. As a non-pharmacological intervention, physical training plays a vital role in improving their sensory integration capabilities. Targeted physical training can enhance autistic children's multiple sensory systems including vestibular sense, proprioception, tactile sense and visual sense, helping them achieve better daily living and self-care abilities. Research Subjects: The research focuses on the impact of physical training on sensory integration rehabilitation of autistic children. Research Methods: Multiple research approaches are adopted in this paper, including literature review, experimental method, questionnaire survey, and mathematical statistics. Thirty autistic children with varying severity of symptoms are divided into two groups with 15 children each. Changes in scores recorded by the Child Sensory Integration Ability Assessment Scale and the Sensory Integration Measurement Scale before and after training, as well as collected questionnaires on training performance, are analyzed for research purposes. Research Results: After 12 weeks of physical training, all 15 autistic children in the experimental group showed varying degrees of improvement in sensory integration ability. During training, physical training not only boosts autistic children's vestibular, proprioceptive, tactile and visual integration abilities, but also facilitates language training. Coaches adopt the training mode of "movement perception – language correspondence – repetitive reinforcement" during teaching to improve children's verbal expression skills. Research Conclusions: As a non-pharmacological intervention, integrating physical training into sensory integration rehabilitation for autistic children at yibin Special Education School exerts a positive influence on their sensory integration recovery.

Keywords

Autistic Children; Physical Training; Sensory Integration Rehabilitation; yibin Special Education School.

1. Preface

Globally, the incidence of autism spectrum disorder (ASD) is rising at an alarming rate.World Health Organization (WHO) data shows that the global ASD incidence rate stands at approximately 1.85%, with a growth of over 200% in the past 20 years.In China, the number of autistic patients has exceeded 13 million, increasing by nearly 200,000 annually, ranking autism as the leading mental disability.Autistic children are often accompanied by sensory

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integration dysfunction, which severely impairs their daily lives, social interaction and cognitive development, manifested as bizarre behaviors and poor self-care skills, imposing a heavy burden on families and society.

With the advancement of national policies such as the Healthy China 2030 Plan Outline and the Sports Power Construction Outline, physical training, a core method to improve public physical fitness, has attracted widespread attention.Beyond enhancing physical health, physical training also plays a key role in disease prevention and sports rehabilitation.For autistic children, physical training serves as an effective non-pharmacological intervention to alleviate sensory integration dysfunction and promote physical and mental development.

While yibin Special Education School provides educational support for autistic children, it lacks targeted physical training programs designed for their sensory integration rehabilitation. Focusing on autistic children at yibin Special Education School, this study explores how physical training impacts their sensory integration recovery.Using scientific research methods to evaluate the intervention effects of physical training, this paper intends to provide theoretical references and practical guidance for physical education and rehabilitation training in special education schools, and contribute to the advancement of sensory integration rehabilitation for autistic children.

2. Introduction

2.1. Research Background

According to WHO statistics, ASD affects around 1.85% of the global population, and has become one of the fastest-growing neurodevelopmental disorders over the past two decades.Data from the 2023 China Disability Census Report released by the China Disabled Persons' Federation shows that China has more than 85 million people with disabilities, among which autistic patients exceed 13 million, with an annual increase of nearly 200,000, topping the list of mental disabilities.National documents including the 14th Five-Year Plan for the Protection and Development of Persons with Disabilities and the Special Education Improvement Plan (2021–2025) emphasize the development of preschool special education and early provision of educational and rehabilitation services for children with special needs.Joint implementation plans issued by multiple national departments will further strengthen care services for autistic children and launch autism support initiatives between 2024 and 2028.

Policies such as the Healthy China 2030 Plan Outline and the Sports Power Construction Outline explicitly advocate research on scientific training, incorporating physical training into national strategic planning as a fundamental component of national fitness and competitive sports.The Ministry of Education promotes the integration of physical education and academic learning, calling for standardized and scientific physical training in school physical education curricula, with existing research covering youth physical fitness assessment and training model innovation.Widely recognized by the state and society as a non-pharmacological intervention, physical training improves autistic children's physical fitness and mental health, alleviates negative emotions, boosts self-confidence, and facilitates cognitive development through enhanced sensory integration.

International studies report that 70%–90% of autistic children present sensory integration dysfunction, a proportion supported by domestic research published in the Chinese Journal of Child Health Care.It is projected that China will have 230 million children by 2025, among whom roughly 2.3 million will be autistic, and around 1.8 million autistic children will experience sensory integration dysfunction.Physical training effectively intervenes in sensory processing abnormalities among autistic children, reducing problematic behaviors and self-care deficits by integrating multi-sensory functions through diverse physical activities.

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According to institutional databases from the Autism Home Network, yibin City, Sichuan Province operates three special education schools: yibin Special Education School, Naxi District Special Education School and Hejiang County Special Education School.This research targets autistic children at yibin Special Education School.While the school delivers specialized education and regular sports activities, it lacks targeted physical training programs for autistic children with sensory integration dysfunction.The findings of this study offer references for designing physical training-based sensory integration rehabilitation programs for local special education schools.

2.2. Research Significance

2.2.1. Theoretical Significance

Thirty autistic children meeting research criteria in small and medium-sized cities like yibin, all diagnosed by Grade A tertiary hospitals and with full parental consent to participate in physical training, form the research sample.By measuring improvements in participants' vestibular sense, proprioception, tactile sense, visual and auditory perception throughout training, this study verifies the positive effects of physical training on sensory integration rehabilitation.All 15 children in the experimental group demonstrated measurable improvements in sensory integration capacity after intervention.The results provide theoretical foundations for developing sensory integration rehabilitation programs utilizing physical training for autistic children at yibin special education institutions.

2.2.2. Practical Significance

This research systematically analyzes how physical training facilitates sensory integration rehabilitation among autistic children at yibin Special Education School.Beyond improving physical function, physical training mitigates autistic children's social barriers and strengthens self-care skills by enhancing sensory integration, supporting their daily learning and life adaptation.This paper delivers practical, effective physical rehabilitation training methods and evidence-based systematic training plans for autistic children enrolled at yibin special education schools.

3. Literature Review

3.1. Concept Definition

Autism, also known as autistic spectrum disorder, refers to a pervasive developmental disorder with onset in early childhood.Physical training refers to systematic physical activities designed to improve physical quality and motor ability, covering strength, endurance, speed, flexibility, coordination, agility and balance.Classified by training objectives, age groups, sports events, intensity and training forms, physical training includes aerobic, anaerobic and mixed training.It must adhere to principles of gradual progression, individualization, diversity and rest recovery to achieve optimal outcomes.This study adopts low-to-moderate intensity physical training tailored to autistic children's age characteristics.

Sensory integration training is a corrective intervention method that uses specialized exercise equipment to deliver targeted sensory and motor training through game-based physical activities.It aims to improve autistic children's sensory processing capacity via structured sensory stimulation, thereby enhancing daily living and social skills.Training targets include improved sensory processing, motor skills, social interaction and self-care, covering vestibular, proprioceptive, tactile, visual and auditory stimulation.

3.2. Domestic Research Review

Domestic studies consistently confirm a positive correlation between physical training and sensory integration rehabilitation for autistic children, yet relevant research remains limited.A

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CNKI literature search yields 19,000 papers on physical training (856 Peking University core journal articles, 484 CSSCI papers), while only 8 papers simultaneously address physical training and autistic children.On the VIP database, 16,000 papers focus on autistic children, with merely 40 exploring physical training for their sensory integration rehabilitation.Existing research confirms that sensory integration training effectively alleviates stereotypical behaviors in autistic children.

3.2.1. Research on the Current Status of Autistic Children

Research on rehabilitation development for autistic children: Xu Yun, Yang Jian and Ji Lingzhi (2018) noted that domestic exploration of autism rehabilitation only began to develop in the mid-1990s, relying initially on empirical trials and foreign models.Lin Yunqiang (2018) found that autism is not always a lifelong condition;early diagnosed children receiving appropriate intervention may eventually meet standard developmental benchmarks and achieve normal social adaptation, reaching the so-called “coptimal outcome”.

Research integrating sensory integration intervention into autism rehabilitation: Song Xiaohong (2024) proved sensory integration training enhances autistic children’s sensory processing and reduces sensory defensiveness and anxiety.Wang Meixue (2021) developed interactive design strategies and evaluation systems for somatosensory games in autism rehabilitation.Zhang Yanmin and Shang Qing (2018) demonstrated that combining sensory integration training with conventional intervention produces synergistic effects, more effectively alleviating sensory dysfunction and associated behavioral problems than single intervention methods.

3.2.2. Research on Physical Training for Autistic Children’s Sensory Integration Rehabilitation

Research on physical training promoting autistic children’s physical and mental development: Liu Xucheng (2024) verified that physical training comprehensively boosts children’s sensory integration, physical health and social adaptability.Wu Keke (2022) found physical training improves physical fitness, social skills and participation motivation among autistic children.Liu Xin (2021) argued physical training cultivates perseverance and generates cascading improvements in psychological well-being, calling for sufficient human and material resources to sustain children’s physical training program.

Research specifically linking physical training and sensory integration rehabilitation: Early sensory integration curricula featured limited activities and equipment;recent scholars have combined sports intervention with sensory training.Nanjing Sport Institute’s practical programs verified positive intervention outcomes of sports-based therapy.Mao Chenrui (2022) found autistic children exhibit overall underdeveloped motor skills with age-inappropriate movement deficits, which physical training significantly ameliorates, improving fundamental motor skills and coordination.Li Danyang (2023) emphasized physical training’s multifaceted benefits for children, including enhanced physical fitness, psychological resilience, disease resistance and immunity.Nevertheless, most domestic research prioritizes interventions targeting core autistic symptoms, while studies integrating physical and sensory integration training remain insufficient and require further exploration.

3.3. Foreign Research Review

Sensory integration rehabilitation for autistic children constitutes a core research field abroad with substantial accumulated findings.The concept of "sensory integration dysfunction" was first proposed by American occupational therapist Anna Jean Ayres in the 1960s–1970s.Ferrari M and Harris SL confirmed sensory stimulation exerts reinforcing effects on autistic children, though individualized adjustment of stimulation type and dosage is critical.A 2011 study in the American Journal of Occupational Therapy divided 6–12-year-old ASD children into

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intervention groups;the sensory integration group achieved higher scores on goal attainment scales and significant reductions in autistic stereotypical behaviors, demonstrating robust intervention efficacy.

Recent international research diversifies sensory integration intervention modalities.A 2025 study published in Frontiers in Psychology innovatively combined basketball training with traditional sensory integration therapy, reporting superior outcomes for children with mild sensory processing disorders compared to standalone sensory intervention, validating synergistic benefits of sports and sensory training.Latif (2021) used music intervention to trigger motor responses in autistic children, confirming artistic activities as viable sensory stimulation carriers and providing new frameworks for multi-channel sensory intervention design.Schoen (2021) systematically reviewed sensory integration interventions and noted that treatment efficacy relies heavily on therapist expertise and structured protocols, highlighting the need to balance innovation and feasibility in novel intervention models .

Collectively, international scholars attach great importance to sensory integration training for autistic children and adopt diversified intervention modalities integrating sports and artistic therapy.However, global physical training research primarily targets neurotypical children, with limited focus on autism rehabilitation.Domestic research faces gaps in systematic, practice-oriented training models for autistic children across different age groups and regional contexts.Given China’s rapidly growing autistic population, demand for specialized physical training-based sensory rehabilitation will continue to rise, requiring improved institutional mechanisms to expand clinical application of such interventions.

4. Research Subjects and Methods

4.1. Experimental Subjects

This study investigates how physical training impacts sensory integration rehabilitation for autistic children aged 6–9 at yibin Special Education School, with a sample of 27 boys and 3 girls.

Inclusion Criteria:Written informed consent obtained from parents or legal guardians;Medical assessment confirming good physical health with no underlying diseases contraindicating physical training;

Developmental evaluation of cognitive, linguistic and motor capabilities;Behavioral assessment screening for self-harm or aggressive tendencies and compliance with adult instructions;Individualized adjustment of training content based on age, developmental level, personal interests and sensory sensitivity to avoid adverse sensory stimulation.

Sample Case Description (Alias: Daxuan)Age: 9 years old;Height: 148cm;Weight: 38kg (within normal developmental range)Diagnosis: Autism Spectrum Disorder confirmed by tertiary hospital assessment and the Psychoeducational Profile, Third Edition (PEP-3);severe sensory integration dysfunctionPhysical deficits: Poor fine motor control (unable to use chopsticks), unstable gait when descending stairs, poor balance, limited attention span, uncoordinated running (unable to jog continuously for over 30 seconds), weak jumping ability (only stationary short jumps)Stereotypical behaviors: Repetitive spinning, object twirling, forceful hand clapping;stable mood with rare meltdowns Social characteristics: Zero spontaneous communication, avoidance of eye contact, withdrawal from interpersonal proximity Prior intervention history: Non-physical training rehabilitation with negligible therapeutic effects

4.2. Research Methods

All participants completed the Child Sensory Integration Ability Assessment Scale and the Sensory Integration Measurement Scale pre-, mid- and post-intervention, with parents and school teachers responsible for scoring.Questionnaires were distributed before and after the

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12-week intervention to compare changes in sensory integration function.The standardized Sensory Integration Measurement Scale quantifies sensory processing performance, while the Child Sensory Integration Ability Assessment Scale evaluates five core sensory domains (vestibular, tactile, proprioceptive, visual and auditory).Scoring benchmarks:Score ≤40: Sensory integration dysfunction 30–40: Mild dysfunction 20–30: Moderate dysfunction <20: Severe dysfunction Scale reliability metrics: Test-retest reliability 0.47–0.73;split-half reliability 0.68–0.77;internal consistency reliability 0.44–0.63.

4.2.1. Literature Review

This study retrieved academic resources from CNKI, VIP, Baidu Academic and library archives to identify existing research gaps: limited localized research on physical training for autistic children's sensory integration rehabilitation at yibin special education schools, which this paper addresses through targeted empirical research.

4.2.2. Experimental Method

Thirty autistic children were randomly sampled and equally divided into an experimental group (15 children, 12 weeks of structured physical training, 2–3 sessions weekly) and a control group (15 children, regular school daily activities without additional targeted physical training).Pre- and post-intervention scores from two standardized sensory scales were statistically analyzed to compare vestibular, proprioceptive, tactile, visual and auditory function between groups.

4.2.3. Questionnaire Survey

Custom questionnaires collected parental feedback on children's behavioral changes across all sensory domains pre- and post-training, including quantifiable motor indicators such as jumping frequency, single-leg balance duration and climbing coordination.

4.2.4. Mathematical Statistics

Pre-intervention sensory scale scores for all 30 participants were compiled to enable random group assignment. Post-intervention data was collected via Questionnaire Star, processed with Excel and SPSS software for comparative statistical analysis of pre-post score differences.

4.2.5. Data Collection Methods

Direct Observation: Researchers recorded each child's training participation motivation, task completion and social interaction during physical training sessions;parents documented daily non-training social behaviors at home.Video Recording: Training sessions and daily activities were filmed to capture subtle behavioral details overlooked during live observation, serving as objective data for cross-verification with parents and research team members.

4.3. Intervention Protocol

Parents completed pre-intervention sensory integration assessments before the 12-week physical training program, with post-intervention reassessment upon program completion. Comparative score analysis between pre- and post-intervention evaluations quantified changes in sensory integration capacity, with average scores calculated for experimental and control groups. Training planning covered clear rehabilitation objectives, standardized session duration, mixed individual/group training formats, and targeted sensory activities addressing specific dysfunction (e.g., tactile stimulation exercises for tactile defensiveness, balance training for vestibular impairment).Detailed records tracked session implementation, child engagement and emergent challenges throughout the intervention cycle.

4.4. Experimental Protocol

A 12-week structured physical training program (2–3 sessions weekly) targeting vestibular, proprioceptive, tactile, visual and auditory function was delivered to 6–9-year-old autistic children in the experimental group.Hypothesis: The intervention significantly improves

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sensory integration capacity, outperforming standard school activities delivered to the control group. Measurable improvements include higher post-intervention scores on standardized sensory scales and observable behavioral gains. Vestibular function: Extended single-leg standing duration, enhanced dynamic balance, reduced falls during locomotion; Proprioceptive function: Smoother coordinated movement during climbing and jumping; Tactile function: Reduced tactile sensitivity, improved tactile discrimination and localization; Visual-auditory integration: Enhanced hand-eye coordination for ball catching, higher accuracy following verbal instructions. Direct observation and video recording data, alongside parental questionnaire feedback, validate these intervention outcomes.

4.4.1. Classification of Sensory Integration Training for Autistic Children

Vestibular Training: Targets balance, spatial and motion perception via rotational equipment (swivel chairs), swinging activities (swings, hammocks) and balance tasks (balance beams);Proprioceptive Training: Improves awareness of muscle, joint and skeletal state through strength training (climbing frames), coordinated movement (rope skipping) and joint mobility drills (bodyweight squats);Tactile Training: Mitigates tactile hypersensitivity or hyposensitivity via multi-texture object exploration, towel/brush massage and supervised water play; Visual Training: Enhances visual information processing through moving target tracking, shape/color discrimination and visual memory drills; Auditory Training: Boosts sound perception and comprehension via sound discrimination, auditory memory and sound localization tasks; Olfactory & Gustatory Training (secondary focus): Odor identification and taste differentiation activities. This research prioritizes vestibular, proprioceptive, tactile, visual and auditory training modules.

4.4.2. Specific Physical Training Content for the Experimental Group

Table 1 Physical Training Program for Sensory Integration Intervention (Experimental Group)

Auditory Sense	Full Cycle (Weeks1–12)	1.Following verbal instructions (simple → compound)2.Story comprehension & responsive dialogue	Integrated into all training sessions, instruction complexity increased weekly
Visual Sense	Full Cycle (Weeks1–12)	1.Color ring jumping on verbal cue2.Dynamic target ring identification while jogging	15 jumps × 3 setsMinimum 1 minute per set × 3 sets
Vestibular Sense	Basic Phase (Weeks1–4)	1.Supported single-leg standing2.Static balance board standing3.Large ball horizontal/vertical visual tracking	15s per leg × 3 sets1-minute standing × 5 sets20 slow repetitions × 3 sets
	Advanced Phase (Weeks5–8)	1.Eyes-closed balance drills2.Single-leg balance stepping on low stairs3.Small ball visual tracking & catching	30s per trial × 3 sets (supervised)10 repetitions × 3 sets20 up/down/side tosses × 3 sets
	Intensive Phase (Weeks9–12)	1.Balance board rotational training2.Dynamic single-leg balance board practice3.Multi-directional partner ball tossing	10 left/right rotations × 3 sets20s per leg × 3 sets3 sets of multi-directional tossing
Proprioception	Basic Phase (Weeks1–4)	1.Eyes-closed feet-together standing2.Straight-legged	30s × 3 sets10 repetitions × 3 sets10 jumps × 3 sets

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	forward bend3.Targeted single/double-foot jumping	
Advanced Phase (Weeks5–8)	1.Eyes-closed single-leg standing2.Slow dynamic bodyweight squats3.90° rotational stability drills	20s per leg × 3 sets (partial support allowed)10 slow squats × 3 sets5 rotations per direction × 3 sets (gradually accelerated)

4.4.3. Training Frequency and Intensity

Frequency: 2–3 sessions weekly to ensure sufficient recovery time, prevent fatigue and training aversion, and sustain consistent participation.Session Duration: 30–60 minutes per session, adjusted flexibly based on children's attention span and fatigue levels to avoid overburden while maximizing intervention efficacy.

5. Research Results

Questionnaire Reliability Analysis The questionnaire contained 34 items (including open-ended questions), with 30 valid responses collected.Cronbach's α coefficient = 0.718, indicating good questionnaire reliability (α between 0.7–0.8 signifies acceptable reliability).

Table 2 Cronbach's Reliability Analysis of Questionnaire

cronbach		
Number of Items	Sample Size	Cronbach'sαCoefficient
34	30	0.718

Sensory Integration Scale Score Statistics SPSS software processed valid pre- and post-intervention scores from the two standardized sensory assessment scales.

Table 3 Pre- and Post-Training Sensory Integration Scores of Autistic Children

Group	Time Period	Number of Children	Pre-Training Dysfunction Level	Estimated Pre-Training Average Score	Post-Training Dysfunction Level	Estimated Post-Training Average Score	Average Score Improvement
Experimental	Pre-Training	3	Severe (<20)	15	Moderate (20–30)	25	+10
Experimental	Pre-Training	5	Moderate (20–30)	25	Mild (30–40)	35	+10
Experimental	Pre-Training	7	Mild (30–40)	35	Near Normal (40–45)	42.5	+7.5
Control	Pre-Training	1	Severe (<20)	15	Severe (<20)	16	+1
Control	Pre-Training	4	Moderate (20–30)	25	Moderate (20–30)	28	+3
Control	Pre-Training	10	Mild (30–40)	35	Mild (30–40)	37	+2

Calculated indicators:

(1) Average score improvement of experimental group: $\triangle=\frac{(3\times10)+(5\times10)+(7\times7.5)}{15}=8.5$

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(2) Standard Deviation of the Experimental Group: $SD_{实验组}=\sqrt{\frac{\sum(\Delta i-\Delta)^2}{n-1}}=\sqrt{\frac{3(10-8.5)^2+5(10-8.5)^2+7(7.5-8.5)^2}{14}}\approx 1.44$

(3) Average Score Improvement of the Control Group: $\triangle=\frac{(1\times1)+(4\times3)+(10\times2)}{15}=2.2$

(4) Standard Deviation of the Control Group: $SD_{对照组}=\sqrt{\frac{\sum(\Delta i-\Delta)^2}{n-1}}=\sqrt{\frac{1(1-2.2)^2+4(3-2.2)^2+10(2-2.2)^2}{14}}\approx 0.56$

5.1. Specific Intervention Effects of Physical Training on Sensory Integration Rehabilitation

Individual case comparisons of pre- and post-intervention sensory scale scores confirm consistent sensory integration gains after the 12-week training cycle.Children exhibited smoother gross motor coordination, resolving rigid, clumsy movement patterns during running, jumping, stair descent and crawling.Substantial vestibular function improvements were observed in the experimental group relative to the control group.

Table 4 Pre- and Post-Training Sensory Subdomain Raw Scores (Case from Experimental Group)

Measurement	Tactile Function	Vestibular Function	Proprioceptive Function	Gross Motor Skills	Fine Motor Skills	Measurement
Pre-Training Raw Score	39	27	26	21	11	Pre-Training Raw Score
Pre-Training Score Gap to Normal Standard	1	13	14	19	29	Pre-Training Score Gap to Normal Standard
Post-Training Raw Score	47	38	41	39	15	Post-Training Raw Score
Post-Training Score Gap to Normal Standard	>40	2	>40	1	<25	Post-Training Score Gap to Normal Standard

5.1.1. Intervention Effects on Vestibular Sense

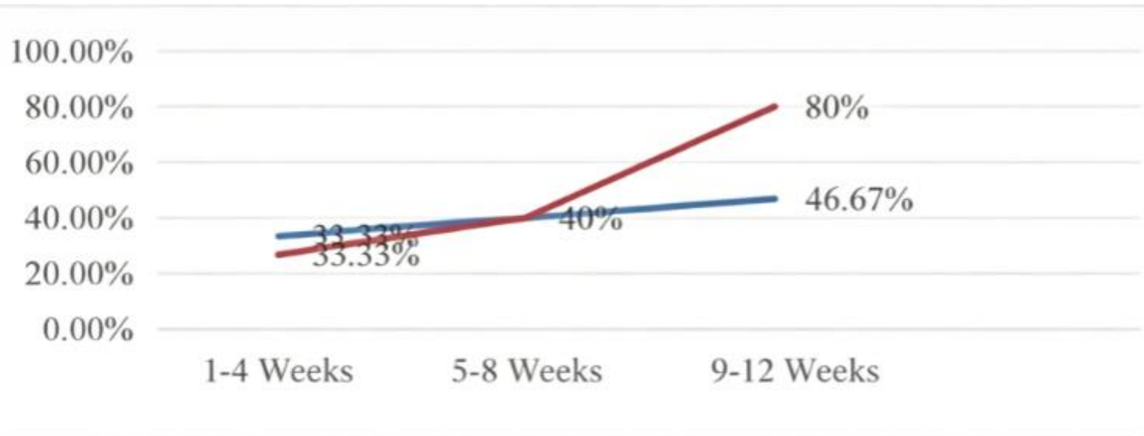

Figure 1 Comparison Chart of the Number of Children in Experimental and Control Groups Before and After Vestibular Training

Basic Phase (Weeks 1–4): Significant static balance gains in the experimental group.Assisted single-leg standing duration increased from baseline to 10–15 seconds;balance task compliance rose from 26.67% to 76.92%.Intensive Phase (Weeks 9–12): 40% of participants maintained

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eyes-closed single-leg standing for ≥8 seconds, a 23.3% improvement over the control group.Dynamic balance board testing revealed reduced center-of-gravity oscillation, reflecting enhanced core stability and motor coordination.Environmental adaptation: 12 participants achieved zero falls under multi-sensory interference (75dB background noise + obstacle courses).80% of children displayed clinically significant reductions in vestibular-related stereotypical behaviors (repetitive spinning, compensatory swaying).Conclusion: The three-stage vestibular training framework (static balance foundation dynamic control enhancement environmental generalization) optimizes vestibular sensory processing, providing evidence-based early intervention protocols for autistic children.

5.1.2. Intervention Effects on Proprioception

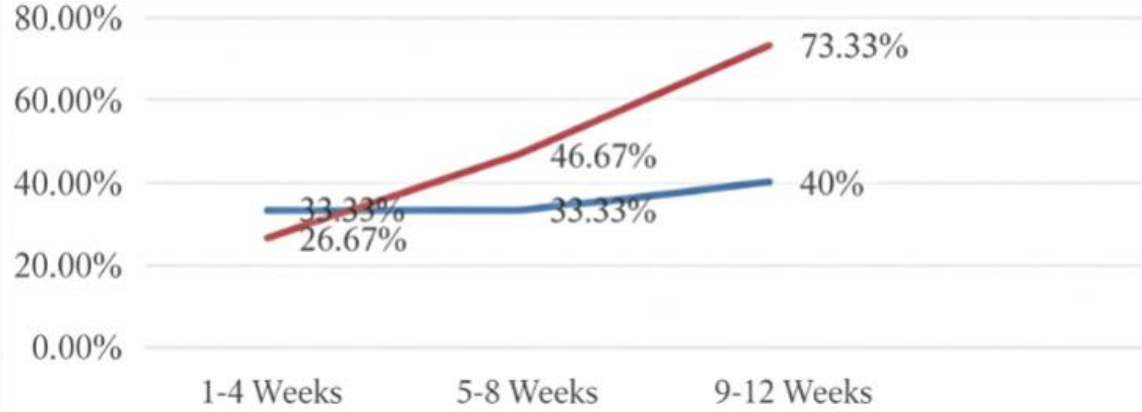

Figure 2 Comparison of Proprioceptive Function Improvement Rates

Experimental vs.Control Group (Weeks 1–12) 12 weeks of physical intervention significantly improved participants' physical function, motor control and adaptive movement patterns relative to the control group.Key outcomes:Enhanced postural stability, reduced center-of-gravity fluctuation during dynamic movement and fewer falls;decreased fear of climbing heights;Improved trunk motor control: stable jump-and-turn sequences, strengthened core muscle activation;Fundamental locomotion (running, crawling) transitioned from rigid mechanical patterns to fluid coordinated movement;Compound task completion rate (squat + jump) increased from 26.67% to 73.33%;extended single-leg standing from 5–10s to 10–20s;Continuous proprioceptive stimulation reinforces sensorimotor integration, improving motor control, movement patterning and environmental adaptation for autistic children.

5.1.3. Intervention Effects on Tactile Sense

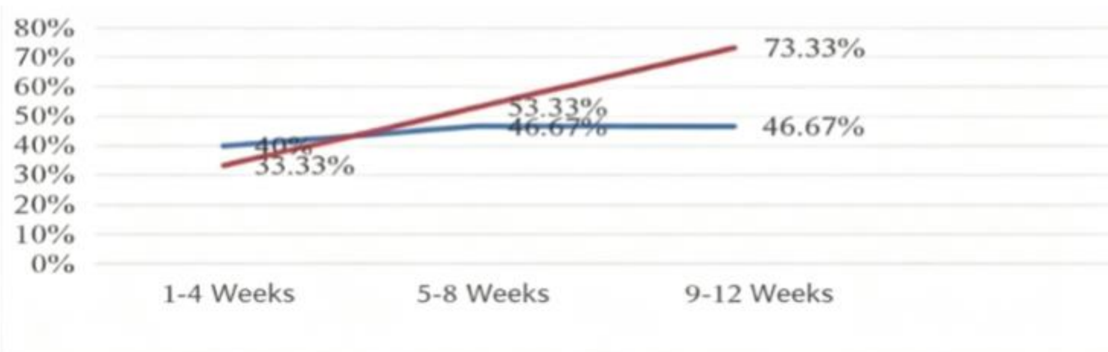

Figure 3 Comparison of Tactile Function Improvement Rates

Control Group (Weeks 1–12) Tactile training produced staged improvements in tactile perception, discrimination and multi-sensory integration across the experimental group:Basic Phase (Weeks 1–4): Improved accuracy of eyes-closed tactile localization, shortened tactile response latency, extended bumpy mat tolerance from 5s to 10s;53.33% of children initiated verbal texture descriptions independently.Advanced Phase (Weeks 5–8): Increased tolerance

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for rough textures, more frequent spontaneous tactile exploration;26.38% reduction in grip force error during multi-texture ball catching, reflecting refined tactile-proprioceptive integration.Intensive Phase (Weeks 9–12): Marked tactile-visual integration gains;ball catching success rates rose rapidly;tactile task compliance increased from 33.33% to 73.33%, far exceeding control group outcomes.Long-term cumulative tactile stimulation effectively remediates tactile processing deficits, validating physical training as an effective intervention for tactile sensory integration dysfunction.

5.1.4. Intervention Effects on Visual-Auditory Integration

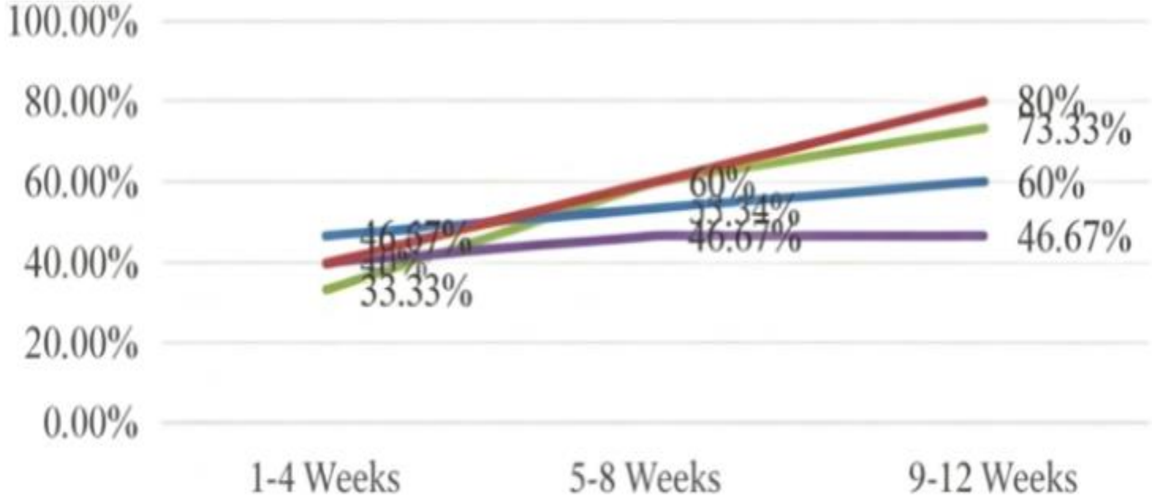

Figure 4 Comparison of Visual-Auditory Integration Improvement Rates

Experimental vs.Control Group (Weeks 1–12) Full-cycle visual-motor integrated training yielded superior visual-motor coordination gains in the experimental group:Visual tracking: Sustained visual focus extended from 5–10s to over 30s;target tracking accuracy improved for large and small moving objects;Hand-eye coordination: Higher ball catching success rates, reduced reaction delay;visual focus compliance (≥30s) rose from 33.33% to 77.33%;Spatial orientation: Fewer collisions in complex environments, higher accuracy following directional verbal instructions;auditory task compliance reached 80%.Embedding visual training within physical intervention strengthens cross-modal sensory integration between visual perception and motor control, improving spatial orientation and coordinated movement for autistic children.

5.2. 5.2 Influence of Training Intensity on Sensory Integration Rehabilitation

Intensity Classification.Low-intensity training: Heart rate at 50%–60% maximum heart rate (walking, gentle stretching);suitable for beginners and sensory-sensitive children;builds exercise interest but yields limited cardiorespiratory and muscle development gains.Moderate-intensity training: Heart rate at 60%–75% maximum heart rate (jogging, cycling, rope skipping);primary intervention intensity for most autistic children;boosts endurance, facilitates sensory release with minimal sensory overload risk, requiring guided participation for sensory-averse children.High-intensity training: Heart rate at 75%–90% maximum heart rate (sprinting, interval training);reserved for physically robust participants;accelerates fitness gains, enhances cardiorespiratory function and muscle power, dissipates hyperactive stereotypical behaviors.This study adopted low-to-moderate intensity training to maximize participation and minimize adverse sensory reactions.

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Table 5 Training Intensity Progression Across 12-Week Intervention

Training Stage	Intensity Level	Representative Activities	Core Training Objectives
Weeks 1–3	Low Intensity	Walking, gentle stretching, static isometric drills	Establish consistent exercise habits, adapt to sensory stimulation
Weeks 4–8	Moderate Intensity	Jogging, cycling, rope skipping, game-based drills	Improve cardiorespiratory endurance and muscle strength
Weeks 9–12	Moderate-to-High Intensity	Fast jogging, obstacle course games	Maximize physical fitness gains, build self-confidence

6. Conclusions and Recommendations

6.1. Research Conclusions

Statistical analysis of questionnaire feedback and pre/post sensory scale scores confirms significant sensory integration improvements in the experimental group following 12 weeks of structured physical training, while the control group demonstrated negligible functional gains.Physical training delivers measurable therapeutic effects for autistic children's sensory integration rehabilitation, validated by individual case comparisons.

Table 6 Pre- vs.Post-Training Functional Changes in Representative Case

Sensory Domain	Pre-Training Performance	Post 12-Week Training Performance
Vestibular Sense	Single-leg standing ≤5s, frequent falls	Single-leg standing ≥10s, stable balance beam walking
Proprioception	Fear of climbing elevated surfaces	Independent completion of indoor climbing apparatus tasks
Tactile Sense	Refusal of sand play, aversion to physical touch	Voluntary participation in tactile activities, reduced tactile defensiveness
Visual-Auditory Integration	Ball catching success rate ≤30%	Ball catching success rate ≥70%
Emotional Behavioral Regulation	3–5 emotional meltdowns per session	Meltdown frequency reduced to 1–2 per session or fewer

While the study is limited by small sample size and inter-individual variability, consistent intervention outcomes confirm physical training as a viable therapeutic tool for sensory integration dysfunction and associated behavioral challenges in autistic children.

6.1.1. Comprehensive Intervention Effects of Physical Training on Sensory Integration Rehabilitation

Vestibular Function Improvements: Extended single-leg balance duration, stable balance beam locomotion, reduced falls, enhanced spatial awareness and diminished head sway during running.Mechanism: Dynamic movement stimulates vestibular nerve conduction, strengthening brain processing of balance and spatial positional information via balance beam walking, rope skipping and rotational games.

Proprioceptive Function Improvements: Improved limb awareness and voluntary motor control, resolving clumsy gait and uncoordinated fine/gross motor performance.Mechanism: Climbing, squatting and light resistance training amplify muscle and joint sensory input, refining motor planning and execution.

Reduced Tactile Sensitivity: Decreased aversion to physical contact and multi-texture exploration;accurate discrimination of material textures.Mechanism: Progressive exposure to

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diverse tactile stimuli (ball games, sand play, massage rollers) recalibrates tactile processing thresholds, with long-term consistent practice required for full therapeutic effects.

Enhanced Visual-Auditory Integration: Prolonged visual tracking, higher ball-catching accuracy, faster responses to verbal instructions.Mechanism: Cross-modal training combining throwing/catching and instruction-following reinforces coordinated processing of visual, auditory and motor signals.

Emotional and Behavioral Regulation: Stabilized mood, reduced anxiety, hyperactivity and stereotypical behaviors, improved sustained attention.Mechanism: Aerobic exercise elevates dopamine secretion to regulate arousal and emotional state;structured training tasks extend attention spans.

6.1.2. Mechanisms Underpinning Physical Training’s Therapeutic Impact

Physical Coordination: Balance training optimizes vestibular spatial perception to stabilize locomotion;coordinated movement drills improve inter-limb synchronization for daily self-care tasks (dressing, shoelace tying).Tactile Processing: Multi-texture equipment exposure normalizes tactile sensitivity, eliminating over- or under-reactivity to physical stimuli.Proprioceptive Awareness: Climbing and jumping amplify muscle-joint sensory input, refining distance and force judgment during manual tasks.Psychological Development: Positive reinforcement upon task completion builds self-esteem and emotional stability;structured training extends attention spans and improves spatial problem-solving.Language Development: Coach/parental verbal guidance during training creates repetitive language exposure, enhancing instruction comprehension and verbal communication via the "movement-language correspondence" intervention framework.Behavioral Reduction: Structured physical activity diverts attention from stereotypical repetitive movements;enriched sensory input improves global sensory processing capacity, reducing social and emotional dysfunction.Family Interaction: Shared training activities strengthen parent-child bonding and improve caregivers’ understanding of their child’s developmental capacity.Overall, physical training delivers holistic benefits across physical, psychological and social domains: improved balance, coordination and strength;greater emotional stability, self-confidence and resilience;increased social participation and independent self-care capacity.Intervention progress varies widely across individuals, requiring personalized program adjustments (extended training cycles, progressive intensity) and activity selection aligned with children’s personal interests to avoid training aversion and burnout.

6.2. Targeted Recommendations

Sensory Domain-Specific Training Suggestions Vestibular Training: Integrate static balance drills (extended single-leg standing) and dynamic anti-interference balance tasks (ball dribbling through obstacle courses) with game-based activities to sustain participant engagement.

Proprioceptive Training: Increase jumping, climbing and light resistance tasks (pulling wheeled carts loaded with books);supervised weighted gear (sand vests, ankle weights) to amplify joint/muscle sensory feedback under professional guidance.

Tactile Training: Add rapid tactile response drills and multi-texture exploration (bumpy mats, sandpaper) to build tactile discrimination and reduce defensiveness through graded exposure to varied pressure, texture and temperature stimuli.

Visual-Auditory Integration Training: Combine hand-eye coordination drills with sequential verbal instructions (simple → compound: "jump through the ring then touch the wall");color-coded marker cone tasks requiring integrated visual discrimination and verbal instruction following to strengthen cross-modal sensory integration.

Multi-Stakeholder Systemic Recommendations

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Government Level:Allocate dedicated fiscal funding for sensory integration rehabilitation facilities and specialized physical training equipment in autism support institutions;Introduce supportive policies to attract professional rehabilitation practitioners and standardize industry regulatory oversight;Mandate professional certification for trainers delivering physical-sensory integration programs to guarantee intervention safety and efficacy.

School Level:Embed structured physical training into formal daily curricula with differentiated lesson plans tailored to individual developmental capacity;Expand professional training opportunities for special education teachers specializing in autism sensory rehabilitation;Foster inclusive campus environments through mixed-ability group sports and collaborative physical games to facilitate peer social interaction.

Family Level:Consistently implement school/rehabilitation center training schedules, delivering a minimum 40 minutes of home-based physical training daily;Adopt positive parenting mindsets, avoiding negative framing of children’s developmental differences;Design functional household tactile/motor tasks (multi-texture cleaning tools for window wiping) to extend sensory integration training into daily routines.

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