JHWCR JOURNAL OF HEALTH, WELLNESS AND COMMUNITY RESEARCH 3007-0570

https://doi.org/10.61919/vkhmm332

Original Article

Effectiveness of Core Stability Exercises Versus Task-Oriented Training on Postural Control in Children with Down Syndrome

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"Cite this Article" Received: 06 April 2026; **Accepted**: 09 May 2026; **Published**: 01 June 2026

Author Contributions: Concept and design: NR, KB; Data collection: NR, RS, KS; Analysis and interpretation: AH, HA; Drafting and critical revision: NR, KB, RS, KS, AH, HA. **Ethical Approval**: The University of Lahore Teaching Hospital, Lahore, Pakistan. **Informed Consent**: Written informed consent was obtained from all participants; **Conflict of Interest**: The authors declare no conflict of interest. **Funding**: No external funding; **Data Availability**: Available from the corresponding author on reasonable request; **Acknowledgments**: N/A.

ABSTRACT

Background: Children with Down syndrome commonly experience hypotonia, muscle weakness, impaired balance, and delayed postural responses, which may restrict functional mobility and daily participation. Core stability exercises and task-oriented training are frequently used in pediatric rehabilitation, but their comparative effectiveness for postural control remains insufficiently established. Objective: To compare the effectiveness of core stability exercises and task-oriented training on postural control in children with Down syndrome. Methods: This comparative interventional study included 36 children with Down syndrome who were allocated into two equal groups. Group A received core stability exercises, while Group B received task-oriented training. Postural control was assessed using the Pediatric Balance Scale before and after intervention. Within-group changes were analyzed using paired-sample t-tests, and between-group differences were examined using independent-sample t-tests, with statistical significance set at $p<0.05$. Results: Both groups demonstrated significant improvement after treatment. The core stability group improved from 31.22 ± 4.16 to 38.44 ± 4.82, with a mean gain of 7.22 ± 2.11 points, while the task-oriented training group improved from 30.94 ± 4.38 to 42.67 ± 4.21, with a mean gain of 11.73 ± 2.46 points. Between-group improvement favored task-oriented training by 4.51 points, with a large effect size. Conclusion: Both interventions improved postural control, but task-oriented training produced greater short-term gains in functional balance among children with Down syndrome.
Keywords: Down syndrome, postural control, core stability exercises, task-oriented training, Pediatric Balance Scale.

INTRODUCTION

Down syndrome is one of the most common chromosomal conditions associated with delayed motor development, hypotonia, ligamentous laxity, muscle weakness, impaired balance, and delayed acquisition of functional motor milestones, all of which may restrict independence in childhood activities and reduce participation in age-appropriate physical and social tasks (1). These impairments often persist beyond infancy and may influence standing balance, gait stability, stair negotiation, reaching, play, and other daily functional activities requiring coordinated postural control (2). Postural control is a foundational component of functional movement because it enables children to maintain body alignment, respond to internal and external perturbations, and perform purposeful activities safely and efficiently. Children with Down syndrome commonly demonstrate reduced balance performance, altered motor coordination, delayed protective responses, and impaired postural adjustments, which

collectively increase the risk of falls and limit functional mobility (3). Biomechanical studies have further shown that children with Down syndrome may present with altered gait patterns and joint stiffness, indicating that impaired neuromuscular control affects both static and dynamic movement performance (4,5). These motor impairments are not merely consequences of muscle weakness but are also linked with delayed motor synergy development, reduced movement adaptability, and difficulty integrating sensory and motor information during functional tasks (6).

The rehabilitation of postural control in children with Down syndrome requires interventions that improve proximal stability, balance reactions, motor planning, and functional task execution. Contemporary motor-control theory emphasizes that postural orientation and equilibrium emerge from the interaction of musculoskeletal capacity, sensory organization, anticipatory control, reactive balance responses, and task-specific environmental demands (7,8). Core stability exercises are commonly used to target trunk, pelvic, and abdominal musculature because proximal control provides a stable base for coordinated upper- and lower-limb movement. Improved trunk activation may enhance sitting balance, standing alignment, gait control, and functional transitions in children with hypotonia and reduced muscle strength. Strength-focused rehabilitation has also been considered clinically relevant in Down syndrome because reduced physical activity and insufficient muscle performance may contribute to persistent functional limitations (9,10). Exercise-based interventions, including trampoline activity and treadmill training, have demonstrated benefits for balance, motor performance, and developmental outcomes in children with intellectual or neuromotor disabilities, supporting the broader role of structured physical training in pediatric rehabilitation (11–13).

Task-oriented training offers a functionally distinct approach by emphasizing repeated practice of meaningful, goal-directed activities rather than isolated impairment-based exercise. This approach is grounded in motor-learning principles, where task specificity, repetition, active problem solving, sensory feedback, and contextual practice are used to improve the performance of activities directly relevant to daily life. Functional strengthening and task-based therapy have shown positive effects on motor performance and mobility in children with neurodevelopmental conditions, particularly when interventions involve repeated practice of activities such as standing, reaching, stepping, walking, transferring, and obstacle negotiation (14–16). Evidence from pediatric neurorehabilitation also supports the clinical value of activity-based interventions that integrate functional goals into therapy rather than relying solely on isolated strengthening approaches (17). For children with Down syndrome, task-oriented training may therefore improve postural control by simultaneously challenging balance, coordination, weight shifting, anticipatory postural adjustments, and confidence during functional movement.

Although both core stability exercises and task-oriented training are used in pediatric physiotherapy, comparative evidence regarding their relative effectiveness for improving postural control in children with Down syndrome remains limited. Existing rehabilitation literature supports strengthening, balance training, treadmill-based interventions, and functional therapy approaches; however, fewer studies directly compare impairment-focused trunk stabilization with functional task-oriented rehabilitation in this population. This gap is clinically important because physiotherapists require evidence to determine whether treatment should prioritize isolated proximal stability training, functional task practice, or an integrated model. Therefore, this study was conducted to compare the effectiveness of core stability exercises and task-oriented training on postural control in children with Down syndrome. It was hypothesized that task-oriented training would produce greater improvement in Pediatric Balance Scale scores than core stability exercises.

MATERIALS AND METHODS

This comparative interventional study was conducted to evaluate the effectiveness of core stability exercises versus task-oriented training on postural control in children with Down syndrome. The study

was carried out at Therapy Plus Clinic, Architect Society, Lahore, Pakistan. A total of 36 children diagnosed with Down syndrome were recruited through non-probability convenience sampling and allocated into two parallel intervention groups, with 18 participants in each group. Group A received core stability exercises, while Group B received task-oriented training. The study was designed to compare pre- and post-intervention changes within each group and to determine whether one intervention produced superior improvement in postural control compared with the other.

Children diagnosed with Down syndrome who presented with impaired postural control and were able to follow simple verbal commands were included in the study. Children were excluded if they had severe visual or hearing impairment, uncontrolled seizures, recent orthopedic surgery, severe congenital heart disease, or any additional neurological or musculoskeletal condition that could interfere with safe participation in exercise training or independently affect postural-control outcomes. Eligible participants were screened according to these criteria, and informed consent was obtained from parents or guardians before enrollment. Demographic and clinical information, including age, gender, height, weight, diagnosis, and relevant clinical history, was recorded before the start of intervention.

The primary outcome variable was postural control, assessed using the Pediatric Balance Scale. The Pediatric Balance Scale is a standardized pediatric adaptation of the Berg Balance Scale and is used to assess functional balance in children with mild to moderate motor impairment through tasks related to sitting, standing, transfers, reaching, turning, and other balance-related activities (18). Baseline assessment was performed before treatment, and the same outcome measure was repeated after completion of the intervention period. The independent variable was the type of rehabilitation intervention, categorized as core stability exercises or task-oriented training, while the dependent variable was change in Pediatric Balance Scale score.

Participants in Group A received core stability exercises targeting activation and strengthening of trunk and pelvic stabilizing muscles. The intervention included bridging, pelvic tilting, abdominal activation, prone extension activities, sitting balance activities, quadruped exercises, and dynamic trunk-control exercises. Exercises were progressed according to each child's tolerance, safety, and functional ability. Participants in Group B received task-oriented training based on functional activities designed to improve postural control during meaningful movement. The training protocol included sit-to-stand practice, reaching tasks, stepping activities, walking on different surfaces, standing balance activities, weight shifting, obstacle negotiation, and functional mobility tasks. Repetition, active participation, controlled progression, and task-specific practice were emphasized to facilitate motor learning and functional carryover.

Each treatment session lasted approximately 30–45 minutes and was delivered under the supervision of a physiotherapist. Safety precautions were maintained throughout the intervention, including close supervision during balance tasks, provision of rest intervals when required, and progression of activity difficulty according to participant tolerance. Parents or guardians were also guided regarding safe handling and activity participation at home. To reduce performance and measurement variability, both groups were assessed using the same standardized outcome measure at pre- and post-intervention time points, and baseline demographic comparability between groups was examined.

Data were analyzed using SPSS software. Continuous variables were summarized as mean and standard deviation, while categorical variables were reported as frequency and percentage. Baseline demographic characteristics were compared between groups to assess pre-intervention comparability. Within-group changes in Pediatric Balance Scale scores were analyzed using paired-sample t-tests, while between-group differences in post-treatment scores and improvement scores were analyzed using independent-sample t-tests. Statistical significance was set at $p<0.05$. Effect size was reported using Cohen's d to support interpretation of the magnitude of between-group difference. Ethical principles were followed throughout the study, including voluntary participation, informed parental or guardian consent,

confidentiality of participant information, non-invasive intervention procedures, and supervised exercise delivery to minimize risk.

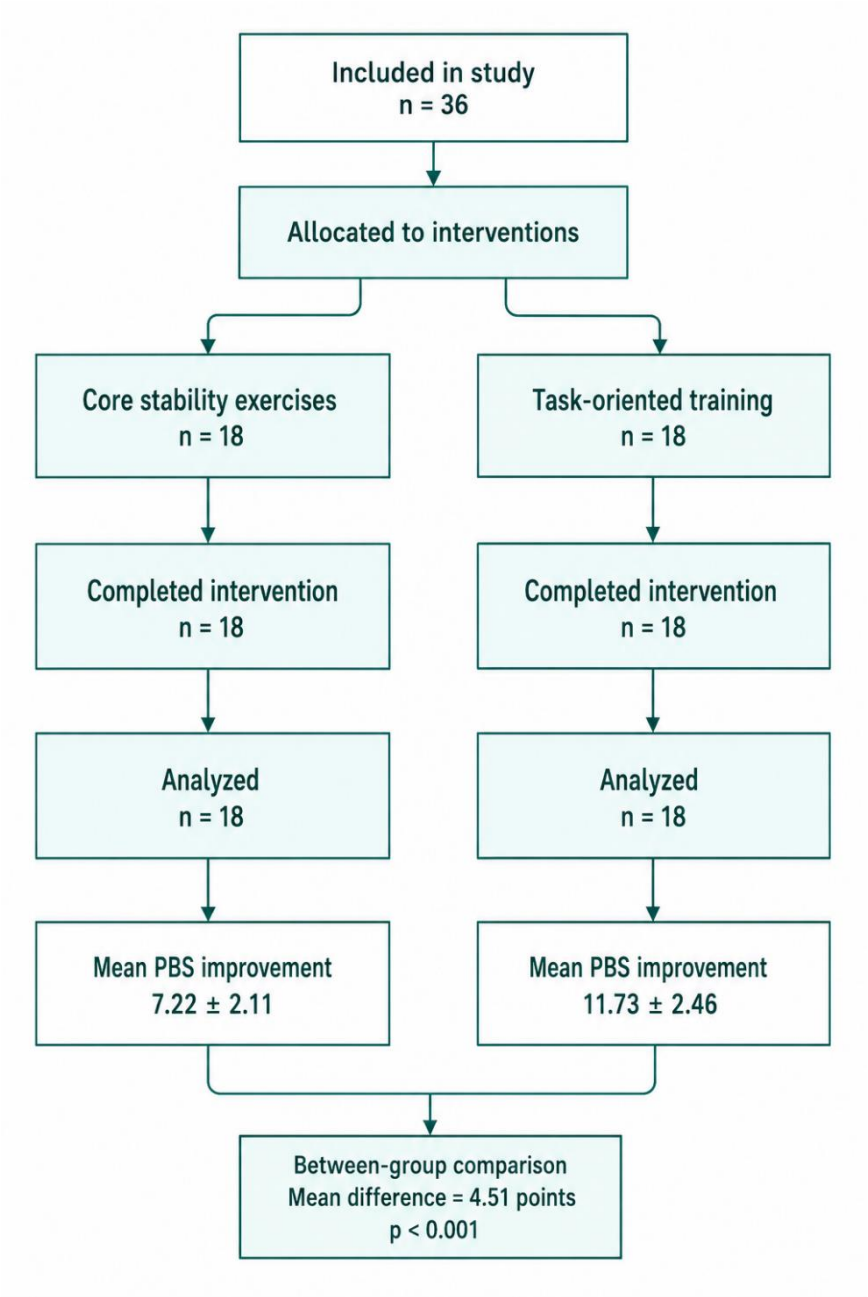

Figure 1 CONSORT Flowchart

RESULTS

A total of 36 children with Down syndrome completed the study and were equally distributed into two intervention groups, with 18 participants in the core stability exercise group and 18 in the task-oriented training group. Baseline demographic characteristics were comparable between groups. The mean age was 8.21 ± 1.64 years in the core stability group and 8.47 ± 1.52 years in the task-oriented training group. Similarly, weight, height, and gender distribution showed no statistically significant between-group differences, indicating baseline comparability before intervention.

Within-group analysis showed statistically significant improvement in Pediatric Balance Scale scores in both groups after intervention. In the core stability group, the mean PBS score increased from 31.22 ± 4.16 before treatment to 38.44 ± 4.82 after treatment, producing a mean improvement of 7.22 ± 2.11 points. In the task-oriented training group, the mean PBS score increased from 30.94 ± 4.38 to 42.67 ±

4.21, producing a larger mean improvement of 11.73 ± 2.46 points. Both improvements were statistically significant, with p-values <0.001.

Table 1. Baseline Demographic Characteristics of Participants

Variable	Core Stability Group (n=18)	Task-Oriented Training Group (n=18)	Mean Difference / χ^2	p-value
Age (years), mean ± SD	8.21 ± 1.64	8.47 ± 1.52	0.26	0.63
Weight (kg), mean ± SD	27.14 ± 4.82	28.01 ± 5.16	0.87	0.58
Height (cm), mean ± SD	121.8 ± 8.5	123.6 ± 7.9	1.80	0.49
Male, n (%)	10 (55.6%)	9 (50.0%)	—	0.74
Female, n (%)	8 (44.4%)	9 (50.0%)	—	0.74

Table 2. Within-Group Pre–Post Comparison of Pediatric Balance Scale Scores

Group	Pre-Treatment PBS Mean ± SD	Post-Treatment PBS Mean ± SD	Mean Improvement ± SD	95% CI for Improvement	p-value
Core Stability Exercises	31.22 ± 4.16	38.44 ± 4.82	7.22 ± 2.11	6.17 to 8.27	<0.001
Task-Oriented Training	30.94 ± 4.38	42.67 ± 4.21	11.73 ± 2.46	10.51 to 12.95	<0.001

Between-group analysis confirmed that the two groups were comparable at baseline for Pediatric Balance Scale scores. The pre-treatment PBS score was 31.22 ± 4.16 in the core stability group and 30.94 ± 4.38 in the task-oriented training group, with a negligible mean difference of 0.28 points. After intervention, the task-oriented training group achieved a higher post-treatment PBS score than the core stability group, with a mean difference of 4.23 points. The comparison of improvement scores also favored task-oriented training, with a between-group mean difference of 4.51 points. The large Cohen's d value for improvement scores indicated a clinically meaningful superiority of task-oriented training over core stability exercises.

Table 3. Combined Between-Group Comparison of Pediatric Balance Scale Outcomes

Outcome	Core Stability Group (n=18)	Task-Oriented Training Group (n=18)	Mean Difference	95% CI	Cohen's d	p-value
Pre-treatment PBS score	31.22 ± 4.16	30.94 ± 4.38	0.28	-2.61 to 3.17	0.07	0.845
Post-treatment PBS score	38.44 ± 4.82	42.67 ± 4.21	4.23	1.16 to 7.30	0.93	0.008
Improvement in PBS score	7.22 ± 2.11	11.73 ± 2.46	4.51	2.96 to 6.06	1.97	<0.001

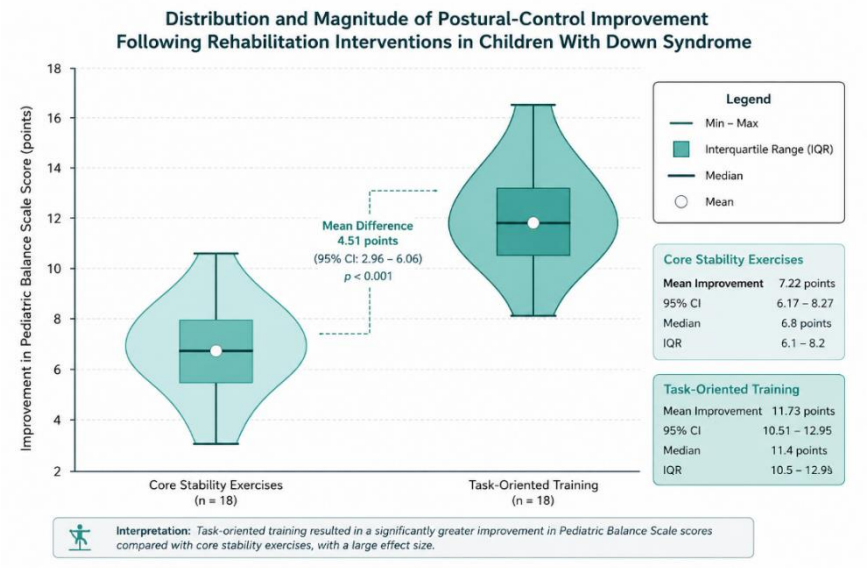

Figure 2 Distribution and Magnitude of Postural-Control Improvement Following Rehabilitation Interventions in Children With Down Syndrome

The figure demonstrates a substantially greater improvement in Pediatric Balance Scale scores among children receiving task-oriented training compared with those receiving core stability exercises. The mean improvement in the task-oriented group was 11.73 points (95% CI: 10.51–12.95), whereas the core stability group demonstrated a mean improvement of 7.22 points (95% CI: 6.17–8.27). The density distribution additionally showed that the majority of participants in the task-oriented group achieved improvements clustered above 10 points, while improvements in the core stability group remained concentrated around 6–8 points. Confidence interval separation and broader upper-range distribution in

the task-oriented group indicate not only statistically significant superiority but also clinically meaningful enhancement in postural control and functional balance performance among children with Down syndrome.

Overall, both interventions produced statistically significant improvement in postural control among children with Down syndrome. However, task-oriented training resulted in greater gains than core stability exercises, as shown by higher post-treatment PBS scores and larger improvement scores. The baseline PBS difference between groups was minimal and non-significant, while the post-treatment and change-score comparisons both favored task-oriented training. These findings suggest that although core stability exercises are beneficial, task-oriented training may be more effective for improving functional balance and postural control in this population.

DISCUSSION

The present study compared the effects of core stability exercises and task-oriented training on postural control in children with Down syndrome and found that both interventions produced statistically significant improvement in Pediatric Balance Scale scores. However, task-oriented training resulted in a greater magnitude of improvement than core stability exercises. The core stability group improved from 31.22 ± 4.16 to 38.44 ± 4.82, with a mean gain of 7.22 points, whereas the task-oriented training group improved from 30.94 ± 4.38 to 42.67 ± 4.21, with a mean gain of 11.73 points. The between-group improvement difference of 4.51 points, supported by a large standardized effect size, indicates that task-oriented training produced superior short-term improvement in functional balance and postural control. Baseline Pediatric Balance Scale scores were comparable between groups, suggesting that the observed post-intervention difference was more likely associated with the intervention approach than with pre-existing imbalance in postural-control status.

The improvement observed in the core stability group is clinically plausible because trunk stability plays a central role in maintaining postural alignment, anticipatory control, and balance during functional activities. Children with Down syndrome frequently demonstrate hypotonia, reduced muscle strength, ligamentous laxity, altered motor coordination, and delayed postural responses, all of which can compromise their ability to maintain equilibrium during sitting, standing, transfers, and ambulation. By targeting abdominal, pelvic, spinal, and proximal stabilizing muscles, core stability exercises may improve the child's ability to control the trunk during static and dynamic activities. This proximal control can provide a more stable base for upper- and lower-limb movement, which may explain the significant improvement in Pediatric Balance Scale scores observed after core stabilization training. The use of a standardized pediatric balance measure also strengthens the clinical interpretability of the findings, as the Pediatric Balance Scale has been adapted and evaluated for children with mild to moderate motor impairment and is relevant for assessing functional balance tasks in pediatric rehabilitation settings (19).

The superior improvement in the task-oriented training group may be explained by the task-specific and motor-learning nature of the intervention. Unlike isolated strengthening exercises, task-oriented training requires repeated practice of meaningful activities such as sit-to-stand transitions, reaching, stepping, weight shifting, walking over different surfaces, obstacle negotiation, and functional mobility tasks. These activities closely resemble the movement demands encountered in daily life and simultaneously challenge balance, coordination, sensory integration, anticipatory postural adjustment, reactive control, and functional problem solving. For children with Down syndrome, who often experience difficulty organizing efficient motor patterns, repetitive practice in real-life movement contexts may produce stronger functional transfer than impairment-focused exercise alone. The larger improvement in Pediatric Balance Scale scores therefore suggests that postural control may respond more effectively when balance is trained within purposeful activities rather than through trunk activation exercises in isolation.

These findings are consistent with broader pediatric neurorehabilitation principles emphasizing that functional practice, repetition, and task specificity are important drivers of motor learning and functional recovery. Previous rehabilitation evidence has shown that activity-based and treadmill-based interventions can improve developmental and motor outcomes in children at risk of neuromotor delay, supporting the concept that repeated exposure to structured movement tasks can enhance motor performance (20). Similarly, pediatric physical therapy frameworks emphasize that intervention planning should connect impairments with functional goals so that improvements in strength, balance, and coordination translate into meaningful activity participation (21). In the present study, task-oriented training may have been more effective because it integrated strengthening, balance control, and functional movement into the same therapeutic context, whereas core stability exercises primarily emphasized proximal muscle activation and trunk control.

The clinical relevance of these results is important for pediatric physiotherapy practice. Improved postural control in children with Down syndrome may contribute to safer mobility, better transfer ability, improved standing balance, greater confidence during movement, and enhanced participation in play, school, and home activities. The difference between groups suggests that task-oriented training may be particularly useful when the primary therapeutic goal is functional balance rather than isolated strengthening. However, the findings should not be interpreted as indicating that core stability exercises are ineffective. Both interventions produced significant improvement, and an integrated rehabilitation program combining core stabilization with task-specific functional practice may be clinically valuable. Core exercises may prepare the child for improved proximal control, while task-oriented activities may convert that improved control into functional performance.

Several limitations should be considered when interpreting the findings. The sample size was small, with 18 participants in each group, which limits statistical power and generalizability. The study was conducted in a single clinical setting using non-probability convenience sampling, which may restrict external validity. The allocation procedure was not described as randomized, and assessor blinding was not reported, creating potential risks of selection and detection bias. The study also lacked long-term follow-up; therefore, it remains unclear whether the observed improvements were retained after completion of treatment. Adherence, home-program compliance, adverse events, and dropout handling were not fully reported, which limits interpretation of feasibility and treatment fidelity. Future studies should use randomized controlled designs, larger multicenter samples, concealed allocation, blinded outcome assessment, prespecified sample-size calculations, longer follow-up periods, and additional outcomes such as gait parameters, functional mobility, caregiver-reported participation, quality of life, and clinically meaningful responder thresholds.

Overall, the findings indicate that both core stability exercises and task-oriented training can improve postural control in children with Down syndrome, but task-oriented training produced greater short-term gains in Pediatric Balance Scale scores. The results support the use of functional, repetitive, goal-directed activities in pediatric rehabilitation and suggest that intervention programs for children with Down syndrome should prioritize task-specific balance and mobility training when the aim is to improve functional postural control.

CONCLUSION

This study concluded that both core stability exercises and task-oriented training significantly improved postural control in children with Down syndrome; however, task-oriented training produced greater improvement in Pediatric Balance Scale scores than core stability exercises. The findings suggest that functional, repetitive, and goal-directed rehabilitation activities may be more effective for enhancing balance and postural stability in this population, particularly when therapeutic goals are linked to daily mobility and functional independence. Although the results favor task-oriented training, the small sample size, single-center design, and absence of long-term follow-up warrant cautious interpretation.

Future randomized controlled trials with larger samples, blinded assessment, standardized intervention dosage, and follow-up evaluation are recommended to confirm the sustained clinical effectiveness of task-oriented rehabilitation in children with Down syndrome.

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