International Journal of Medical and Allied Health Sciences

ISSN: 2583-1879
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Research Article

THE EFFECT OF CORE STABILITY PROGRAM ON THE FINE MOTOR ACTIVITIES OF THE UPPER LIMB IN CHILDREN WITH CEREBRAL PALSY

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Article Information: Received on 09-09-2026, Accepted 25-09-2026, Available online 27-09 -2026

Abstract

Background: Cerebral palsy (CP), permanent motor disease occurred by non-progressive abnormalities during brain development, resulting in neurological, motor, and postural impairments.

Method: Research was carried out at Santosh College of Occupational Therapy in Ghaziabad. Forty-four children who met the required criteria were allocated into experimental group and control group. Each group had twenty-two children. Before and after the intervention, assessments were carried out using the BBT and ABILHAND-Kids questionnaire. The group that was tested did a structured core stability training three times a week for 45 minutes over 8 weeks. The other group had a fine motor intervention program with the same schedule and time.

Results: Both groups demonstrated improvement following the intervention. There was no discernible difference between the groups according to baseline analysis ($p > 0.05$). However, following treatment, experimental group considerably outperformed control group ($p < 0.001$), suggesting that adding core stability exercises improved upper limb fine motor abilities more successfully than fine motor intervention alone.

Conclusion: Core stability training is an effective therapeutic approach for improving upper limb fine motor abilities in CP children. Incorporating core stability exercises into rehabilitation programs may enhance manual dexterity, functional hand use, and overall functional outcomes.

Keywords: Cerebral palsy; core stability; fine motor skills; pediatric rehabilitation; upper limb function.

1. Introduction

Cerebral palsy, a lifelong, non-deteriorating disease that restricts the normal development of movement and posture during the prenatal, perinatal, or early neonatal period [1]. It is regarded as the main reason for serious physical disabilities in children and teenagers. It happens when there is damage to the brain of a developing fetus or a baby, leading to a range of long-term problems with how the brain develops [2]. These issues mainly affect a person's ability to control their posture and movement [2].

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doi: https://doi.org/10.54618/IJMAHS.2026632

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Contemporary diagnostic criteria have expanded to include activity limitations and associated impairments such as cognitive deficits, seizure disorders, and disturbances in behavior, vision, hearing, nutrition, and communication [3].

CP encompasses various motor and postural dysfunctions that significantly restrict functional capacity [4]. The underlying brain lesion disrupts normal neural signaling to the musculoskeletal system, resulting in abnormal muscle tone and reduced voluntary motor control [4].

Cerebral palsy is clinically classified into several subtypes, according to the predominant motor impairment, including spastic which can be unilateral/hemiplegia or bilateral/diplegia/quadriplegia, dyskinetic i.e. hyperkinetic, dystonic and choreoathetoid and ataxic or mixed forms [5]. Core stability training is highlighted as a useful approach to help improve balance & body control in CP children [6].

CP children benefit from individualized core stabilization and strengthening programs that support both fine and gross motor functions. Such interventions improve stability, balance, gait, postural control, and reduce abnormal muscle tone [3]. Thus,study purpose was to assess how a core stability program affected CP kids upper limb fine motor skills.

Even with its promise, obstacles including patient data security, uniform standards, and the clarity of algorithmic decisions hinder broad implementation. Through ongoing partnerships and tech progress, AI holds potential to drive tailored medical care and redefine diagnostic approaches in contemporary healthcare [3].

Methodology

Study Design and Setting:

A research investigation was carried out to assess, deliberated, and sanctioned by Institutional Ethical Committee at Santosh College of Occupational Therapy **(Reference Number: SCOT/JULY-25/ECPEADS-04).**Information was collected from Santosh Medical College and Hospital in Ghaziabad and the Bridging Barrier Child Development Center in Greater Noida to examine how core stability program influence upper extremity fine motor skills in CP kids.

Participants

Children who have GMFCS Levels I or II cerebral palsy and are between the ages of 6 and 12 could take part in the study. However, children with visual impairments, seizures that can't be controlled, Joubert syndrome, spinocerebellar ataxia, ataxia-telangiectasia, or other neuromuscular conditions were not allowed to join. Forty-four people were chosen and split into 2 groups, experimental group & control group, 22 people per group.The split was done randomly using the chit method.

Experimental group: underwent an 8-week, 24-session, 45-minute rigorous core stability training program three times a week, comprising warm-up, static core stability, dynamic core stability, functional integration, and cool-down phases. Sessions were conducted in a quiet, well-organized environment.

TABLE 1: TREATMENT PROTOCOL OF EXPERIMENTAL GROUP (Abd-Elhameed et al., 2025)

PHASE	DURATION	EXERCISE TYPE	REPETITIONS/ SETS
Warm up	5 minutes	breathing and stretching	2 - 3 mins each
phase 1: static core stability	week 1 - 2	Supine abdominal bracing / drawing-in	hold 10 - 15 sec. × 3 - 4
		Prone plank on mat (or modified plank)	10 - 20 sec × 3
		Seated abdominal isometric (sit upright)	hold 10 sec × 3, rest between
phase 2: dynamic core stability	week 3 - 5	Quadruped exercise	10 reps/side × 3 sets
		Bridging	10 reps per side × 3 sets
		Trunk rotation (seated or supine)	10 reps × 3 sets
phase 3: functional integration	week 6 - 8	Ball exercises	5 - 10 min of combined tasks each session
		Reaching tasks while balancing on ball / seated on ball	10 reps × 3 directions

		Catch / throw while on ball or in sitting	10 reps × 3 sets
cool down	5 - 10 minutes	relaxation and stretching	2-3 mins each

Control group: received structured fine motor training, including straw insertion, threading and posting, mask-making, and playdough cupcake activities, with the same frequency and duration.

TABLE 2: TREATMENT PROTOCOL OF CONTROL GROUP (Samina Ashraf et al., 2019) [7].

NAME OF ACTIVITY	DESCRIPTION	DURATION
WARM UP	Greet child and do some finger stretching	5 minutes
STRAW POKING IN HOLES	Child pokes plastic straw into small holes in a container	5 minutes
THREADING	threading large beads or pasta onto strings or shoelaces	5 minutes
POSTING	drop coins/buttons through a slit in a box	5 minutes
MASK MAKING	cut paper shape,glue on features, decorate mask with stickers/colours	5-10 minutes
PLAY DOUGH CUPCAKES	roll, press, shape playdough into cupcake,decorate with small beads	5-10 minutes
COOL DOWN & REVIEW	talk about what they did,favourite activity and stretch fingers again	5 minutes

Outcome Measures

The main results were about how well the children could use their hands, measured at the start and after 8 weeks of the treatment.They used the Box and Block Test (BBT) & ABILHAND-Kids questionnaire to check this. The BBT tested manual dexterity by counting how many blocks a person could move across a divider in one minute, and the ABILHAND-Kids questionnaire asked parents about how hard it was for their child to do everyday tasks that use both hands.

Statistical Analysis

Data analysis was done by IBM SPSS Statistics version 29.0.1.0. Continuous variables were presented as average plus or minus the standard deviation. The basic features of the groups were to make sure they were alike. The study employed paired sample t-tests to contrast scores within each group & independent sample t-tests were used to contrast outcome across groups for Box and Block Test (BBT) & ABILHAND-Kids.

3. RESULTS

Demographic Characteristics

The sample included 44 participants, average age was 7.77 years plus or minus 1.63 years in the control group and 7.18 years plus or minus 1.26 years in the experimental group. The control group consists of 19 boys and 3 girls, & the experimental group comprise of 13 boys and 9 girls. Detailed information about the population characteristics is shown in Table 3..

Table 3: Demographic Statistics of Participants (Control vs Experimental)

Variable	Category	Control Group n=22 (%) / Mean ± Standard Deviation	Experimental Group n=22 (%) / Mean ± Standard Deviation
Age (in years)	Mean ± St. D	**7.77 ± 1.63**	**7.18 ± 1.26**
Gender	Male	**19 (86.36%)**	**13 (59.09%)**
	Female	**3 (13.64%)**	**9 (40.91%)**
Total		**22 (100%)**	**22 (100%)**

Baseline Comparisons

There were no big differences between both groups when looking at the Box and Block Test (BBT) ($p = 0.683$ and $p = 0.721$) or the ABILHAND-Kids ($p = 0.789$ and $p = 0.758$).This shows that both groups were similar at the beginning of the study (Table 4).

Scale	t Value	p Value	Interpretation
Pre-BBT (Control Group)	-0.41	0.683	No significant difference
Pre-ABILHANDS-Kids (Control Group)	-0.27	0.789	No significant difference
Pre-BBT (Experimental Group)	-0.36	0.721	No significant difference
Pre-ABILHANDS-Kids (Experimental Group)	-0.31	0.758	No significant difference

Post-Intervention Analysis

After the intervention, the results showed that both groups had meaningful improvements in their BBT and ABILHAND-Kids scores, and these improvements showed statistical significance ($p < 0.05$). However, experimental group showed more improvement, with significant changes in BBT ($t = -4.92$, $p < 0.001$) and ABILHAND-Kids ($t = -3.87$, $p < 0.001$) in contrast to the control group (Table 5).

Table 5: Post-Data Analysis

Scale	t Value	p Value	Interpretation
Post-BBT (Control Group)	-2.18	0.034	Significant difference
Post-ABILHANDS-Kids (Control Group)	-1.94	0.038	Significant difference
Post-BBT (Experimental Group)	-4.92	<0.001	Significant difference
Post-ABILHANDS-Kids (Experimental Group)	-3.87	<0.001	Significant difference

Within-group paired t-test results showed that there were significant increases from pre-intervention to post-intervention in both BBT and ABILHAND-Kids scores ($p < 0.001$) for both groups; however, the experimental group had larger improvements than the control group.

4. DISCUSSION

This study looked at how a core stability training program affected fine motor skills of upper limbs in CP kids. Both groups improved after the treatment, but the experimental group had much better results in BBT and ABILHAND-Kids scores.This shows that adding

core stability training to regular therapy helps improve fine motor skills and hand abilities more effectively.

The results match what Abd-Elfattah and Aly found in 2021, where they saw big improvements in children with hemiplegic CP use of their hands after doing core stability exercises (Abd-Elfattah et al., 2021). Küçük and Cekmece (2025) [8]. showed that core stabilization exercises helped improve trunk control, upper body movement, and balance, as reported by Küçük KE et al in 2025. Abd-Elhameed and Kamal (2025) [2], also reported improved upper-limb reaching after core stability training, emphasizing the role of trunk stability in upper-limb function (Abd-Elhameed et al., 2025) [2].

The present findings are further supported by Kim and An (2018), who identified a significant relationship among trunk control & upper extremity ability assessed using TCMS, ABILHAND-Kids, and BBT (Kim D. H .et al., 2018) [9]. . Darji and Diwan (2022) [6]. similarly noticed strong positive association among trunk control and upper-extremity skills, supporting the inclusion of trunk-focused interventions in rehabilitation (Darji P. P. et al., 2022). [2].

The greater improvement in the experimental group may be attributed to enhanced activation and coordination of the core musculature, which improves postural stability and provides a stable base for hand function & manipulation. Increase in ABILHAND-Kids and BBT scores further suggest enhanced functional hand abilities and manual dexterity. Overall, the findings support integrating core stability exercises into conventional rehabilitation to optimize upper-extremity ability outcomes in CP children.

The study had some limits. The intervention didn't last very long, and only two tools—BBT and ABILHAND-Kids—were used to measure results. Also, there was no follow-up to check how the effects lasted over time. This made it hard to see if core stability training really helps with fine motor skills in the long run. For future research, it would be better to use bigger groups from different places, longer training periods, follow-up checks, and more tests to look at trunk control, muscle strength, balance, and coordination. This would give a clearer picture of how well core stability training works over time.

5. CONCLUSION

In conclusion, the core stability program improved fine motor and functional upper-extremity performance in CP children. Although both groups demonstrated improvement, the experimental group showed greater gains in BBT and ABILHAND-Kids scores, highlighting the importance of trunk stability in supporting upper-limb function and functional independence. Incorporating core stability training into routine rehabilitation may therefore enhance upper-extremity performance in CP children.

DECLARATIONS

Acknowledgements: Authors sincerely acknowledge and appreciate the support, guidance, and valuable constructive contributions of all those who assisted throughout the course of this research.

Authors' Contributions: SM conceptualized the study, drafted the protocol, carried out data collection, and wrote the initial manuscript draft. RKS supervised the project and critically revised the manuscript.PR edited the manuscript and coordinated submission. All the authors read the final version of the manuscript and gave their approval.

Ethical Approval and Consent: Ethical Clearance: (SCOT/JULY-25/ECPEADS-04). Each person who took part in the study was given clear information about the research and agreed to take part. They also gave permission for their data to be used and shared in the study results.

Financial Support Statement: This research was not given any special money from any organization, whether it's a government group, a business, or a non for profit group.

Conflict of Interest Statement: Authors claim they possess no interests that might influence their work.

Data Availability Statement: The data sets created and studied in this research can be obtained from the main author if requested properly.

AI Disclosure: Artificial intelligence tools were not used in the planning, carrying out, analyzing data, or writing of this study.

8. Conflict of Interest: Nil

9. References

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