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Original Article

Physical Medicine and Rehabilitation Section

Effectiveness of Task-specific Closed-chain Exercises on Functional Mobility in 6 to 12-year-old Spastic Diplegic Children: A Randomised Controlled Trial

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ABSTRACT

Introduction: Cerebral palsy is the leading cause of childhood disability worldwide. Children with spastic diplegia often have trouble with balance, making walking and reaching movements difficult. As a result, they may be less active, have lower strength, require assistance in daily activities, and find it difficult to take part in community activities in adulthood. Children with disabilities have lower engagement in school activities. Targeting the 6 to 12-year age group is therefore crucial, as early functional gains can influence long-term independence and participation.

Aim: To determine the effectiveness of task-specific closed-chain exercise training on balance, gait parameters (cadence, stride length, step length and speed), and gross motor function in children aged 6 to 12 years with spastic diplegic cerebral palsy.

Materials and Methods: The present single-blinded, randomised controlled trial was conducted at Goa Medical College (Bambolim) Goa, India. The study was carried out from October 2022 to November 2023. 30 participants were randomly allocated into two groups (n=15 each); group A: Task-specific closed-chain exercises and group B: Conventional physiotherapy. Both groups received 45-minute sessions, three times per week for six weeks. Outcome measures included the Paediatric Balance Scale (PBS), Gross Motor Function Measure (GMFM-88) Dimensions D and E, the 10-Meter Walk Test (10MWT), and observational assessment of gait parameters (cadence, stride length, step length and gait speed) using paper-and-ink footprint analysis. Assessments were done at baseline (0 weeks), post-intervention (6 weeks), and follow-up (10 weeks). Statistical analysis was performed with Statistical Package for Social Sciences (SPSS) version 24, with significance set at $p<0.05$. Demographic comparisons done using Chi-square and t-tests, while independent and paired t-tests assessed inter- and intra-group differences.

Results: Both groups were homogenously distributed in age, gender, and physical ability level. Between-group comparisons revealed no statistically significant differences at any time point for PBS scores, gait parameters and gross motor function $p>0.05$. Within-group analysis showed improvements in PBS scores, gait parameters (gait speed, stride length, step length, cadence) and gross motor function from baseline to follow-up. group A demonstrated stronger gains overall, with large effect sizes in gait parameters and gross motor function {Stride length: group A (d=0.7), group B (d=0.4), GMFM-E: group A (d=0.8), group B (d=0.7)}. group B, however had greater improvement in PBS scores group A (d=0.7), group B (d=0.8).

Conclusion: Task-specific closed-chain exercises helped children with spastic diplegia to improve their balance, walking, and overall movement abilities. This alongside conventional physiotherapy led to positive changes, the task-specific exercises proved beneficial in walking and gross motor skills. These exercises help children to move more confidently and independently, allowing them to take part more comfortably in everyday and community activities.

Keywords: Balance, Cadence, Gait speed, Gross motor function, Paediatric rehabilitation, Physiotherapy, Stride length

INTRODUCTION

Cerebral palsy is a childhood disability affecting motor function, resulting from non-progressive disturbances occurring in the developing fetus or infant brain, having multifactorial aetiologies [1,2]. About 35% of children with cerebral palsy have spastic diplegia, characterised by predominant lower-limb involvement leading to impaired gait and balance [3]. The Gross Motor Function Classification System (GMFCS) is used to evaluate the child's motor functions, plan treatment, and predict progress over time [4]. Children with cerebral palsy have impaired proprioception and exhibit difficulty with both static and dynamic balance compared to their typically developing peers [5,6]. These children experience motor limitations related to sitting, standing, walking, and running [7]. Gait in children with cerebral palsy is characterised by slower walking speed, reduced stride length, and prolonged double-limb support time due to impaired neuromuscular control.

Daily activities in children with cerebral palsy should be routinely monitored as they grow older, as the access to assistive devices and support services, especially social support, decreases and caregivers grow older too [8]. Caregivers, particularly in low- and middle-income families, often experience emotional strain, guilt, and financial burden while balancing caregiving with work and family [9]. All these challenges show the importance of giving early and targeted interventions.

Research has shown that strengthening exercises, such as closed-chain exercises and task-specific training, significantly improve gait, balance, and overall motor function without worsening spasticity [10-12]. Task-specific exercise approaches focus on repeatedly practicing meaningful, functional, everyday tasks. They are based on motor-learning principles, which emphasise the person-task-environment interaction in skill development [13,14]. However, literature indicates that many physiotherapy interventions for CP lack strong randomised controlled trial evidence; it remains unclear whether the improvements are maintained long-term, as most studies have limited follow-up [15-18]. Moreover, only a limited number of studies have assessed gait, balance, and gross motor function together within a single intervention program [19,20], and research involving Indian paediatric populations also remains limited [21,22].

This study targets children aged 6 to 12 years, which is a key period in the developmental phase and the future adult population and combines both task-specific and closed-chain exercises, comparing them with conventional physiotherapy. By analysing the outcomes at baseline, post-intervention, and follow-up in children with GMFCS Levels I-III, the study attempts to reveals the immediate and short-term retained effects of this integrated training on balance, gait, and gross motor function.

Therefore, the study aims to assess the effectiveness of task-specific closed-chain exercise training on balance; gait parameters, including cadence, stride length, step length, and walking speed; and gross motor function in children aged 6 to 12 years with spastic diplegic cerebral palsy.

MATERIALS AND METHODS

The present study is a single-blind randomised controlled trial held at Goa Medical College (Bambolim) between October 2022 and November 2023, following ethics approval from the Institutional Ethics Committee (IEC No: GMCIEC/2022/160). Participants receiving physiotherapy at the Paediatric Neuro-Rehabilitation Centre (PNRC), under the GMC Paediatric Department, and eight special schools selected using taluka-wise cluster sampling (out of 12 talukas, 4 talukas were randomly allocated using lottery method and within those Talukas randomly 2 schools were selected). Permission was obtained from the respective school principals and teachers. Written informed consent was provided by parents or guardians, and assent was obtained from all participating children. The trial was prospectively registered in the Clinical Trials Registry-India under the registration number ClinicalTrial.gov CTRI/2023/02/049844.

Sample size calculation: Thirty children diagnosed with spastic diplegic cerebral palsy were recruited for this study. Sample size was calculated using G*Power (version 3.1.9.2) using the study by Saikia Baruah T et al., as reference with α=0.05 and 80% power [23]. Therefore, the sample size was 15 participants/group, so total of 30 participants.

Inclusion and Exclusion criteria: Children aged 6 to 12 years with spastic diplegic CP classified under GMFCS Levels I-III [4], able to follow verbal instructions, and willing to participate were included. Exclusion criteria were GMFCS Levels IV and V; the presence of visual, hearing, or cognitive impairments; orthopaedic deformities that restricted gait or functional mobility; a history of seizures; lower-limb orthopaedic surgery within the preceding 12 months; or botulinum toxin injections within the previous six months.

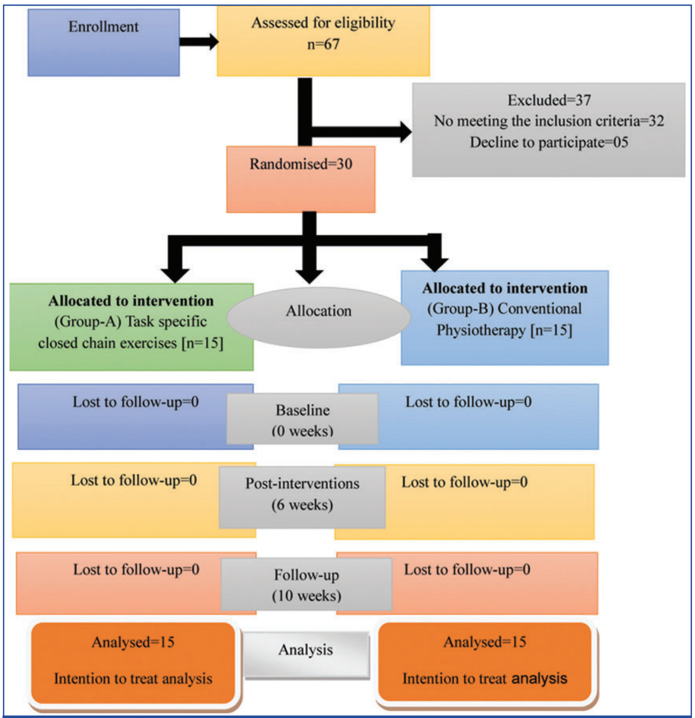
Study Procedure

Participants were randomised using computer-generated random numbers. Children were assigned either to group A for task-specific closed-chain exercises or group B for conventional physiotherapy. The CONSORT diagram below illustrates the study flow [Table/Fig-1].

Intervention: All participants received warm-up and cool-down exercises before and after each therapy session. The warm-up protocol included lower-limb range-of-motion exercises and stretching of the tibialis anterior, knee flexors, hip flexors, and hip adductors, performed for 5-10 minutes (10 repetitions ×3 sets) [23].

group A: Task-specific closed-chain exercise training

Participants in group A received a structured task-specific closed-chain exercise program for 45 minutes, three times per week. Each exercise was performed for five repetitions [24].



[Table/Fig-1]: CONSORT flow diagram.

The protocol included:

- Squat and throw a ball;
- Tabletop activity like pushing and pulling a toy car;
- Lifting a ball and throwing it diagonally in standing;
- Alternate leg ball kicking;
- Sit-to-stand transitions using stools of varying heights;
- Walking with sticks coordinating upper and lower-limb movements;
- Walking on a sensory pathway with varied obstacles.

These activities align with evidence supporting task-specific functional training and closed-chain strengthening in CP rehabilitation [25,26].

Group B: Conventional Physiotherapy

Participants in group B received conventional physiotherapy for 45 minutes, three times per week [24,27].

The program included:

- Mat-based exercises like bridging and abdominal strengthening with trunk rotation on a bolster;
- Lower-limb strengthening in squatting, kneeling, and half-kneeling positions;
- Gluteal and core muscle facilitation;
- Pelvic dissociation and reaching activities;
- Wobble board-balance activities (stride standing, walk standing);
- Swiss ball exercises;
- Gait training over a 10-Meter distance with parallel bars or a walker.

Both groups received therapy three times per week for six weeks, totalling 18 supervised sessions. To reduce dropout rates, two sessions per week were administered, and one session consisted of home-based exercises. Parents and participants were instructed to maintain a home-exercise log and mark completed sessions weekly.

Outcome Measures

Balance, gait, and gross motor function were assessed and conducted at baseline (0 weeks), post-intervention (6 weeks), and follow-up (10 weeks). The assessor was blinded to minimise observer bias. Balance was evaluated using the PBS, a paediatric adaptation of the Berg Balance Scale for children with motor impairments [28]. It includes 14 items assessing tasks such as standing, reaching, turning, and transferring. A 5-point ordinal scale (0-4) with maximum score of 56; higher scores indicate better balance (ICC=0.992) in children with CP [28].

Gait performance was evaluated using observational gait analysis, the ink-footprint method, and the 10MWT. The following spatiotemporal gait parameters were recorded:

- Cadence (steps/min)
- Stride length (distance between two heel strikes of the same foot) (cm)
- Step length (distance between heel strikes of opposite feet) (cm)
- Walking speed (m/s)

The ink-footprint method was used to obtain spatial parameters, while cadence and speed were measured during the 10MWT. The 10MWT is used as a measure mobility in children [29]. Participants walked a 10-meter distance at a comfortable speed, and the time was recorded (ICC=0.91).

The GMFM is used to evaluate changes in gross motor skills with cerebral palsy in the 5-month to 16-year age group [30]. Gross motor abilities were evaluated using the GMFM-88, for assessing motor function in children with cerebral palsy (ICC=0.952–1.000) [31]. It has 88 components scored on a 4-point ordinal scale, grouped into five dimensions: A, B, C, D, and E. Focusing on functional mobility and closed-chain training, only Dimensions, D (standing-13 components from 52-64) and E (walking, running, jumping - 24 components from 65-88) were assessed in this study

The GMFM-88 Dimension D (Standing) and Dimension E percent score is calculated by dividing the sum of the raw scores for all items in Dimension D and E separately by the maximum possible score for that dimension (39 and 72, respectively), and then multiplying by 100. Three trials were allowed per item, and the best performance was recorded, and scores were expressed as percentages for each dimension.

STATISTICAL ANALYSIS

Statistical analyses were performed using SPSS software (version 24.0). The level of significance was set at p< 0.05 for all tests. Descriptive statistics were used to summarise demographic and baseline characteristics. Between-group differences in demographic variables were examined using the Chi-square test for categorical data and the independent t-test for continuous variables. To evaluate treatment effects, independent t-tests were used to compare intergroup differences between the experimental and control groups at each assessment time point (0, 6, and 10 weeks). Dependent (paired) t-tests were applied to analyse intragroup changes across the three time points within each group.

RESULTS

The baseline characteristics (age, gender distribution, and GMFCS levels) showed no statistically significant differences between group A and group B (p>0.05). This confirms that the two groups were homogeneous at baseline [Table/Fig-2]. There were no statistically significant differences observed between the groups at any time point (p>0.05) [Table/Fig-3].

Both groups showed improvements in mean scores post-intervention and at follow-up from baseline, p<0.001, with group A consistently demonstrating slightly higher gains. Improvement in each group confirms the effectiveness of the interventions [Table/Fig-4].

Both groups showed improvements in gait parameters over time, including walking speed, stride length, step length, and cadence. However, no statistically significant differences were observed between group A and group B at any time point (p>0.05) [Table/Fig-5]. Both intervention groups demonstrated significant improvements in gait parameters over time, including walking speed, stride length, step length, and cadence post intervention and follow-up from baseline [Table/Fig 6]. The GMFM-88 Dimension D (Standing) and Dimension E percent score is calculated by dividing the sum of the raw scores for all items in Dimension D and E separately by the maximum possible score for that dimension and then multiplying by 100.

Characteristics	Group	Value	p-value
Age (years) mean±SD	Group A (n=15)	7.2±2	0.3150
	Group B (n=15)	8±2.3	
Gender {n (%)}	Group A (n=15)	Male: 60%	0.3858
		Female: 40%	
	Group B (n=15)	Male: 53.33%	
		Female: 46.67%	
GMFCS Level {n (%)} [4]	Group A (n=15)	Level I: 46.67%	0.6852
		Level II: 26.67%	
		Level III: 26.67%	
	Group B (n=15)	Level I: 40%	
		Level II: 33.33%	
		Level III: 26.67%	

[Table/Fig-2]: Demographic data.
Chi-square test and t-test *p<0.05 indicates significant

Time points	Group A Mean±SD	Group B Mean±SD	Mean Difference	t-value	p-value
Baseline (0 weeks)	34.27±18.8	32.67±16.7	1.60	0.2462	0.8073
Post-intervention (6 weeks)	42.80±15.2	40.13±16.0	2.67	0.4653	0.6453
Follow-up (10 weeks)	42.60±14.6	39.53±16.1	3.07	0.5452	0.5900

[Table/Fig-3]: Between group comparison of Group A and Group B with PBS scores [28] at different treatment time points.
Independent T-test [28]

Groups	Changes from	Mean Diff.	SD Diff.	% of change	t-value	p-value	Effect size
Group A	Baseline-Post Intervention	8.53	5.42	24.90	-6.0943	0.0001*	0.7000
	Baseline - F/U	8.33	5.83	24.32	-5.5390	0.0001*	
	Post-Intervention-F/U	-0.20	1.37	-0.47	0.5641	0.5816	
Group B	Baseline-Post Intervention	7.47	2.67	22.86	-10.8347	0.0001*	0.8940
	Baseline - F/U	6.87	2.29	21.02	-11.5884	0.0001*	
	Post-Intervention-F/U	-0.60	0.83	-1.50	2.8062	0.0140*	

[Table/Fig-4]: Within group comparison of group A and group B with PBS scores at different treatment time points.
Dependent T-test [28]

Both groups showed improvements in GMFM (D-dimension) scores, with no significant between-group differences, indicating comparable effects. Likewise, GMFM (E-dimension) scores improved similarly across groups, with no significant differences at baseline, post-intervention and follow-up [Table/Fig-7].

Both group A and group B achieved statistically significant improvements in GMFM Dimensions D and E from baseline to post-intervention and baseline to follow-up. group A demonstrated stronger gains overall, with a large effect size in Dimension D

Time point	Gait parameters	Group A	Group B	Mean Difference	t-value	p-value
		Mean±SD	Mean±SD			
Baseline (0 weeks)		0.68±0.36	0.66±0.42	0.01	0.0841	0.9336
Post-intervention (6 weeks)		0.73±0.39	0.71±0.46	0.02	0.1245	0.9018
Follow-up (10 weeks)	10 Meter walk (m/s)	0.71±0.38	0.70±0.45	0.01	0.0751	0.9407
Baseline (0 weeks)		39.07±19	45.67±20	-6.60	-0.8985	0.3766
Post-intervention (6 weeks)	Stride length (cm)	43.40±21.4	50.60±22.4	-7.20	-0.8976	0.3770
Follow-up (10 weeks)		42.63±21.61	48.95±21.63	-6.31	-0.7997	0.4306
Baseline (0 weeks)		27.70±15.5	26.53±10	1.17	0.2436	0.8093
Post-intervention (6 weeks)		30.57±16.6	30.53±10.3	0.03	0.0066	0.9948
Follow-up (10 weeks)	Step length (cm)	30.43±16.5	28.45±11.8	1.99	0.3777	0.7085
Baseline (0 weeks)		97.47±39.8	96.47±37.8	1.00	0.0705	0.9443
Post-intervention (6 weeks)	Cadence (steps/min)	102.13±38.9	100.73±37.9	1.40	0.0998	0.9212
Follow-up (10 weeks)		102.00±37.6	99.47±37.3	2.53	0.1850	0.8546

[Table/Fig-5]: Between groups comparison of group, A and group B with 10 M walk (M/S), stride length, step length, and cadence at different treatment time points, Independent t-test [29]

Gait parameters	Groups	Changes from	Mean Diff.	Sd Diff.	% of change	t-value	p-value	Effect size
10 M Walk (M/S)	Group A	Baseline-post intervention	0.06	0.04	8.18	-4.8115	0.0003*	0.356
		Baseline - F/U	0.03	0.03	5.12	-4.7526	0.0003*	
		Post-intervention- F/U	-0.02	0.03	-2.82	2.505	0.0252*	
	Group B	Baseline-post intervention	0.05	0.07	7.22	-2.8294	0.0134*	0.311
		Baseline - F/U	0.04	0.06	5.32	-2.3932	0.0313*	
		Post-intervention- F/U	-0.01	0.02	-1.78	2.9418	0.0107*	
Stride Length (cm)	Group A	Baseline-post intervention	4.33	2.39	11.09	-7.0281	0.0001*	0.748
		Baseline - F/U	3.57	2.18	9.13	-6.3413	0.0001*	
		Post-intervention- F/U	-0.77	1.07	-1.77	2.7833	0.0147*	
	Group B	Baseline-post Intervention	4.93	5.15	10.8	-3.712	0.0023*	0.497
		Baseline - F/U	3.28	2.89	7.18	-4.3969	0.0006*	
		Post-Intervention- F/U	-1.65	2.5	-3.27	2.5652	0.0224*	
Step Length (cm)	Group A	Baseline-post intervention	2.87	1.72	10.35	-6.4694	0.0001*	0.663
		Baseline - F/U	2.73	1.96	9.87	-5.3935	0.0001*	
		Post-intervention- F/U	-0.13	1.33	-0.44	0.3885	0.7035	
	Group B	Baseline-post intervention	4	2.2	15.08	-7.0294	0.0001*	0.513
		Baseline - F/U	1.91	3.25	7.21	-2.2796	0.0388*	
		Post-intervention- F/U	-2.09	3	-6.83	2.6924	0.0175*	
Cadence (steps/min)	Group A	Baseline-post intervention	4.67	8.04	4.79	-2.2476	0.0412*	0.253
		Baseline - F/U	4.53	7.84	4.65	-2.2405	0.0418*	
		Post-intervention- F/U	-0.13	2.83	-0.13	0.1828	0.8576	
	Group B	Baseline-post intervention	4.27	4.89	4.42	-3.3785	0.0045*	0.366
		Baseline - F/U	3	5.13	3.11	-2.2662	0.0398*	
		Post-intervention- F/U	-1.27	1.83	-1.26	2.6794	0.0180*	

[Table/Fig-6]: Within groups comparison of group, A and group B with 10 M walk (M/S), stride length, step length and cadence at different treatment time points [29].
Dependent t-test *p<0.05 indicates significant

Time points	Dimension GMFM-88	Group A	Group B	Mean difference	t-value	p-value
		Mean±SD	Mean±SD			
Baseline (0 weeks)	GMFM (D-dimension)	70.42±29.73	73.99±30.85	-3.57	-0.3227	0.7493
Post-intervention (6 weeks)		82.91±23.60	83.42±24.11	-0.51	-0.0583	0.9539
Follow-up (10 weeks)		84.10±22.88	82.90±25.10	1.20	0.1364	0.8925
Baseline (0 weeks)	GMFM (E-dimension)	61.66±30.26	61.66±29.64	0.00	-0.0002	0.9998
Post-intervention (6 weeks)		74.81±29.05	72.22±28.79	2.59	0.2449	0.8083
Follow-up (10 weeks)		74.35±28.73	71.76±28.79	2.59	0.2470	0.8067

[Table/Fig-7]: Between groups comparison of group, A and group B in GMFM (D-dimension) [31] scores at different treatment time points.
Independent t-test

compared to group B's medium effect, while both groups showed medium effects in Dimension E. Importantly, the changes from post-intervention to follow-up were not significant, indicating that improvements were successfully maintained [Table/Fig-8].

GMFM	Groups	Changes from:	Mean Diff.	SD Diff.	% of change	t-value	p-value	Effect size
GMFM (D-dimension)	Group A	Baseline- post intervention	12.48	10.83	17.73	-4.4635	0.0005*	0.5810
		Baseline - F/U	13.68	11.70	19.42	-4.5287	0.0005*	
		Post intervention- F/U	1.19	3.48	1.44	-1.3271	0.2057	
	Group B	Baseline- post intervention	9.42	8.52	12.73	-4.2814	0.0008*	0.5770
		Baseline - F/U	8.91	7.60	12.04	-4.5379	0.0005*	
		Post intervention- F/U	-0.51	1.44	-0.61	1.3801	0.1892	
GMFM (E-dimension)	Group A	Baseline- post intervention	13.15	6.25	21.33	-8.1446	0.0001*	0.8210
		Baseline - F/U	12.69	6.01	20.58	-8.1832	0.0001*	
		Post intervention- F/U	-0.46	1.63	-0.62	1.0960	0.2916	
	Group B	Baseline- post intervention	10.56	5.42	17.13	-7.5434	0.0001*	0.7980
		Baseline - F/U	10.09	5.23	16.37	-7.4680	0.0001*	
		Post intervention- F/U	-0.47	0.85	-0.65	2.1293	0.0515	

[Table/Fig-8]: Comparison of different treatment time points in group A and group B with GMFM (D-dimension) and GMFM (E-dimension) scores.
Dependent t test *p<0.05 indicates significant [31]

DISCUSSION

Task-specific exercises do repetitive practice of functional activities based on motor-learning principles, which aligns with the International Classification of Functioning, Disability, and Health (ICF) framework [13]. Pierce SR et al., found a positive relationship between age and knee-flexor passive torque in children aged 7-14 years. The present sample (6 to 12 years) included children with walking difficulties likely influenced by spasticity [32]. Gender differences have been reported across CP subtypes, with males more frequently affected in most forms except ataxic diplegia [33,34]. In this study, gender distribution was equal. Spasticity varies with GMFCS level; levels I-II has lower spasticity than III-IV [35].

Children with CP have impaired axial control, low strength, and poor postural control, particularly in the lower limbs [36]. Both task-specific and conventional physiotherapy improved PBS, GMFM, and gait parameters, consistent with previous findings [37-43]. Improvements may be linked to improved trunk strength, coordination, and postural control. Perturbation training in the conventional group may explain its notable balance gains [36].

Crossing obstacles tests dynamic balance and requires anticipatory control. Children with GMFCS I-II can modify kinematics to avoid falls [44], though they typically show reduced approach and crossing speeds [45]. In this study, both groups demonstrated significant improvements in speed, stride length, step length, and cadence over 10 weeks. Recent systematic reviews show that gait training improves gait in CP [46,47]. Likely because of increased lower-limb strength improving gait stability and efficiency. Enhanced stride length may show reduced crouch and better stance-leg stability [46]. Arm swing also plays a stabilising role, with trunk sway increasing alongside walking speed [48,49].

Task-specific training involving obstacle crossing, inter-limb coordination, and functional weight-bearing exercises led to the better results seen in group A. Practicing these varied movements improved error-adjustment and motor adaptability [50], while closed-chain exercises improved proprioception and motor recruitment [51]. Children with GMFCS I show higher motor capacity than those in levels II-III [52]. Baseline GMFM-D and GMFM-E scores in this study reflected relatively good standing and walking abilities. Both groups improved in GMFM-D, while GMFM-E gains were greater in the task-specific group, consistent with previous meta-analysis findings, evidence favouring task-oriented training (MD=7.36, $p<0.001$) [13].

Motor programs delivered as task-oriented training in a home environment are effective in enhancing motor function and balance in children with cerebral palsy [53]. Previous research on Segmental trunk control explains ~40% of GMFM variance, highlighting its central role in mobility [54]. Sah AK et al., (2019) further reported significant improvements in trunk control (+4.2, $p<0.01$), balance (+5.1, $p<0.001$), and GMFM (+6.7, $p<0.001$) with task-oriented activities [55], while closed kinetic chain exercises yielded greater gains in gait and GMFM-D/E ($p<0.05$) [23]. Collectively, these findings emphasise the effectiveness of axial stability and task-specific practice in enhancing balance, gait, and overall motor function in CP. The present study findings reveal that improvements in balance and gait directly contributed to enhanced GMFM scores across both groups.

Limitation(s)

The present study did not account for prior procedures (e.g., tendon release, botulinum toxin) that may have influenced baseline motor function or treatment response. Daily activity levels, school therapy, and other rehabilitation services were uncontrolled, potentially contributing to improvements. Home environments varied in space, caregiver support, and assistive devices, affecting consistency. Finally, adherence to the home exercise program was not objectively monitored, limiting certainty about compliance.

CONCLUSION(S)

Both task-specific closed-chain exercise training and conventional physiotherapy were effective in improving balance, gait parameters (cadence, stride length, speed), and gross motor function in children with spastic diplegia classified under GMFCS Levels I, II, and III. While conventional physiotherapy also contributed to positive functional gains; the improvements in gait, stride length, cadence, and GMFM Dimensions D and E were more pronounced with task-specific closed-chain exercises.

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