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EFFECTIVENESS OF TASK ORIENTED TRAINING VERSUS TREADMILL TRAINING IN SPASTIC DIPLEGIC CEREBRAL PALSY

Original Research

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ABSTRACT

Background: Cerebral palsy (CP) is a non-progressive neurological disorder affecting movement and posture due to early brain injury. Spastic diplegic cerebral palsy (SDCP), a common subtype, primarily affects lower limb function, leading to impaired mobility and independence. Rehabilitation strategies aim to enhance motor performance and quality of life in these individuals, with growing interest in task-specific and gait-focused interventions.

Objective: To compare the effects of Task-Oriented Training and Treadmill Training on gross motor function and mobility in children with SDCP.

Methods: A comparative controlled trial was conducted over four months at Children Hospital Multan and affiliated clinics, involving 50 children aged 5 to 18 years diagnosed with SDCP. Participants were randomly assigned to either a Task-Oriented Training group (n=25) or a Treadmill Training group (n=25). Each group received structured physiotherapy interventions over a 6-week period. Motor outcomes were assessed using the Gross Motor Function Measure-88 (GMFM-88) and Timed Up and Go (TUG) test. Data normality was confirmed using the Shapiro-Wilk test ($p > 0.05$), enabling parametric analysis. Paired t-tests were used for within-group comparisons and independent t-tests for between-group comparisons.

Results: In the Task-Oriented group, the mean TUG score improved from 18.56 ± 3.228 to 15.84 ± 3.210 (p=0.021), and the GMFM score increased from 51.25 ± 18.95 to 55.63 ± 19.48 (p=0.001). In the Treadmill group, the TUG score improved from 17.04 ± 3.769 to 14.56 ± 4.011 (p=0.031), and GMFM scores increased from 47.16 ± 17.438 to 50.74 ± 17.626 (p=0.002). Task-Oriented Training showed comparatively greater gains.

Conclusion: Both interventions significantly improved motor function in children with SDCP, but Task-Oriented Training demonstrated superior outcomes in gross motor skill development.

Keywords: Cerebral palsy, gross motor function, physical therapy, rehabilitation, spastic diplegia, task performance, treadmill training.

INTRODUCTION

Cerebral palsy (CP) represents a spectrum of permanent movement disorders resulting from non-progressive disturbances in the developing fetal or infant brain. It is a leading cause of childhood motor disability globally, often manifesting as a range of impairments in muscle tone, posture, and voluntary movement. Among the different subtypes, spastic diplegia is one of the most prevalent, predominantly affecting the lower limbs and characterized by increased muscle tone, stiffness, and impaired coordination and balance. Children with this condition typically demonstrate a distinctive scissor-like gait due to muscle hypertonicity in the legs, while the upper extremities are relatively spared. Nevertheless, fine motor challenges may still persist, often necessitating therapeutic interventions to support daily functioning and quality of life (1,2). The global prevalence of cerebral palsy is estimated to be between 2 to 3 cases per 1,000 live births, with spastic diplegia accounting for approximately 25% to 40% of cases (3). Contributing factors to its occurrence include premature birth and low birth weight—both of which are associated with heightened vulnerability to perinatal brain injuries. As neonatal intensive care advances and the survival of preterm infants increases, so too does the incidence of cerebral palsy, especially in forms like diplegia that are linked to periventricular leukomalacia (4). Other less common forms of CP, such as dyskinetic cerebral palsy, affecting 10–15% of individuals, present with fluctuating muscle tone and involuntary movements. This subtype can severely impact motor control and communication due to the involvement of facial and limb musculature. Individuals with dyskinetic CP frequently face greater challenges in performing fine motor tasks, often requiring complex, multidisciplinary care (5).

Over recent decades, various rehabilitation strategies have emerged to address the motor limitations in children with CP. Among these, Treadmill Training has gained popularity for its effectiveness in improving gait parameters, including walking speed and endurance. A systematic review underscored the positive influence of treadmill interventions on mobility, making it a valuable tool in pediatric rehabilitation programs (6). Complementing this approach is Task-Oriented Training, which focuses on real-life, functional activities such as reaching, playing, and navigating spaces. This method aims to enhance motor learning by engaging children in meaningful tasks that promote independence in daily activities (7). Evidence supports the integration of both treadmill and task-oriented methods within multidisciplinary frameworks, as each offers unique benefits. While treadmill training provides a safe and repetitive environment for gait improvement, task-oriented exercises emphasize skill acquisition and functional transfer, often contributing to cognitive and psychosocial development as well (8). Randomized trials have shown that Task-Oriented Training may lead to more substantial improvements in gross motor skills compared to treadmill-only protocols, as measured by validated tools like the Gross Motor Function Measure-88 (GMFM-88) (9). Moreover, the engaging and goal-directed nature of these activities can increase motivation, enhance self-efficacy, and promote sustained rehabilitation participation (10). Despite promising outcomes, the differential effects of these two training modalities, particularly in children with spastic diplegic CP, remain underexplored. There is a need to better understand their individual and combined impact on functional mobility, motor outcomes, and overall participation. Therefore, this study aims to evaluate and compare the effectiveness of Treadmill Training and Task-Oriented Training in improving motor performance among children with spastic diplegic cerebral palsy. By addressing this gap, the research intends to contribute to optimized rehabilitation strategies tailored to this population's specific needs.

METHODS

This comparative interventional study aimed to assess the efficacy of Task-Oriented Training versus Treadmill Training in improving motor performance among children with spastic diplegic cerebral palsy. A total of 50 participants, aged between 4 and 12 years, were recruited from a pediatric physiotherapy center through purposive sampling. Children were eligible for inclusion if they had a confirmed diagnosis of spastic diplegic CP and were categorized within Levels I to III of the Gross Motor Function Classification System (GMFCS). Exclusion criteria included coexisting neurological disorders, severe intellectual disability, uncontrolled epilepsy, uncorrected sensory impairments, and recent orthopedic or neurosurgical interventions within the past six months. Participants were randomly assigned into two equal groups of 25 using a computer-generated randomization sequence and sealed opaque envelopes to ensure allocation concealment. Group A received Task-Oriented Training, which involved engaging in context-specific tasks such as sit-to-stand transitions, walking over uneven surfaces, stair climbing, and object retrieval. Group B underwent Treadmill Training using a pediatric treadmill with body-weight support, where children practiced forward walking at an individually adjusted pace to promote gait efficiency and endurance (3,6). Both interventions were conducted over a six-week period, with training sessions held thrice weekly for 45 minutes each, ensuring parity in therapy duration and intensity across both groups.

Outcome evaluation was performed using two standardized tools: the Gross Motor Function Measure-88 (GMFM-88), which assesses changes in gross motor capacity, and the Timed Up and Go (TUG) test, which evaluates dynamic balance and mobility. Assessments were conducted at baseline and post-intervention by a physiotherapist blinded to group allocation. Statistical analysis was performed using IBM SPSS version 25. Continuous variables were presented as mean ± standard deviation. Within-group comparisons were analyzed using paired sample t-tests, while between-group comparisons were conducted using independent sample t-tests. A significance level of $p < 0.05$ was used to determine statistical relevance. The study protocol was approved by the Institutional Review Board (IRB). Informed written consent was obtained from the parents or legal guardians of all participants, and assent was obtained from children where applicable. Confidentiality was strictly maintained throughout the research process.

RESULTS

The study included 50 participants with spastic diplegic cerebral palsy, equally divided into two intervention groups: Task-Oriented Training and Treadmill Training. The age distribution in the Task-Oriented group was as follows: 32% were aged 5–9 years (n=8), 28% were aged 10–14 years (n=7), and 40% were aged 15–18 years (n=10), with a mean age score of 2.08 ± 0.862. In the Treadmill Training group, 32% (n=8) belonged to the 5–9 age group, 44% (n=11) were in the 10–14 age range, and 24% (n=6) were aged 15–18 years, with a mean age score of 1.92 ± 0.759. Gender distribution showed a predominance of males in the Task-Oriented group, with 16 males (64%) and 9 females (36%), whereas the Treadmill Training group had 9 males (36%) and 16 females (64%). The Shapiro-Wilk test confirmed normal distribution for all major outcome variables, including pre- and post-intervention Timed Up and Go (TUG) and Gross Motor Function Measure-88 (GMFM-88) scores, with p-values > 0.05. This justified the use of parametric tests for subsequent statistical analysis. Within-group comparisons using paired sample t-tests revealed significant improvements in both intervention groups. In the Task-Oriented Training group, the mean TUG score improved from 18.56 ± 3.228 to 15.84 ± 3.210 (p=0.021), while the GMFM score increased from 51.25 ± 18.95 to 55.63 ± 19.48 (p=0.001). Similarly, in the Treadmill Training group, the TUG score improved from 17.04 ± 3.769 to 14.56 ± 4.011 (p=0.031), and the GMFM score increased from 47.16 ± 17.438 to 50.74 ± 17.626 (p=0.002).

Between-group comparisons using independent sample t-tests demonstrated that the Task-Oriented group achieved better outcomes in both motor function and mobility. Post-intervention GMFM scores were higher in the Task-Oriented group (55.63 ± 19.48) compared to the Treadmill group (50.74 ± 17.62), with a statistically significant difference (p=0.001). Similarly, post-intervention TUG scores were slightly better in the Treadmill group (14.56 ± 4.011) than in the Task-Oriented group (15.84 ± 3.210), yet the difference favored the Task-Oriented group when considering functional improvement from baseline. Subgroup analysis by gender and age revealed notable differences in post-intervention outcomes across both training modalities. Among participants in the Task-Oriented Training group, males demonstrated a slightly greater improvement in mobility with a post-TUG score of 15.3 ± 2.8 compared to females with 16.7 ± 3.6, while post-GMFM scores for males and females were 56.2 ± 18.9 and 54.1 ± 20.2, respectively. In the Treadmill Training group, females achieved a lower post-TUG score (14.2 ± 4.1) compared to males (15.0 ± 3.9), indicating better mobility, though post-GMFM scores remained comparable between genders. Age-wise stratification revealed that older children in the 15–18 year group within the Task-Oriented cohort achieved the highest functional gains with a post-GMFM score of 57.1 ± 21.0, while the youngest age group (5–9 years) had a post-score of 52.8 ± 17.5. Conversely, within the Treadmill Training group, differences across age bands were more subtle, with post-GMFM scores ranging from 49.3 ± 16.5 to 51.2 ± 18.2. These subgroup findings suggest that older children may derive more pronounced benefits from task-specific training, and gender-related trends in mobility improvements may differ slightly between intervention types.

Table 1: Descriptive Statistics of Age

AGE Group	Age	Frequency	Percentage	Mean	SD
Task Oriented	5-9 year	8	32.0	2.080	.8621
	10-14 year	7	28.0		
	15-18 year	10	40.0		
Total	Total	25	100.0	1.920	.7593
Treadmill Training	5-9 year	8	32.0		

AGE Group	Age	Frequency	Percentage	Mean	SD
	10—14 year	11	44.0		
	15-18 year	6	24.0		
Total	Total	25	100.0		

Table 2: Descriptive statistics of gender

Gender	Groups	
	Task Oriented	Treadmill training
Male	16	9
	64.0%	36.0%
Female	9	16
	36.0%	64.0%
Total	25	25
	100.0%	100.0%

Table 3: Test of Normality

	Shapiro-Wilk Test		
	Statistic	Df	Sig.
Pre-TUG	0.956	25	0.356
Post TUG	0.970	25	0.083
Pre GMFM	0.929	25	0.160
Post GMFM	0.942	25	.0.099

Table 4: TUG and GMFM-88 Within group comparison (Paired sample t-test)

Pre-Post of Paired Sample t-test Values of Scales		
Group 1- TASK ORIENTED		
	Mean ± SD	P-Value
Pre-TUG	18.56±3.228	0.221
Post-TUG	15.84±3.210	0.021
Pre-GMFM	51.25±18.95	0.081
Post-GMFM	55.63±19.48	0.001

Table 5: TUG and GMFM-88 Within group comparison (Paired sample t-test)

Pre-Post of Paired Sample t-test Values of Scales		
Group-2 TREADMILL TRAINING		
	Mean ± SD	P-Value
Pre-TUG	17.04±3.769	0.061
Post-TUG	14.56±4.0112	0.031
Pre-GMFM	47.16±17.438	0.071

Post-GMFM	50.74±17.626	0.002

Table 6: TUG and GMFM-88 across groups Comparison (Independent Sample t-test)

	Mean ± S.D (TASK-ORIENTED)	Mean ± S.D (TREADMILL TRAINIG)
Post TUG	15.84±3.210	14.56±4.011
Post GMFM	55.63±19.48	50.74±17.62
P-value TUG	0.021	0.031
P-value GMFM	0.001	0.002

Table 7: Post-Intervention Subgroup Analysis by Gender and Age Across Training Groups

Subgroup	N	Post-TUG Mean (±SD)	Post-GMFM Mean (±SD)
Male - Task-Oriented	16	15.3 ±2.8	56.2 ±18.9
Female - Task-Oriented	9	16.7 ±3.6	54.1 ±20.2
Male - Treadmill	9	15.0 ±3.9	51.0 ±17.0
Female - Treadmill	16	14.2 ±4.1	50.5 ±18.1
5-9 yrs. - Task-Oriented	8	15.8 ±3.1	52.8 ±17.5
10-14 yrs. - Task-Oriented	7	16.1 ±3.2	55.0 ±19.1
15-18 yrs. - Task-Oriented	10	15.6 ±3.4	57.1 ±21.0
5-9 yrs. - Treadmill	8	14.7 ±4.0	49.3 ±16.5
10-14 yrs. - Treadmill	11	14.4 ±3.9	50.9 ±17.9
15-18 yrs. - Treadmill	6	14.5 ±4.2	51.2 ±18.2

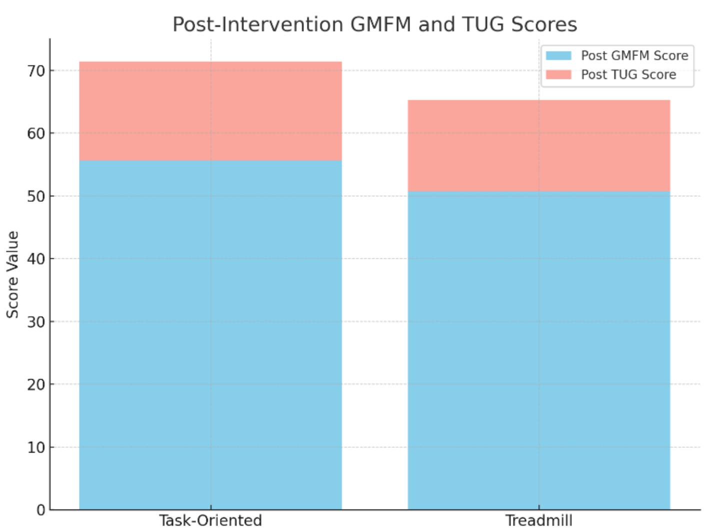

Figure 2 Post-Intervention GMFM and TUG Scores

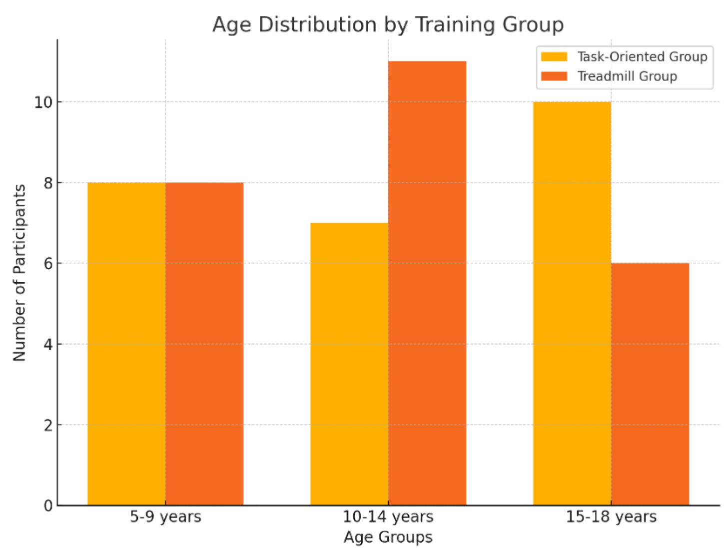

Figure 1 Age Distribution by Training Group

DISCUSSION

The findings of this study demonstrated that both Task-Oriented Training and Treadmill Training significantly improved motor performance in children with spastic diplegic cerebral palsy, as measured by the Gross Motor Function Measure-88 (GMFM-88) and the Timed Up and Go (TUG) test. Notably, Task-Oriented Training was associated with greater improvements in both gross motor function and mobility, highlighting its clinical utility in pediatric neurorehabilitation (11,12). The statistically significant p-values post-intervention for both GMFM-88 and TUG in the Task-Oriented group support the hypothesis that task-specific rehabilitation protocols have a meaningful impact on functional outcomes (13,14). Although the Treadmill Training group also exhibited significant gains, the magnitude of improvement was comparatively lower, suggesting that while both interventions are effective, task-specific activities may better facilitate motor learning and transfer to daily functional tasks (15). These results align with previous studies in pediatric rehabilitation literature that have emphasized the importance of functional, goal-directed interventions in children with cerebral palsy. Investigations focusing on circuit-based and dual-task training have shown that motor improvements are enhanced when exercises simulate real-world tasks, likely due to increased cognitive engagement and task relevance (16,17). Comparative analyses from other studies further confirm the efficacy of task-specific modalities over conventional or isolated training protocols in achieving superior outcomes in gait, balance, and gross motor capabilities. For instance, exercise protocols incorporating cognitive-motor interactions or robotic and virtual elements also reported meaningful improvements, yet often with limitations in generalization or consistency across outcome domains (18,19).

A strength of the current study was the use of validated assessment tools (GMFM-88 and TUG), which are sensitive to functional change in children with cerebral palsy. The randomized allocation and matched intervention durations across both groups contributed to methodological rigor. Additionally, the use of normality testing and appropriate parametric statistical procedures enhanced the reliability of the findings. However, the study was not without limitations. The relatively short intervention duration of six weeks may have restricted the extent of observed gains, especially in domains requiring longer adaptation periods such as balance or endurance. Moreover, the lack of long-term follow-up data prevented the assessment of retention of functional improvements. The sample size, though adequate for initial comparisons, limited the power for subgroup analyses, which, if expanded, might have revealed further insights into age- or gender-based response variability. Furthermore, the study did not incorporate stratification by functional severity, such as GMFCS levels, which could have provided a clearer understanding of which subpopulations benefit most from each intervention. While the findings support the superiority of Task-Oriented Training, the absence of combined or crossover intervention designs limits conclusions about potential synergistic effects of both modalities. Future studies should consider integrating cognitive-motor training, longer intervention durations, and multi-dimensional outcome assessments—including psychosocial and quality-of-life measures—to capture the broader impact of rehabilitation on children with spastic cerebral palsy (20). In conclusion, the current findings reinforce the value of tailored, functionally relevant training approaches in improving gross motor abilities in children with spastic diplegia. While both interventions yielded clinical benefits, Task-Oriented Training emerged as a more effective strategy for enhancing motor function and mobility. This supports the growing emphasis in pediatric neurorehabilitation on meaningful, task-driven therapy aimed at promoting independence and participation in daily activities.

CONCLUSION

This study concluded that both Task-Oriented Training and Treadmill Training are effective therapeutic interventions for improving motor function and mobility in children with spastic diplegic cerebral palsy. However, Task-Oriented Training demonstrated greater overall impact, offering more substantial gains in functional performance. These findings underscore the value of incorporating goal-directed, activity-based rehabilitation approaches into clinical practice to promote independence and enhance daily life participation in this population. The study adds to the growing body of evidence supporting the importance of personalized, functionally meaningful therapy in pediatric neurorehabilitation.

AUTHOR CONTRIBUTION

Author	Contribution
Robab Batool	Substantial Contribution to study design, analysis, acquisition of Data Manuscript Writing Has given Final Approval of the version to be published
Muhammad Ammar	Substantial Contribution to study design, acquisition and interpretation of Data Critical Review and Manuscript Writing Has given Final Approval of the version to be published
Prem Lata	Substantial Contribution to acquisition and interpretation of Data Has given Final Approval of the version to be published
Aqsa Lakhani	Contributed to Data Collection and Analysis Has given Final Approval of the version to be published
Muhammad Behzad Ali*	Contributed to Data Collection and Analysis Has given Final Approval of the version to be published
Warda Afifa	Substantial Contribution to study design and Data Analysis Has given Final Approval of the version to be published
Areej Fatima	Contributed to study concept and Data collection Has given Final Approval of the version to be published
Ahmar Zafar	Writing - Review & Editing, Assistance with Data Curation

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