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Effects of task-oriented learning on the functional mobility and balance of kids with cerebral palsy

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Abstract

Background: The purpose of this review is to evaluate and investigate how a physical therapy intervention affects children with cerebral palsy's functional mobility and balance. The most frequent cause of motor disability in children is cerebral palsy (CP).

Aim: In order to investigate and evaluate the impact of task-oriented training provided by physiotherapists on functional mobility and balance in children with cerebral palsy, this study combined experimental research and meta-analysis.

Method: The Timed Up and Go (TUG), the Pediatric Balance Scale (PBS), and the Gross Motor Function Measure (GMFM) domains D and E were all used as measurement tools. The standardised mean difference (SMD) and 95% confidence intervals (95%CI) were calculated and examined using pre- and post-test results.

Results: The results of the Pediatric Balance Scale (mean D 3.81) and Timed Up& Go test (mean D 1.97) showed a significant impact of task-oriented training, whereas the results of the Gross Motor Function Measure D & E showed no statistical or clinical significance.

Conclusion: According to the meta-analysis's findings, task-oriented training significantly improves the performance of children with cerebral palsy on the Timed Up& Go test and the Pediatric Balance scale, in contrast to alternative treatment approaches employed in the included trials. In every study, both the experimental and comparison groups showed improvements in functional mobility and balance.

Keywords: Stretching, physical therapy, goal-oriented tasks, cerebral palsy, and the pediatric balance scale

Introduction

Early childhood is typically when cerebral palsy (CP), a disorder affecting posture, muscle tone, and movement, first appears. The pathophysiology is caused by injury to the developing brain during pregnancy, infancy, or soon after birth. Even though the original neuropathologic lesion is not getting worse, children with cerebral palsy may develop a number of secondary disorders over time that will affect their functional abilities in different ways. The permanent mobility and postural abnormalities known as cerebral palsy (CP), which hinder a person's capacity to participate in meaningful activities, are believed to be caused by an underdeveloped or undeveloped brain. In addition to motor deficits, CP is often associated with epilepsy, secondary musculoskeletal problems, and challenges with sensation, perception, cognition, communication, and behavior. Individuals with cerebral palsy (CP) differ greatly in their risk factors, underlying specific etiology, clinical features, degree of functional limitations, related and secondary disorders, available treatments, and how the condition develops over the course of their lifetime. For all live births, the overall prevalence of CP varies from 1.5 to 3 per 1,000 live births due to variations in both location and income. The reported prevalence of cerebral palsy tends to be highest during infancy because many newborns and children experience a disappearance of abnormal neuromotor findings within the first few years of life, especially within the first two to five years. A family history of cerebral palsy, low birth weight, and prematurity are additional risk factors for cerebral palsy. There are no known risk factors for half of all children with cerebral palsy who were born at full term, according to numerous epidemiological studies. Cerebral palsy is thought to be caused by brain damage sustained during pregnancy or infancy, though it can occasionally appear after birth. Developing after birth but before age five is known as

postnatal cerebral palsy. Head injuries, meningitis, and near drowning are the most common causes of cerebral palsy after birth.

The motor system's neurologic impairment in children with cerebral palsy is typified by ataxia, hypotonia, dyskinesia, and spasticity, in that order. It is not unusual to see mixed presentations. Hypotonia is usually truncal, whether or not spasticity is present, and there is also spasticity in the extremities. Based on clinical findings, CP is usually classified as either spastic, dyskinetic, hypotonic, or mixed.

Functional strength training combined with plyometric exercises and balance training have been used to improve function in individuals with CP. Strength and speed are two aspects of muscle power that are enhanced by plyometric exercise. According to research, the best way to activate muscles during functional strength training is to focus on particular muscles. A 12-week adaptive bungee trampoline program has been shown to increase lower limb muscle strength. Bouncing, hopping, heel jumps, jumping with eyes closed, practicing a series of jumps, and games like dodgeball were all part of this bungee trampoline program.

The purpose of this review is to evaluate and investigate how a physical therapy intervention affects children with cerebral palsy's functional mobility and balance. With a prevalence of 2 to 2.5 per 1000 live births worldwide and in the Nordic region, cerebral palsy (CP) is the most prevalent cause of childhood motor disability (Hollung *et al.* 2021; Oskoui *et al.* 2013) ^[20, 21]. The term "CP" describes a collection of long-term neuromotor conditions that impact a person's posture, muscle tone, and movement, resulting in restrictions on their ability to participate in and engage in physical activities. Non-progressive disruptions take place in the immature or developing fetal brain. A variety of secondary conditions, including epilepsy, secondary musculoskeletal issues, and disruptions in sensation, perception, cognition, communication, and behavior, frequently accompany the motor disorders of cerebral palsy (Patel *et al.* 2020; Rosenbaum *et al.* 2007) ^[12, 6]. Reduced functional abilities are frequently caused by a variety of motor challenges and secondary conditions related to cerebral palsy. The physiological capacity of an individual to move freely and securely in a range of settings is known as functional mobility. A child can have multiple opportunities to participate in physical activities in various settings by performing movements like standing, bending, walking, climbing, and rising from a supine position. Balance and upright postural control are essential for mobility and movement because they require the capacity to both predict and recover from instability (Liao *et al.* 1997; Rose *et al.* 2002) ^[22, 23]. According to Chen *et al.* (2013) ^[24] and Franjoine *et al.* (2003) ^[25], these fundamental elements enable a child to autonomously engage and take part in various levels of fundamental everyday, social, and recreational activities at home, in school, and in the community. The aim of this review is to investigate improvements in functional mobility and balance reactions in children with cerebral palsy, which are typically lower and impaired to varying degrees in children with typical development (Liao *et al.* 1997; Rose *et al.* 2002) ^[22, 23]. According to Gan *et al.* (2008) ^[26], and Rose *et al.* (2002) ^[23], neuromuscular impairments that manifest as impaired muscle tone, selective motor control, and poor postural control mechanism result in a reduced functional balance

capacity and, consequently, a limited ability to move around independently.

Improvements in functional mobility and balance have been observed in children with different levels and subtypes of the Gross Motor Function Classification System (GMFCS), skills in The Gross Motor Function Measure (GMFM), Timed Up & Go (TUG), Pediatric Evaluation of Disability Inventory (PEDI), and Pediatric Balance Scale (PBS) are examples of standardized clinical tests (Ko 2020; Kumar & Ostwal, 2016; Ogwumike *et al.* 2019) ^[27, 28, 29]. Additionally, task-oriented intervention improved the quality of life for children diagnosed with cerebral palsy (CP), according to Badaru *et al.* (2021) ^[30]. However, there is currently no systematic evaluation of the clinical significance of task-oriented training's effect in comparison to other physical therapy interventions. Thus, in light of physical therapy's evidence-based practice, which should rely on methodically developed evidence in clinical decision making while integrating the values of the patient and family, a thorough evaluation of task-oriented training and a discussion of the findings from multiple clinical trials analyzing the intervention are important. The most trustworthy evidence regarding the impact of interventions in health care practice is thought to be meta-analyses and systematic reviews of clinical trials. For ambulant school-aged children with cerebral palsy, Toovey *et al.* carried out a systematic review of task-specific gross motor skills training sessions. The review comprised randomized clinical trials, one repeated-measures study, one single-subject design study, and comparative studies.

Conventional exercise therapy

This covers the course of treatment, which consists of weight-bearing exercises, passive stretching, progressive resisted exercises, passive movement, and progressive habilitation exercises. Studies have demonstrated how well traditional exercise therapy works for improving joint range of motion, local muscular endurance, and muscle strength. Because strength training was believed to increase muscle stiffness and spasticity, it was previously deemed inappropriate for children with cerebral palsy. The current consensus that strength training is not contraindicated for people with spasticity is supported by the authors' findings that there was no change in spasticity during or after training.

Objectives

The current study will ascertain how different organ systems in children's health are affected by physiotherapy treatment for cerebral palsy.

Objectives of the study are as followings:

1. To enroll patients suffering from cerebral palsy.
2. To use task-oriented exercises to alleviate symptoms of cerebral palsy.
3. To analyze the results statistically in order to confirm the effectiveness of physiotherapy in the treatment of cerebral palsy.
4. To ascertain whether stretching is beneficial in the treatment of spastic cerebral palsy.
5. To ascertain how weight-bearing exercise affects CP.
6. To assess the balance and gait of individuals suffering from spastic cerebral palsy.

7. To investigate how weight-bearing activities affect children with spastic cerebral palsy (CP) using the Modified Ashworth Scale (MAS).
8. To use the Modified Time Up&Go Test Scoring (MTUGT) to examine how weight-bearing activities affect spasticity in children with cerebral palsy.
9. To investigate the impact of weight-bearing activities on CP children's spasticity based on motor functions by GMFCS Levels.

Significance of the study

It will be a step in the right direction toward raising the rate at which CP patients recover. As a result, it will lessen the spread of CP symptoms.

Hypothesis

- **Null hypothesis:** People with cerebral palsy will not significantly differ in how well task-oriented exercises affect their functional mobility and balance.
- **Alternative hypothesis:** Task-oriented exercises will have a substantial impact on CP patients' functional mobility and balance.

Materials and Methods

Research design: Experimental

The patient sample will be divided equally (20 each) into 2 groups as below

- **Group 1:** Task Oriented Upper & Lower Limb Functions.
- **Group 2:** Task Oriented Upper & Lower Limb Functions with Conventional Therapy.
- **Research area:** Kolkata West Bengal, Lucknow Uttar Pradesh and Bareilly, Uttar Pradesh
- **Duration of the study:** 3 months
- **Sample size:** 60 individuals with CP.
- **Method of Data Collection:** The data will be collected manually from each patient

Sample collection procedure

The process will be explained to each patient.

The patient will sign the consent form.

Determine the patient's dependent variable.

- In terms of gross motor function classification systems, all patients had grades I and II and were ambulatory with a crouching gait.
- According to the modified Ashworth scale, spasticity is a grade 1, grade 1+, or grade 2.
- Every patient has neither visual nor auditory impairments and is able to follow instructions.
- Hip dislocation, fixed contractures or deformities, surgical procedures such as rhizotomy and tenotomy, injections of Botulinum toxin, baclofen pumps, osteoporosis, heart conditions, uncontrollable convulsions, and leg length discrepancy will all result in the exclusion of patients.

Instrument required

1. Timed Up & Go Test, 2. Paediatric balance scale, 3. Modified Ashworth Scale -spasticity (Hypertonicity), 4. Gross Motor Function Classification System (GMFCS)-classify motor function, 5. Chair (Back and arm cushioning), 6. Vestibular ball, 7. Colourful pegs, markers, 8. Body weight suspension treadmill, 9. Couch, Stopwatch

Subject Selection Criteria

Inclusion Criteria

Age 4-16 years, Diplegic spastic patients, Both gender (male and female), Patients had grades I and II according to gross motor function classification systems, spasticity of grade 1 or grade 1+ or 2 grade according to modified Ashworth scale.

Exclusion Criteria

Tetraplegic patient, Hip dislocation, Fixed contracture deformity, 6 months child, LLD, convulsions

Outcome Measures

Paediatric balance scale

Modified Ashworth Scale

Modified Time Up & Go Test

Variables

- **Dependent variables:** Gait, ROM. Task oriented task, Conventional therapy
- **Independent variables:** Age, gender

Procedure

Participants were split equally between the experimental (Group A) and control (Group B) groups. The experimental group received task-oriented training (TOT), which consists of various functional tasks for the lower limbs to improve walking and balance. Sidestepping, stair climbing, walking in a straight line, walking on an incline, walking and carrying a glass filled with water to improve multitasking, catching and throwing the ball for better balance, standing unsupported and reaching in various directions for specific objects placed at a distance from the arm to activate lower limb muscles, and sitting to stand from the floor to strengthen lower limb muscles were all part of these exercises. Every task had a five-minute time limit. Throughout training, the child received verbal cues and encouragement to finish the task. The tasks were advanced based on how well each child performed. Increases in speed, repetitions, and task switching were all part of these progressions. It was suggested that these tasks be practiced at home for an hour.

Reaching and balance exercises, sideways and forward-backward walking, tandem walking, sitting to standing, throwing and catching the ball in different directions, and carrying an object while walking were all included in the experimental group's task-oriented training (TOT) in our study. Standard mat exercises, limb range of motion (ROM), walking on a treadmill without an incline, walking in parallel bars, and cycling were all part of the control group's regimen. Encouragement and motivation were provided at every stage of the children's treatment. For six weeks, each participant received three 30-minute sessions per week.

All-limb range of motion (ROM) exercises and traditional mat activities, lower limb strengthening and stretching exercises for weak and tight muscles, walking on a treadmill at a pace that is comfortable for the child with no inclination, cycling on a stationary or moving bicycle, and parallel bar walking. Each five-minute exercise focused on the effects of task-oriented training on walking in children with cerebral palsy. It was recommended to perform the aforementioned exercises for an hour at home and to use thermotherapy for ten minutes once a day to help with spastic muscles. Data collection instruments included the

Modified Ashworth scale (MAS), the Timed Up and Go (TUG) test, and the Gross Motor Function Classification Scale (GMFCS).

This chapter justifies and clarifies the methodology and sources used in this thesis. The treatment effect was examined in the review and meta-analyses of trials that employed the Gross Motor Function Measurement (GMFM), Timed Up & Go (TUG), and Pediatric Balance Scale (PBS) as their main outcome measures. There were more than two studies for every measurement tool. Each study's post-test results were input into RevMan, a program that provides a summary estimate of the impact of task-oriented intervention. Furthermore, the effect sizes of the experimental and control groups in every single trial were computed.

The three assessment tools-the Timed Up & Go test (TUG), the Paediatric Balance Scale (PBS), and the Gross Motor Function Measure (GMFM)-that were chosen as the primary outcome measures are described separately in the sections that follow. To evaluate the evidence gathered from the studies and discuss the significance of the outcomes from the included trials, it is imperative to understand the features of the measurement tools. The Pediatric Balance Scale, or PBS the Berg Balance Scale was modified to create the Paediatric Balance Scale (PBS) in 1994. Since then, it has been used as a standardized assessment tool to measure children's functional balance abilities and identify balance dysfunction. According to the PBS, a child's ability to achieve and sustain upright control during everyday activities in their familiar surroundings-at home, school, and in society-is referred to as functional balance. In order to help a physical therapist plan, justify, and adjust individual intervention techniques, PBS can be used to assess and identify age-appropriate functional balance as well as changes and regression in balance (Franjoine *et al.* 2003) [25].

The PBS comprises 14 items with a maximum score of 56 points, with 0 representing the lowest function and 4 representing the highest function. Tasks like sitting to standing, standing with eyes closed, standing in "tandem," standing on one foot, turning, picking up an object off the floor, and reaching forward with an outstretched arm are among the scored items. Page 27 of 83 (Franjoine *et al.* 2003) [25].

The PBS is highly relevant for identifying functional mobility and balance because all of these tasks can be viewed as everyday tasks that children with mild to moderate cerebral palsy must complete in their daily lives. The robust psychometric properties of the Paediatric Balance Scale are supported by the research conducted by Franjoine *et al.* (2003) [25]. Developed in 1991, the Timed Up & Go (TUG) test is used as an assessment tool in clinical

practice today to gauge dynamic balance, anticipatory postural control, and functional mobility. Although its initial purpose was to assess functional mobility and fall risk in the elderly, it has since been used in clinical settings with children and adolescents who have disabilities and motor limitations, including cerebral palsy.

Data-Analysis

Parents signed an informed consent form for the research participants, and their answers were recorded on an MS Excel sheet for evaluation. About 40 participants who satisfied all the inclusion requirements were included in the study. For every subject, exercises were performed at equal intervals. Data were gathered according to each subject's improvements in GMFCS levels, which were measured using MAS scoring (pre and post treatment for 6 weeks) and MTUGT scoring (pre and post treatment for 6 weeks). Normality levels were checked using the Shapiro-Wilks test, which also provided descriptive statistics. Pairwise t-tests were performed with the assumption that $p < 0.05$ was significant.

Results

60 of the 68 subjects who were originally enrolled in our study remained after dropouts. 30 subjects were included in the experimental group while 30 were in the control group. Of the study's participants, 32 were men (i.e., 53.3%), and 28 were women (i.e., 47.3%). In the experimental group, there were five female participants and ten male participants. There were eight male and ten female participants in the control group, respectively. The subjects were 9.5 ± 2.7 years old on average. Out of 60 subjects, 24 children had a gross motor functional scale (GMFCS) level of 1, 29 children had GMFCS level 2 and 5 children had gross motor functional scale (GMFCS) level 3.

Table 1: Within the group analysis TUG, PBS, MAS for group A [n= 20]

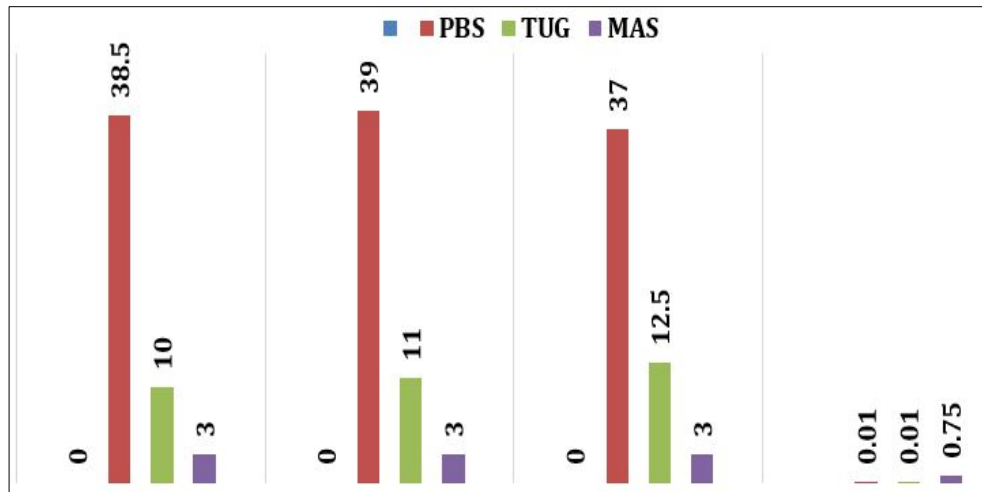
Outcomes	1 st week	3 rd week	6 th week	9 th week	12 th week	p-value
	Median	Median	Median	Median	Median	
PBS	38.5	39	37	38	38	0.01
TUG	10	11	12.5	11.5	12	0.01
MAS	3	3	3	3	3	0.75

Table 2: Within the group analysis TUG, PBS, MAS for group B [n=20]

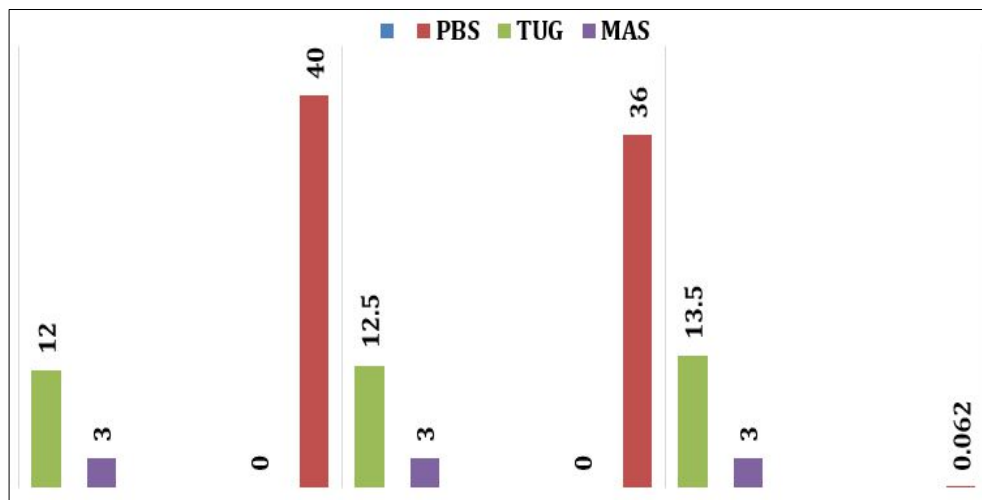
Outcomes	1 st week	3 rd week	6 th week	9 th week	12 th week	p-value
	Median	Median	Median	Median	Median	
PBS	37	40	36	38	41	0.062
TUG	12	12.5	13.5	11.5	11.5	0.03
MAS	3	3	3	3	3	0.722

Table 3: Effects of task oriented training on walking and balance in children with CP.

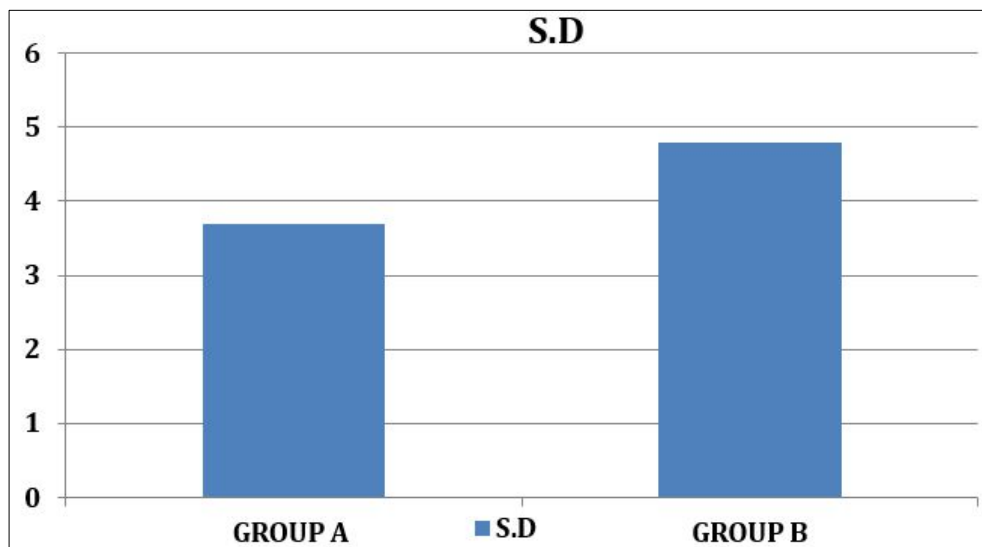
Variables	Assessment	Group A mean +_ SD	Group B mean +_ SD
	At baseline	41.3+_18.4	41.1+_21.6
	At 12 th week	38.9+_15.9	39.7+_21.1
	Mean difference	-2.7	-1.3
	At baseline	11.8+_4.1	12.8+_4.6
	At 12 th week	12.6+_3.7	12.7+_4.8
	Mean difference	1.6	0.8



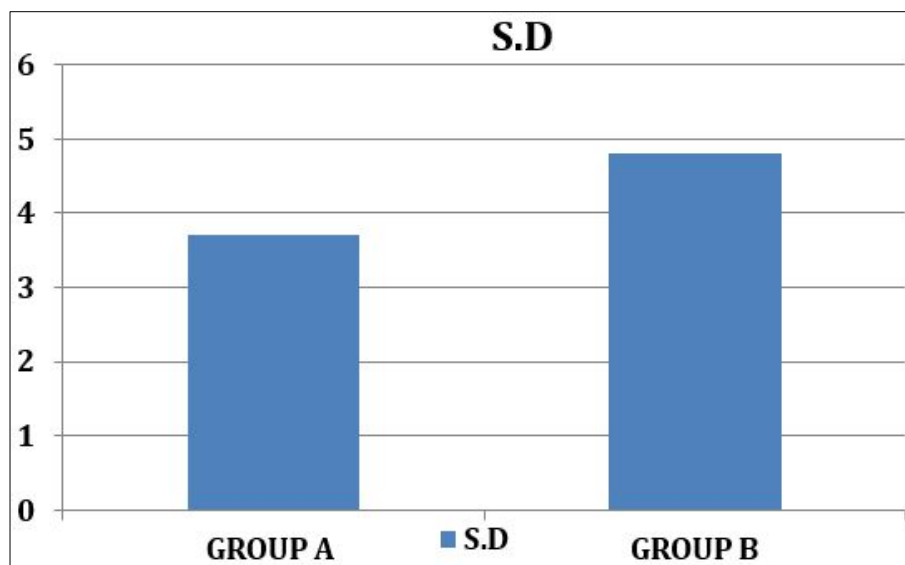
Graph 1: Graph showing the group analysis TUG, PBS, MAS for group A



Graph 2: Graph showing the group analysis TUG, PBS, MAS for group B



Graph 3: Graph shows the effect of TOT on walking in patient CP



Graph 4: Graph shows the effect of TOT on balance in patient CP

Discussion

The time up and go test (TUG) and functional walking test (FWT) were used to evaluate the participants in order to demonstrate the benefits of task-oriented training (TOT) for children with spastic cerebral palsy. Additionally, this study was carried out to investigate a potential intervention that could eventually aid in overcoming the walking and balance deficiencies of children with cerebral palsy. In order to assess the impact of task-oriented training on balance and spasticity in children with a spastic form of diplegic cerebral palsy, MK Franklin Shaju carried out a study in 2016. Task-oriented training and traditional physiotherapy were compared during the 6-week intervention period in a randomized control trial. The Time Up and Go Test and the Paediatric Balance Scale (PBS) were the scales used to evaluate mobility and balance, respectively.

The two groups' pre- and post-intervention mean differences were 18.1 and 4.596, respectively. After a 15-week task-oriented training program, 26 children with cerebral palsy (CP) demonstrated significant ($p < 0.05$) improvements on the Paediatric Balance Scale (PBS). Similarly, a 2009 study by Salem *et al.* with a sample size of 10 children with cerebral palsy and an intervention period of 5 weeks demonstrated that task-oriented training decreased the experimental subjects' time required to finish the time-up and-go test. The results of the time up and go test showed a significant P value, meaning that these results were somewhat consistent with our results. The time it took for participants in both groups to finish the time up-and-go test, which was used to gauge the subjects' improved balance, decreased during the sixth week of the intervention. On the other hand, group A demonstrated a greater reduction in test completion time. Given that the intervention lasted only six weeks, the p-value for the result was not significant.

HyunKyung Han conducted research in Korea that demonstrated the impact of task-oriented training on children with cerebral palsy's "gross motor function measure, balance, and gait function." In this randomized controlled trial, 24 participants received an intervention over a 4-week period. The task-oriented training group's functional gait outcomes showed higher Functional Gait Index scores than the control group. The experimental group's mean $\pm$ standard deviation (SD) was 15.25 ± 10.25

after 4 weeks of treatment, while the control group's was 4.42 ± 5.26 . Thus, it is evident that after receiving task-oriented training, the functional gait of the subjects was significantly better than that of the control group, which received conventional therapy, including neurodevelopment treatment. The impact of task-oriented training on CP children's functional ability was investigated. Evaluation was conducted using the Five-Time Sit to Stand Test and the Mobility Assessment Scale. The task-oriented training group showed notable improvements after 6 weeks of training. 68 participants in the current study were diagnosed with cerebral palsy and received task-oriented training for six weeks. Compared to the control group, the task-oriented training group demonstrated greater progress. Therefore, patients with cerebral palsy who received task-oriented training demonstrated greater improvement in their walking and balance. In a different study, gross motor functional GMFM-66 scores improved following activity-focused physiotherapy. Furthermore, the PEDI scale's Mobility dimension had a mean difference (SD) of 2.3. A study was carried out in 2017 to examine how task-oriented training affected posture and mobility. Following an 8-week intervention, we observed significant improvements ($p < 0.05$) in gross motor functional GMFM scoring for walking and standing. The gross motor functional GMFM scores were 56.34 ± 18.86 before and 59.81 ± 17.764 after the intervention. Our study's findings are supported by this discovery. Both groups' functional walking improved by the end of the sixth week for the CP kids.

Nevertheless, following task-oriented training, the experimental groups' improvements in functional walking test scores outpaced the control group's gains from traditional therapy. The groups' mean and standard deviation both increased. For functional walking, the experimental group's mean $\pm$ SD was 11.8 ± 4.1 at baseline and 13.6 ± 3.7 at week 9, while the control group's mean $\pm$ SD was 12.8 ± 4.6 at baseline and 13.7 ± 4.8 at week 9. This suggests that the functional walking improvement following task-oriented training was significantly superior to that of traditional physiotherapy treatment. The major limitations of our study were non-cooperation, difficulty obtaining attention, and loss of follow-up because of health problems.

Conclusion

It has been determined that both methods work well for helping kids with cerebral palsy walk and balance. But for kids with spastic cerebral palsy, task-oriented training significantly improves their walking and balance. To evaluate gait patterns and walking muscles, specific digital parameters should be used. For a more accurate comparison, more participants should be gathered. Since nutrition is crucial to CP participants' health, its effects on mobility and balance should also be evaluated.

Limitation

There are certain limitations to this study. First, the subjective approach to data collection through measurement. The second is that only university students were included in the small sample size and age range.

Future study

The same study will be carried out with a large sample size of students, including those in the childhood and elderly age groups, and some objective variables.

Significance in Clinical Practice

Moderate physical fitness and slightly poor sleep quality are found in subjects who engage in sedentary behavior. This indicates a negative correlation between sedentary behavior and both sleep quality and physical fitness. With a 95% confidence level, this assertion is accurate, and the current study's data can be applied to clinical settings. Additionally, recommendations for improving physical activity levels or decreasing sedentary behavior should be made to this population.

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