



Comparison between Task-Oriented Training and Proprioceptive Neuromuscular Facilitation Exercise on Upper Extremity Function in Spastic Cerebral Palsy



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Abstract: This research investigates and compares the impacts of task-oriented training and proprioceptive neuromuscular facilitation (PNF) on the motor function of the affected arm in children diagnosed with spastic cerebral palsy (CP). The study addresses the need for effective interventions to address the motor challenges in this population. Thirty participants were randomly assigned to either Group A (task-oriented training) or Group B (PNF training) in a two-month comparative study conducted in special schools. Both groups participated in daily 40-minute sessions five days a week for eight weeks. Pre and post-tests, utilizing the Assistive Hand Assessment (AHA-22) and Manual Ability Measure (MAM-16), were administered to evaluate outcomes. The analysis revealed no significant differences in post-test scores between Group A and Group B, indicating comparable effectiveness of both interventions in improving upper extremity function in children with spastic cerebral palsy. This study contributes valuable insights into therapeutic approaches for enhancing motor function in children with spastic cerebral palsy. Both task-oriented training and proprioceptive neuromuscular facilitation emerge as effective methodologies, providing healthcare professionals and educators with evidence-based options for optimizing outcomes in this population. These findings hold international relevance, offering a foundation for informed decision-making in the selection of interventions for children with spastic cerebral palsy across diverse global contexts.

Introduction

Cerebral palsy (CP) is a persistent motor disorder resulting from non-progressive brain lesions acquired during rapid brain development, characterized by muscle fibrillations or paralysis (Kriger, 2006). It is a well-

recognized neurodevelopmental condition (Khanna et al., 2023; Khant et al., 2023; Arun et al., 2024) commencing in early childhood and enduring throughout the lifespan, initially reported by Little in 1861. CP is a developmental disorder emerging in early childhood with functional



limitations stemming from central nervous system disorders (Bax et al., 2005). It encompasses a diverse group of early-onset, non-progressive neuromotor disorders affecting the developing fetal or infant brain (Oskoui et al., 2013; Ketelaar et al., 2001). Children with CP experience upper limb motor deficits, impacting activities such as reaching, grasping, and prehension, thereby affecting self-care, education, and social interaction (Song, 2014). The most common form of CP is spastic, presenting with additional clinical signs like limited range of motion, diminished selective control, and muscle weakness (Kulinski et al., 2023). The severity of gross motor function limitations in children with cerebral palsy is significant (Chrysagis et al., 2009), restricting their engagement in physical activities and posing health risks due to constrained motor actions or skills (Kriger, 2006). In 2001, the United Cerebral Palsy Foundation estimated 764,000 diagnosed cases in the United States, with approximately 8,000 new cases annually, emphasizing the prevalence of bilateral spastic CP (66%–73%) over unilateral cases (26%–34%) (Allsopp et al., 2008). The task-oriented approach recognizes movement as an interaction between various brain systems organized around a goal and constrained by the environment (Kolit et al., 2023). It encompasses interventions like (Blundell et al., 2003), treadmill and ground walking, bicycling, endurance and circuit training (Rensink et al., 2009), sit-to-stand exercises, and reaching tasks to enhance balance (Marda et al., 2023). Emphasizing functional arm tasks such as grasping objects and constraint-induced (movement) therapy (CIMT) (Shih et al., 2023), this patient-focused approach (Song et al., 2014) targets functional activities of the affected arm in children with CP (Ahl et al., 2005). Proprioceptive Neuromuscular Facilitation (PNF) integration patterns stimulate proprioceptors in muscles and tendons, effectively maximizing the exercise unit's reaction (Kumar et al., 2016; Basak and Biswas, 2016;). Utilizing maximum resistance in spiral and diagonal movements, PNF promotes a larger neuromuscular response and exploration of postural reflex and prioritizes eccentric muscle contraction, which is particularly beneficial for hemiplegic patients (Chen et al., 2005; Lindquist et al., 2011; Olubukola et al., 2021). When addressing hand function impairment, the goal is to enhance the functional use of hands for everyday tasks, recognizing the collaborative nature of bimanual performance (Basak and Dutta, 2016; Nikolovska et al., 2023). Evaluation instruments often test one hand at a time, assessing maximum capability rather than actual performance (Sporea et al., 2023). The Assisting Hand

Assessment (AHA), designed for children with unilateral upper limb dysfunction, demonstrates validity and reliability, particularly in hemiplegic CP or obstetric brachial plexus palsy cases (Krumlinde-Sundholm et al., 2007). The Manual Ability Measure (MAM) is a task-oriented and patient-oriented outcome tool measuring manual ability. Specifically, the MAM-16, a self-reporting measure assessing unimanual and bimanual function, has demonstrated good validity and reliability through Rasch analysis (Chen et al., 2005).

Methodology

This study employed a rigorous comparative design featuring a pre-and-post methodology conducted within specialized schools over an extensive two-month period dedicated to thorough data analysis. The sample size comprised 30 individuals meticulously selected based on stringent inclusion and exclusion criteria, utilizing a simple random sampling method to stratify participants into two groups, denoted as Group A and Group B. Before the study commencement, parents of the subjects received a comprehensive explanation of the research objectives and their informed consent was obtained through signed consent forms. The initial data collection phase involved acquiring demographic details, including gender, age, hemiparetic side, and causative factors, with a steadfast commitment to maintaining confidentiality. Group A underwent a regimen of task-oriented training, encompassing bilateral and unilateral activities focused on hand grip, coordination, finger strength, and joint weight bearing. These activities included drumming for improved hand grip and dexterity, age-appropriate play for enhanced overhead activities and coordination, scissor cutting and pasting for hand function and finger strength and a ball game for hand grip strength and overhead activities. Unilateral activities in Group A involved holding a drinking cup to strengthen the upper limb, progressing to increased water quantity, and carrying/dragging wooden blocks to improve joint weight bearing. In contrast, Group B received proprioceptive neuromuscular facilitation (PNF) exercises comprising D1 and D2 patterns for flexion and extension. D1 flexion involved shoulder flexion, adduction, external rotation, elbow flexion or extension, forearm supination, wrist flexion, radial deviation, and finger/thumb flexion, adduction. D1 extension covered shoulder extension, abduction, internal rotation, elbow flexion or extension, forearm pronation, wrist extension, ulnar deviation, and finger/thumb extension, abduction. D2 flexion and extension patterns similarly targeted specific joint movements. These exercises aimed to enhance

neuromuscular facilitation and joint mobility in the upper extremities. Both interventions were administered for 40 minutes per day, five days a week, over eight weeks. Pre-and-post assessments were conducted at the outset and conclusion of the two-month study, employing the Assistive Hand Assessment (AHA-22) and the Manual Ability Measure (MAM-16). Stringent comparisons and analyses were undertaken on the gathered data, both within and between the groups, to derive meaningful insights, thus providing a comprehensive understanding of the effectiveness of task-oriented training and proprioceptive neuromuscular facilitation exercises in improving arm functions in children with spastic cerebral palsy.

Results and Discussion

The collected data were tabulated and analyzed using both descriptive and inferential statistics. All the parameters were assessed using Statistical Package for Social Science (SPSS) version 19. Paired t-test was adopted to find the statistical difference within the groups & Independent t-test (Student t-test) was adopted to find the statistical difference between the groups.

Table 1 shows a comparative analysis of the Assistive Hand Assessment (AHA) scores between Group A and Group B in both pre-test and post-test evaluations. In the pre-test phase, Group A exhibited a mean score of 49.00 with a standard deviation (SD) of 3.27, while Group B showed a mean score of 50.00 with an SD of 3.27. Post-test results demonstrated significant improvement, with Group A achieving a mean score of 74.60 (SD = 3.45) and Group B attaining a mean score of 75.60 (SD = 3.45). The t-tests revealed no statistically significant differences between the groups in either the pre-test or post-test, emphasizing comparable advancements in assistive hand function (* p < 0.05).

Table 2 elucidates the Comparative Analysis of the Manual Ability Measure (MAM-16) scores between Group A and Group B during pre-test and post-test evaluations. In the pre-test phase, Group A displayed a mean score of 51.40 (SD = 3.29), while Group B exhibited a mean score of 50.26 (SD = 3.41). Post-test results demonstrated substantial improvement, with Group A achieving a mean score of 65.00 (SD = 2.97) and Group B attaining a mean score of 65.80 (SD = 2.78).

Table 1. Comparison Of the Assistive Hand Assessment Score Between Group – A and Group – B.

AHA	GROUP A		GROUP B		t-TEST	SIGNIFICANCE
	MEAN	SD	MEAN	SD		
PRE TEST	49.00	3.27	50.00	3.27	0.837	.410*
POST TEST	74.60	3.45	75.60	3.45	0.792	.435*

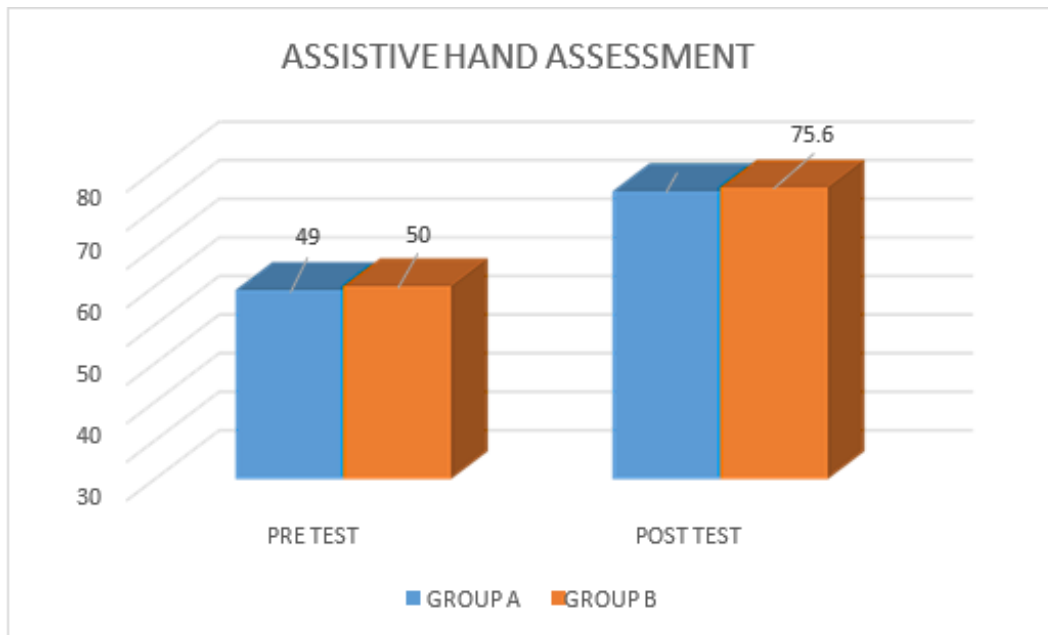


Figure 1. Comparison of the Assistive Hand Assessment Score Between Group – A And Group – B In Pre-Test and Post-Test.

The t-tests indicated no statistically significant differences between the groups in either the pre-test or post-test, underscoring comparable enhancements in manual ability (*p < 0.05).

Table 3 underscores the intra-group dynamics within Group A by comparing Assistive Hand Assessment (AHA) and Manual Ability Measure (MAM-16) scores

Table 2. Comparison of the Manual Ability Measure (Mam-16) Score Between Group – A And Group – B In Pre-Test and Post-Test.

MAM 16	GROUP A		GROUP B		t-TEST	SIGNIFICANCE
	MEAN	SD	MEAN	SD		
PRE-TEST	51.40	3.29	50.26	3.41	1.188	.245*
POST TEST	65.00	2.97	65.80	2.78	0.760	.453*

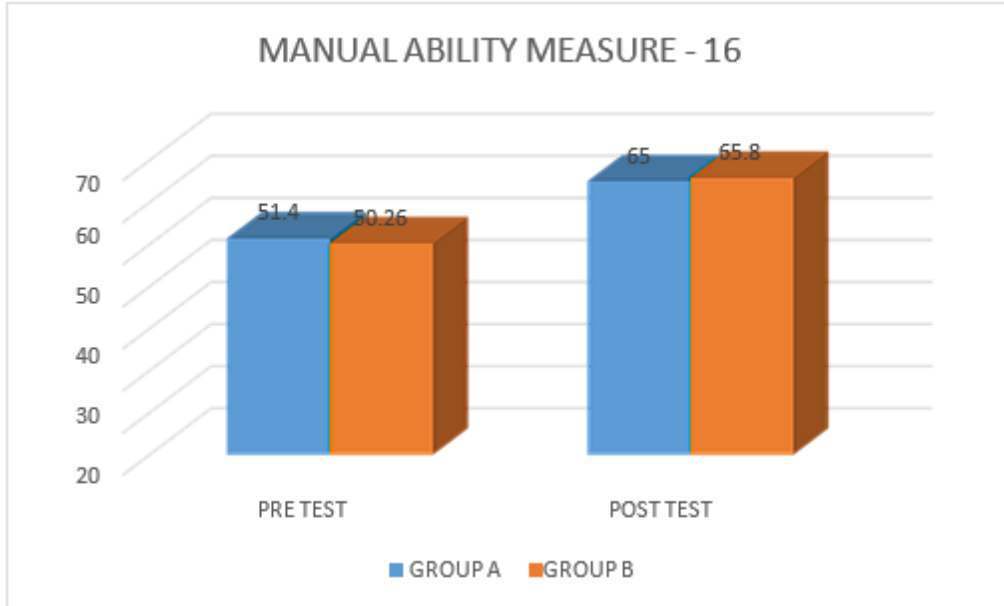


Figure 2. Comparison of The Manual Ability Measure (Mam-16) Score Between Group – A and Group – B In Pre-Test and Post-Test.

Table 3. Comparison of AHA and Mam-16 Score Between Pre-Test and Post Test Within Group – A.

GROUP – A	PRE TEST		POST TEST		t-TEST	SIGNIFICANCE
	MEAN	SD	MEAN	SD		
AHA*	49.00	3.27	74.60	3.45	93.926	.000**
MAM – 16*	51.40	3.29	65.00	2.97	24.333	.000**

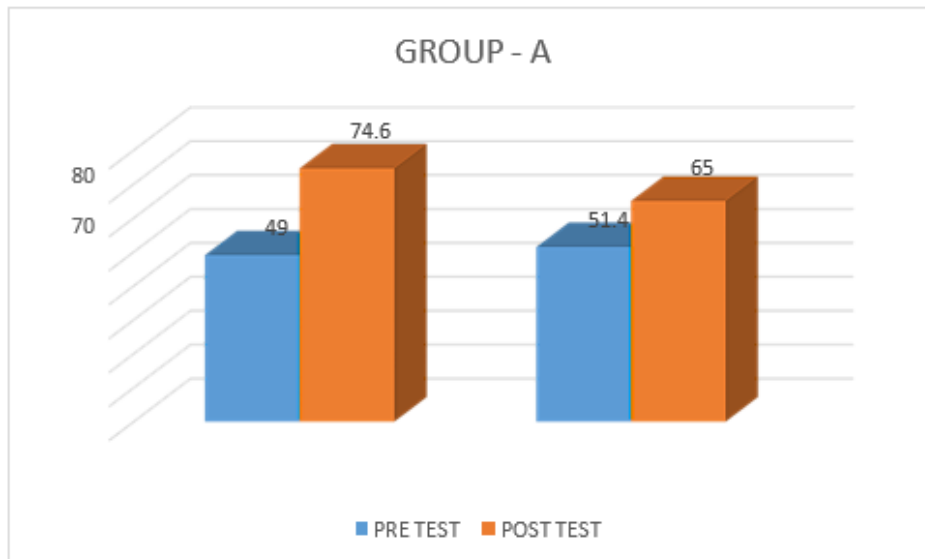


Figure 3. Comparison of AHA and Mam-16 Score Between Pre-Test and Post-Test Within Group – A.

between pre-test and post-test phases. In the pre-test, Group A demonstrated an AHA mean score of 49.00 (SD = 3.27) and a MAM-16 mean score of 51.40 (SD = 3.29). Post-test outcomes revealed remarkable improvements, with AHA scores surging to a mean of 74.60 (SD = 3.45) and MAM-16 scores rising to a mean of 65.00 (SD = 2.97). The t-tests exhibited highly significant differences ($p < 0.001$) for both AHA and MAM-16 scores within Group A, accentuating the substantial advancements in assistive hand function and manual ability over the intervention period.

The study results indicate that there is no statistically significant difference in post-test scores (AHA and MAM) between Group A and Group B, with a p-value exceeding 0.05. Consequently, the null hypothesis, suggesting no divergence in outcomes between the two groups, is accepted. A closer examination of the mean values for the Assistive Hand Assessment (AHA-22) in Table 1 reveals post-test mean scores of 74.6 for Group A (Task-Oriented Training) and 75.6 for Group B (Proprioceptive Neuromuscular Facilitation Exercise).

Table 4. Comparison of AHA and Mam-16 Score Between Pre-Test And Post-Test Within Group – B.

GROUP – B	PRE TEST		POST TEST		t-TEST	SIGNIFICANCE
	MEAN	SD	MEAN	SD		
AHA	50.00	3.27	75.60	3.45	93.926	.000
MAM – 16	50.26	3.41	65.80	2.78	22.101	.000

Within Group B, Table 3 delineates the intragroup comparison of pre-test and post-test scores for both the Assistive Hand Assessment (AHA) and Manual Ability Measure (MAM-16). In the pre-test phase, Group B exhibited an AHA mean score of 50.00 (SD = 3.27) and a MAM-16 mean score of 50.26 (SD = 3.41). Post-test results manifested substantial progress, with AHA scores increasing to a mean of 75.60 (SD = 3.45) and MAM-16 scores rising to a mean of 65.80 (SD = 2.78). T-tests underscored highly significant differences ($p < 0.001$) for both AHA and MAM-16 scores within Group B, affirming significant advancements in assistive hand function and manual ability following the intervention.

The comparison yields a p-value greater than 0.05, indicating no significant disparity between the two groups in terms of post-test mean values for AHA-22. Thus, the null hypothesis is accepted, signifying comparable improvements in assistive hand function for both intervention approaches (Nshimiyimana et al., 2023). Similarly, the analysis of mean values for the Manual Ability Measure (MAM-16) in Table 2 elucidates no significant difference in post-test mean scores between Group A (Task-Oriented Training) and Group B (Proprioceptive Neuromuscular Facilitation Exercise). The post-test mean values for Group A and Group B are

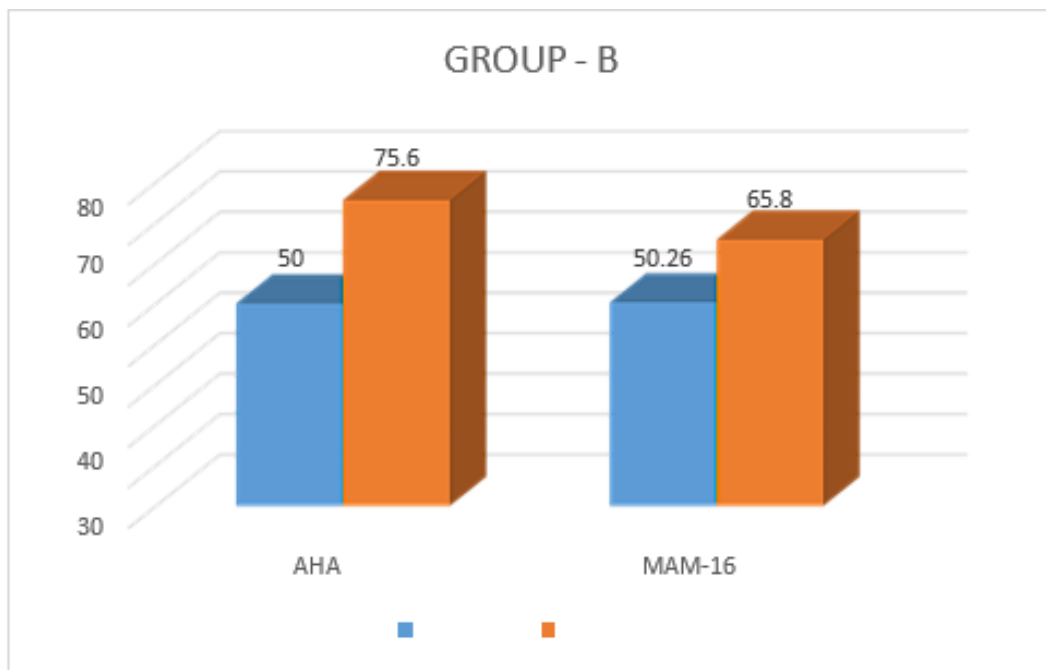


Figure 4. Comparison of AHA and MAM-16 Score Between Pre-Test and Post Test Within Group – B.

65.0 and 65.8, respectively, with a p-value exceeding 0.05. Consequently, the null hypothesis is accepted, emphasizing comparable advancements in manual ability for both groups. The study findings suggest that task-oriented training in Group A and proprioceptive neuromuscular facilitation exercise in Group B yield comparable outcomes in terms of assistive hand function and manual ability. The acceptance of the null hypothesis implies that the two interventions are equally effective in enhancing the targeted outcomes, providing valuable insights for therapeutic interventions in similar contexts (Shahid et al., 2023). Upper limb impairment is a prevalent challenge affecting nearly 50% of children with cerebral palsy (CP), exerting a substantial impact on their ability to engage in daily activities. This impairment, particularly in children with spastic hemiplegic CP, manifests early in life and can significantly limit activity and participation. Motor control issues, coupled with inefficient movement patterns, pose obstacles to manipulative function, leading to difficulties in performing specific tasks. The consequences extend beyond the affected children to impact their parents and caregivers, underscoring the need for effective interventions to ameliorate upper limb function (Raina et al., 2005; Oh et al., 2023). This study delves into the comparative efficacy of task-oriented training and proprioceptive neuromuscular facilitation (PNF) exercises in addressing upper extremity function in children with spastic CP (Schneiberg et al., 2010). The investigation spans interventions over eight (8) weeks, with outcomes measured through the Assistive Hand Assessment (AHA-22) and Manual Ability Measure (MAM-16). The findings unveil that both task-oriented training and PNF exercises result in significant improvements in upper limb functions. Notably, the post-test scores for AHA-22 and MAM-16 exhibit marked enhancements in both groups. Importantly, statistical analyses confirm the absence of significant differences in post-test scores between Group A (task-oriented training) and Group B (PNF exercise), leading to the acceptance of the null hypothesis. This study's outcomes align with prior research. Ketelaar et al. (2001) conducted a randomized controlled study demonstrating the positive effects of a functional therapy program on motor abilities in children with CP, emphasizing the benefits of task-specific therapy in enhancing daily motor tasks. Ahl et al. (2005) reported favorable outcomes from functional, goal-directed therapy in children with CP, influencing gross motor capacity and performance in self-care, mobility, and social function. Blundell et al.'s group

circuit training program focused on functional activities, resulting in sustained functional performance improvement in children with CP. Moreover, Jong-Hoon Moon et al. (2017) emphasized the positive impact of task-oriented training on hand dexterity, supporting the current study's findings. Poonam Chaturvedi et al. (2020) demonstrated the effectiveness of PNF techniques in improving functional activities of daily living (Talgeri et al., 2023). The neuromuscular mechanisms of PNF, explained by the author, shed light on its impact on motor-evoked potentials (Shimura and Kasai, 2002).

Conclusion

The study's conclusion underscores the viability and efficacy of both task-oriented training and PNF exercises in enhancing upper extremity functions in children with spastic CP. Task-oriented training, incorporating daily and play activities, not only improves motivation but also promotes active participation. PNF exercises featuring diagonal patterns prove effective in mitigating dysfunction in the affected arm. Crucially, the versatility of both Task-Oriented Training and PNF extends beyond CP, holding promise for various neurological conditions such as stroke, Parkinson's disease, multiple sclerosis, and balance disorders, thereby offering potential applications for individuals at heightened risk of falls. In summary, this research provides valuable insights into the comparable effectiveness of task-oriented training and PNF exercises in addressing upper limb function among children with spastic cerebral palsy. The implications extend to broader neurological contexts, highlighting the potential of these interventions in diverse rehabilitation settings.

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Conflict of Interest

Nil

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