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Effect of Neurodevelopmental Treatment Frequency on Functional Abilities in Children with Cerebral Palsy: A Literature Review

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Abstract

Introduction: Cerebral palsy (CP) is a major cause of motor dysfunction in children, often requiring comprehensive and long-term rehabilitation. Neurodevelopmental Treatment (NDT) is a commonly applied intervention designed to improve motor control, posture, and functional abilities. This review aims to examine how the frequency of NDT therapy affects functional outcomes in children with CP.

Methods: A systematic literature review was conducted using PubMed, ProQuest, Scopus, and Google Scholar. Six peer-reviewed articles published between 2013 and 2023 were selected based on inclusion criteria: studies involving children with CP who received NDT therapy and assessed outcomes such as gross motor function, balance, postural control, or occupational performance. Keywords used included "Neurodevelopmental Treatment," "cerebral palsy," "therapy frequency," and "functional ability."

Results: The findings indicate that a higher frequency of NDT therapy (three to five sessions per week) is associated with more significant improvements in gross motor skills, postural control, and balance. However, lower-frequency therapy (twice weekly) also produced positive outcomes when delivered consistently. Four of the six studies showed greater benefits with high-frequency sessions, while the remaining two reported notable improvements at lower frequencies. Moreover, combining NDT with complementary approaches such as the CO-OP method or Bobath therapy enhanced functional performance and parent-reported satisfaction.

Conclusion: Therapy frequency plays a crucial role in determining the functional outcomes of children with CP undergoing NDT. While high-frequency therapy offers optimal benefits, consistent low-frequency sessions can still be effective. Clinicians should individualize therapy plans based on each child's needs to achieve the best possible rehabilitation outcomes.

Keywords: cerebral palsy, Neurodevelopmental Treatment, functional ability, therapy frequency, rehabilitation

Introduction

Cerebral palsy (CP) is an umbrella term for a group of disorders affecting movement and posture due to non-progressive disturbances in the developing fetal or infant brain.[1] Risk factors for CP span across the preconception, prenatal, perinatal, and early postnatal periods, and include genetic abnormalities, congenital malformations, prematurity, kernicterus, intrauterine growth restriction, infections, hypoxic-ischemic injury, cerebrovascular incidents, and accidental brain trauma.[1]

Globally, a systematic review of population-based registries and prevalence studies conducted over six decades estimated the birth prevalence of CP at 2.1 per 1,000 live births.[2] In high-income countries (HICs), CP prevalence has significantly declined, especially in regions such as Europe, Australia, and Japan, largely due to advancements in maternal care and neonatal intensive care services. In contrast, the prevalence in low- and middle-income countries (LMICs) remains higher and is often associated with different etiological pathways.[1]

The dynamic nature of CP prevalence reflects broader medical, socioeconomic, and healthcare developments. Thus, continuous surveillance—particularly in LMICs—is essential to understand how improvements in healthcare systems influence CP incidence.[3] For instance, a study by Jahan et al. (2020) in countries such as Indonesia, Nepal, Bangladesh, and Ghana reported 2,664 children diagnosed with CP.[4] In contrast, HICs have reported decreased CP incidence due to improved public health interventions, maternal and neonatal care, and early identification of high-risk infants such as preterm newborns or full-term infants experiencing hypoxic-ischemic encephalopathy.[1]

In Indonesia, the 2018 Basic Health Research (Riskesdas) conducted by the Ministry of Health estimated a CP prevalence of 0.09% among children aged 24–59 months, or approximately 9 cases per 1,000 births (Indonesian Ministry of Health, 2018). The same year, the Central Bureau of Statistics (BPS) through the National Socioeconomic Survey (Susenas) reported 866,770 individuals living with CP across all severity levels.

Functional abilities in children with CP vary depending on the type and severity of the condition. Many children face challenges in activities of daily living, including ambulation, feeding, and communication, significantly impacting

their physical, emotional, and social well-being.[5] A study by Ramadhani and Romadhoni (2021) reported that motor impairments in children with CP are associated with reduced quality of life and an increased need for family support.[6]

Neurodevelopmental Treatment (NDT) is a widely used rehabilitation approach aimed at improving postural control and motor function in children with CP. NDT is an individualized intervention based on a thorough assessment of each child's unique functional profile.[7] Despite its long-standing use, the optimal frequency for administering NDT remains a subject of debate. The frequency of rehabilitation interventions, including NDT, plays a critical role in treatment efficacy. Therapy administered too infrequently may yield suboptimal outcomes, while overly frequent sessions may cause fatigue in the child and add burden to families. A meta-analysis by Te Velde et al. (2022) suggests that the ideal therapy frequency lies between two and four sessions per week, tailored to the child's specific needs.[8]

Numerous studies have explored the effect of NDT frequency on functional outcomes in children with CP, but findings remain inconsistent. Some research supports the notion that higher-frequency NDT (e.g., five sessions per week) leads to more substantial improvements in gross motor function compared to lower-frequency sessions.[9,10] Conversely, other studies have found no statistically significant differences in outcomes such as hand function or upper limb mobility when comparing high-frequency NDT to standard occupational therapy protocols.[8,11] These discrepancies may be attributed to methodological variations, sample size differences, and participant heterogeneity.

Currently, there is no consensus on the optimal frequency of NDT therapy to maximize functional gains in children with CP. This gap highlights the need for further evaluation through a systematic literature review. By synthesizing findings across multiple studies, a clearer understanding of how therapy frequency influences motor and functional outcomes may be achieved. Such insights can guide evidence-based clinical decision-making and inform policy development in pediatric rehabilitation.

Therefore, this article aims to provide a comprehensive synthesis of the effects of NDT therapy frequency on the functional abilities of children with cerebral palsy. Using a systematic literature review methodology, this study will analyze relevant published data to assess current evidence, identify trends, and evaluate strengths and limitations in previous research. The central research question addressed is: *What is the effect of different NDT therapy frequencies on the functional outcomes of children with cerebral palsy?*

Methods

This study employed a systematic literature review design, covering publications from 2020 to 2024. Article searches were conducted using relevant keywords and Boolean operators (AND, OR, NOT, or AND NOT) across major academic databases, including PubMed, ProQuest, Scopus, the Cochrane Library, and Google Scholar. The keywords used were "cerebral palsy," "neurodevelopmental treatment," "functional abilities," "gross motor function," and "fine motor skills." Article screening was performed by applying predefined inclusion and exclusion criteria, using search terms tailored to the research topic.

The inclusion criteria were as follows: (1) children diagnosed with cerebral palsy (CP); (2) intervention involving neurodevelopmental treatment (NDT) aimed at improving functional abilities; (3) outcome measures assessing functional ability, such as gross motor function, fine motor skills, or functional independence; (4) study design consisting of randomized controlled trials (RCTs), experimental studies, cohort studies, case-control studies, or pilot studies; (5) publications dated between 2020 and 2024; and (6) articles written in English and published in accredited journals. The exclusion criteria were: (1) participants older than 18 years; (2) interventions other than NDT or combined therapies not primarily focused on NDT; (3) studies not measuring children's functional abilities; (4) study designs such as expert opinions, systematic reviews, meta-analyses, or literature reviews; (5) publications prior to 2020; and (6) articles written in languages other than English or published in non-accredited journals.

The keyword selection was guided by the PICO framework: (1) P (Population/Problem): children with cerebral palsy; (2) I (Intervention): neurodevelopmental treatment (NDT); (3) C (Comparison): no direct comparison with other interventions; and (4) O (Outcome): functional abilities, including gross motor function, fine motor skills, or functional independence. The included studies focused solely on the effects of NDT frequency and did not compare NDT with other therapeutic approaches.

The selection process involved multiple screening phases: (1) title screening, (2) abstract screening, and (3) full-text review to assess eligibility. A PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) flow diagram was employed to illustrate the number of articles identified, screened, excluded, and ultimately included. Two independent reviewers conducted the screening to minimize bias, with discrepancies resolved through discussion.

Data extraction was performed using a standardized form capturing key study characteristics, participant demographics, type and frequency of NDT interventions, and measured outcomes. The reviewed studies involved children with varying ages and degrees of cerebral palsy severity, as detailed in the individual articles.

Data synthesis was carried out using a qualitative approach to summarize findings and address the research question. Articles were thematically grouped based on intervention frequency and corresponding functional outcomes. These themes were then analyzed for consistency and categorized according to whether they supported or contradicted the study's hypothesis regarding the impact of NDT therapy frequency on functional outcomes.

Results

Article Selection and Methodology

The article selection process followed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines (Figure 1). Articles were identified through searches in PubMed, ProQuest, Scopus, and Google Scholar using the keywords: "Cerebral Palsy" OR "CP" AND "Neurodevelopmental Treatment" OR "NDT" AND "Functional Ability" OR "Motor Function." The initial search yielded 1,360 articles. Following title and abstract screening, application of inclusion and exclusion criteria, and full-text assessments, 20 articles were deemed eligible for further

evaluation. After thorough reading and relevance screening to the research topic, six articles were selected for in-depth review. These included two articles from PubMed, one from Scopus, three from Google Scholar, and none from ProQuest. The selected studies were then analyzed to address the research questions.

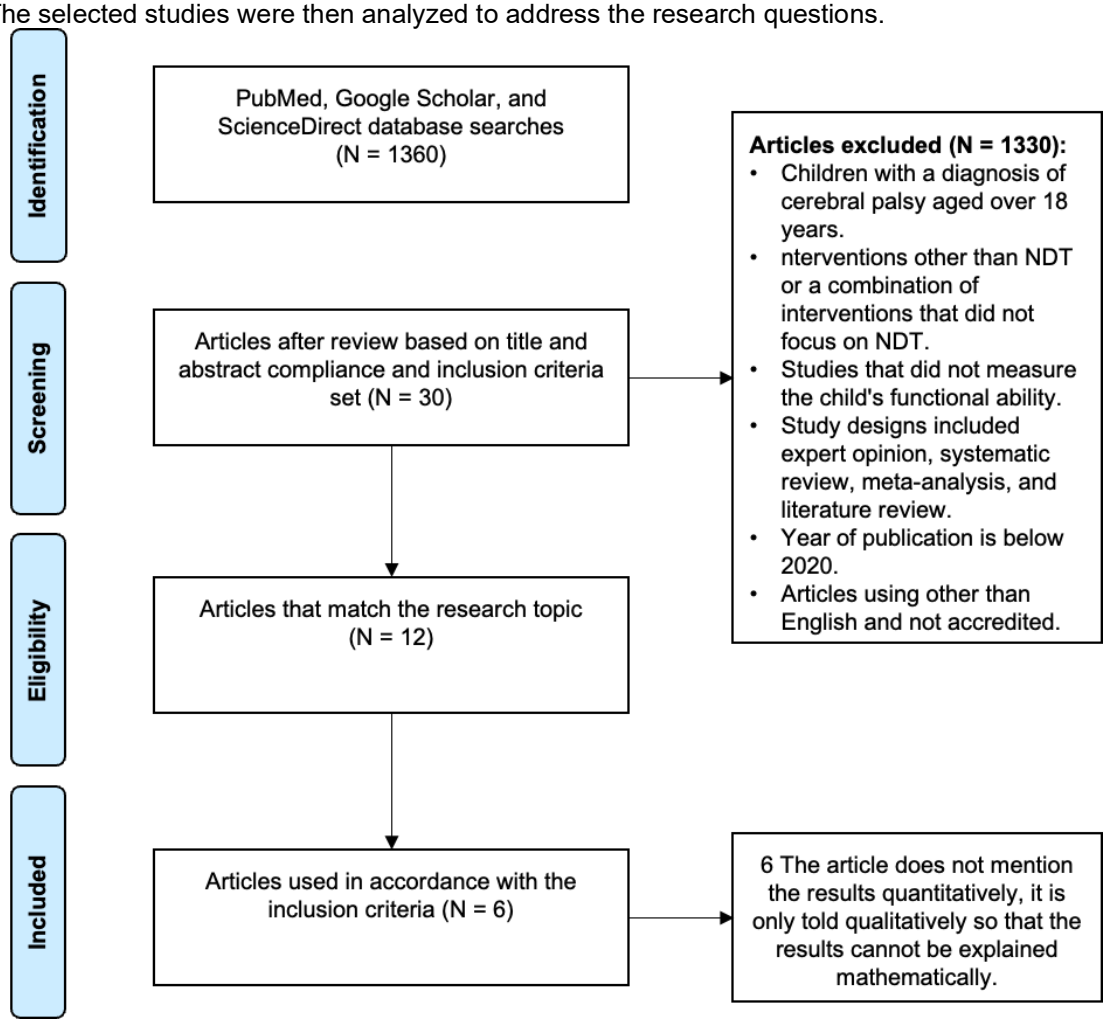

Figure 1. PRISMA Flow Diagram

Table 1 presents a synthesis matrix summarizing the key findings from the selected studies on Neurodevelopmental Treatment (NDT) for improving the functional abilities of children with cerebral palsy (CP). The table outlines the study design, population, intervention details, therapy frequency, results, and conclusions of each study, providing a comprehensive overview of the therapeutic effects of NDT in enhancing motor function, balance, postural control, and other functional outcomes in children with CP.

Table 1. Synthesis Matrix: Neurodevelopmental Treatment for Functional Abilities in Children with Cerebral Palsy

Author, Year	Article Title	Study Design	Population/Sample	Intervention	Therapy Frequency	Results	Conclusion
Li et al., 2023[12]	Effect of ultra-early intervention of NDT therapy on nerve and motor development in infants at high risk of cerebral palsy	Cohort Study	120 high-risk CP infants (intervention), 120 high-risk CP infants (control), 120 healthy infants	Ultra-early NDT starting at 7 days vs. NDT at 3–5 months	2×/week for 6 months	Intervention group showed significant improvement in DQ and GDS scores ($p < 0.05$)	Ultra-early diagnosis and NDT intervention significantly improved motor development and reduced CP risk
Khan et al., 2022[13]	Effects of Neurodevelopmental Therapy on Gross Motor Function and Postural Control in Children with Spastic Cerebral Palsy: A Randomized Controlled Trial	Single-blinded RCT	66 children aged 2–6 years with spastic CP	Group A: NDT + routine therapy; Group B: routine therapy only	3×/week for 3 months	NDT group showed significant improvement in GMFM-88 ($p < 0.001$) and PPAS ($p < 0.05$)	NDT significantly improved gross motor and postural functions
Acar et al., 2022[14]	The Effects of Neurodevelopmental Therapy on Feeding and Swallowing Activities in Children with Cerebral Palsy	Single-blinded RCT	40 children aged 18–54 months with CP	Group A: OMIS + NRCT + NDT-B; Group B: OMIS + NRCT	2×/week for 6 weeks	Significant improvement in TIS and SOMA scores in Group A ($p < 0.001$)	NDT-B enhanced trunk control, feeding, and oral motor skills; recommended for integration into feeding programs

Continuation Table 1. Synthesis Matrix: Neurodevelopmental Treatment for Functional Abilities in Children with Cerebral Palsy

Author, Year	Article Title	Study Design	Population/Sample	Intervention	Therapy Frequency	Results	Conclusion
Prakash & Singh, 2014[15]	Effect of Neuro-Development Treatment with Rood's Approach on Posture Control and Balance in Cerebral Palsy Children	Experimental Study	30 children aged 5–15 years with CP (GMFCS I–III)	Group A: NDT + muscle stimulation; Group B: NDT + Rood's Approach	3×/week for 8 weeks	Group B improved GMFM score; difference not statistically significant (p = 0.396)	NDT + Rood's Approach showed better results, though not statistically significant
Ungureanu et al., 2022[16]	Balance Rehabilitation Approach by Bobath and Vojta Methods in Cerebral Palsy: A Pilot Study	Pilot Study	12 children with CP, mean age 7 ± 3.28 years	Vojta (20 min) + NDT Bobath (60 min)	5×/week for 6 months	Significant increase in Berg score (32.35%, p = 0.0001); left-right balance improved	Combined Vojta and Bobath therapies effectively enhanced balance and symmetry
Kolit & Ekici, 2023[17]	Effect of the Cognitive Orientation to daily Occupational Performance (CO-OP) approach for children with cerebral palsy: A randomized controlled trial	RCT	30 children aged 5–12 years with CP (GMFCS I–III, MACS I–II)	Experimental: CO-OP + NDT; Control: NDT only	2×/week for 5 weeks	COPM and PEDI scores significantly improved (p < 0.05); high parental satisfaction (VAS >8)	CO-OP enhanced occupational performance and satisfaction when combined with NDT

Cerebral palsy (CP) is the most prevalent motor disorder among children, typically resulting from brain injury or abnormal brain development that disrupts movement, posture, and coordination. This condition can significantly impact multiple aspects of development, ranging from fundamental motor skills such as walking and sitting to more complex activities like feeding and writing. Therefore, comprehensive treatment and rehabilitation are essential to enhance the quality of life in children with CP.

One widely adopted therapeutic approach is Neurodevelopmental Treatment (NDT), which focuses on improving motor, postural, and coordination skills through structured and targeted interventions. The effectiveness of NDT is influenced by various factors, particularly the frequency of therapy. This review explores the impact of NDT therapy frequency on the functional abilities of children with CP, based on evidence from six peer-reviewed studies.

The reviewed studies employed diverse methodologies—including randomized controlled trials (RCTs), cohort, and pilot studies—to examine how NDT affects functional outcomes in children with CP. Across these studies, therapy frequency varied from twice to five times weekly over different durations, reflecting clinical heterogeneity yet consistently indicating improvements in motor function, postural control, and daily activity participation.

Khan et al. (2022) demonstrated that administering NDT three times per week for 12 weeks led to significant improvements in gross motor function and postural control, as measured by the GMFM-88 and PPAS. Acar et al. (2022) similarly observed enhancements in trunk control and feeding function after applying NDT-B twice weekly for six weeks. Prakash and Singh (2014) compared two combinations—NDT with Rood's Approach versus NDT with muscle stimulation—administered thrice weekly for eight weeks. Although both groups improved, the difference was not statistically significant, highlighting the complexity of response variability.

In a high-frequency model, Ungureanu et al. (2022) delivered combined Bobath and Vojta NDT sessions five times weekly over six months. This approach significantly improved balance and weight distribution symmetry, as evidenced by increased Berg scores and measurable body weight shifts. Meanwhile, Kolit and Ekici (2023) explored the addition of the CO-OP approach to NDT in children with CP. With sessions held twice weekly for five weeks, the experimental group experienced significant improvements in functional performance and parental satisfaction, supporting the integration of cognitive strategies with physical rehabilitation.

Li et al. (2023) adopted an ultra-early intervention strategy in high-risk infants, beginning NDT within the first week of life and continuing twice weekly for six months. This early and consistent intervention was associated with substantial improvements in developmental outcomes, suggesting the critical role of early therapeutic engagement in modifying neurodevelopmental trajectories.

Overall, the reviewed literature underscores the importance of therapy frequency in achieving optimal functional outcomes in children with CP. Higher frequency and early initiation of NDT appear to yield greater improvements, particularly in motor function, balance, postural control, and daily living skills. These findings support the integration of individualized, high-frequency NDT protocols into routine care for children with CP.

Discussion

Effect of NDT Therapy Frequency on Gross Motor Ability

One of the functional abilities most significantly affected by NDT therapy is gross motor ability. Khan et al. (2022) demonstrated that children with cerebral palsy who underwent neurodevelopmental therapy three times a week for 12 weeks exhibited significant improvements in gross motor skills, as assessed by the Gross Motor Function Measure (GMFM-88). Basic motor abilities such as lying down, sitting up, standing, and walking showed marked enhancement. With three therapy sessions per week, the higher frequency provided sufficient time for the child to practice various motor movements regularly. This repetitive practice is crucial in helping children with CP overcome motor difficulties.

The study indicates that higher-frequency NDT therapy accelerates the gross motor development of children with CP. However, although higher therapy frequency yields better results, other studies also show positive outcomes with lower frequencies. For instance, Acar et al. (2021) utilized a therapy frequency of twice a week for six weeks, resulting in improved motor abilities and postural control in children with CP. These findings suggest that while therapy frequency plays a key role, positive outcomes can still be achieved with lower frequencies, provided the therapy is consistent and well-structured.[18]

The findings from Khan et al. (2022) and Acar et al. (2021) not only highlight the positive outcomes of NDT therapy at varying frequencies but also offer insights into the mechanisms contributing to these outcomes. The significant improvements observed in gross motor skills—such as the ability to sit, stand, and walk—can be attributed to the neuroplasticity of the developing brain in children with cerebral palsy (CP). Frequent and repetitive practice of motor tasks, as facilitated by higher-frequency NDT sessions, reinforces motor pathways and enhances motor learning through cortical reorganization. This explains why children receiving therapy three times a week showed more pronounced improvements, as they had more opportunities to engage in structured, therapist-guided movement that reinforced correct patterns and gradually replaced maladaptive ones [19,20]

However, the positive outcomes observed in Acar et al. (2021) with a lower therapy frequency suggest that consistency and quality of intervention are also essential. This supports the notion that while more frequent sessions may expedite progress, less frequent sessions, if well-structured and individualized, still foster measurable functional gains. These findings are applicable beyond CP therapy and may inform intervention strategies for other neuromotor disorders where motor learning and rehabilitation are central. For example, stroke rehabilitation or developmental delay interventions can benefit from a balance between therapy intensity and individualized pacing, emphasizing that quality, consistency, and contextual adaptability of therapy are as vital as frequency.

Effect of Therapy Frequency on Postural Control and Balance

Postural control and balance are two critical aspects that can be improved through NDT therapy. Prakash and Singh (2024) demonstrated significant improvements in balance and postural control in children with CP who received therapy three times a week for eight weeks, combining NDT with the Roods approach. The higher frequency of therapy enabled the children to practice body control and balance in various body positions, essential for developing their motor and postural skills. This improvement in balance is significant, as good balance is foundational for other motor skills, such as walking, standing, and performing daily activities. Moreover, Ungureanu et al. (2022) conducted a study utilizing both NDT Bobath and Vojta therapy, administered five times weekly over six months, and found that more frequent therapy significantly improved balance and postural control. These findings emphasize the importance of high-frequency therapy to enhance aspects of balance, which serves as the foundation for more complex motor skills.

The studies by Prakash and Singh (2024) and Ungureanu et al. (2022) provide compelling evidence that higher-frequency NDT therapy can significantly enhance postural control and balance in children with CP, while also elucidating the mechanisms underlying these improvements. Postural control and balance are foundational motor skills that underpin a child's ability to perform more complex functions, such as gait, transfers, and self-care. The mechanism behind these improvements lies in the repeated activation and coordination of postural muscles and sensory systems through structured, purposeful movements guided by NDT principles. Frequent therapy sessions, such as three to five times per week, promote sensorimotor integration by continuously stimulating proprioceptive, vestibular, and tactile inputs—enabling the central nervous system to adapt and improve motor responses. Incorporating the Roods and Vojta approaches further enhances these outcomes by targeting specific reflex patterns and facilitating postural reactions. The significance of balance improvement extends beyond physical mobility; it impacts a child's ability to interact with their environment, fostering confidence, participation, and independence in daily life.[21–23]

Additional Intervention Types

The combination of interventions has been shown to enhance the effectiveness of Neurodevelopmental Therapy (NDT) in supporting the development of children with cerebral palsy (CP). Several studies indicate that adding other intervention elements to the NDT program can lead to more optimal results. For example, NDT-Bobath (NDT-B) programs incorporating oral motor intervention strategies (OMIS) and nutritional-related caregiver training (NRCT) significantly improve feeding function and trunk control in CP patients compared to NDT-B programs that rely solely on OMIS and NRCT. Although NDT is widely used, some studies, such as those by Velde et al. (2022), suggest that activity-based and body-structure approaches may be more effective than single NDT in improving motor function. Nonetheless, NDT still yields positive results, particularly in enhancing torso control and other functional skills.[24]

In terms of intensity, increasing the frequency and duration of NDT therapy contributes to improved gross motor function. Studies by Tsorlakis et al. (2004) and Lee et al. (2017) emphasize that an intensively applied NDT program produces more significant results than a low-intensity program. A comparison of NDT and other interventions, such as Adeli suit therapy, reveals that although there is improvement in mechanical efficiency, no significant difference in gross motor skills was found between the two methods.[25]

Furthermore, numerous studies highlight the significance of a multifaceted approach in enhancing the efficacy of NDT. Acar et al. (2022) found that incorporating OMIS and NRCT within a six-week NDT program (conducted biweekly) markedly enhanced children's oral eating and motor skills. A study by Kolit and Ekici (2023) indicates that the Cognitive Orientation to Daily Occupational Performance (CO-OP) approach, when paired with NDT, enhances children's occupational performance and positively influences parental satisfaction. These data support the conclusion that a multimodal or mixed-therapy approach can significantly improve the efficacy of NDT in facilitating the development of children with CP.

Comparison Between Groups

The results show that the group receiving NDT intervention, in addition to routine physical therapy, experienced more significant improvements in functional abilities compared to the group undergoing only routine physical therapy or single therapy. This underscores the benefit of an integrative approach that incorporates NDT into a routine therapy program, leading to greater improvements in a child's abilities, particularly in terms of gross motor function, trunk control, and activities of daily living. One of the advantages of NDT is its individualized approach, based on postural analysis and movement patterns typical of children with CP. When combined with routine exercise or standard physiotherapy approaches, NDT targets more specific functional areas and facilitates more effective movement. This research highlights that NDT is not only effective as a primary intervention but also serves as a supportive therapy that reinforces the results of other primary therapies. Children with CP can significantly benefit from physical therapy sessions incorporating NDT to improve rehabilitation outcomes.

The findings reinforce the notion that an integrative approach, combining NDT therapy with routine physical therapy, has a greater impact than a single therapy. A comparison between the combined therapy group and the group receiving only routine therapy revealed that the multimodal approach more significantly improved children's functional abilities, particularly in body control, gross motor function, and activities of daily living (ADLs). This can be explained by how NDT tailors therapy to the unique needs of each child, based on typical posture and movement patterns of children with cerebral palsy (CP). With more targeted strategies, NDT reaches functional areas often not addressed by standard therapies, such as trunk stability, which is crucial for a child's balance and independence.[26–28]

Effect of NDT Therapy on Occupational Skills

In addition to gross motor skills and balance, occupational skills are crucial components in therapy for children with CP. Kolit and Ekici's (2023) study, which combined NDT with the CO-OP approach, showed that therapy twice a week for five weeks improved the occupational skills of children with CP, such as their ability to perform daily activities. Children receiving CO-OP therapy combined with NDT showed improvements in the Canadian Occupational Performance Measure (COPM), which measures the child's level of satisfaction and performance in daily tasks. Although the therapy frequency was lower compared to other studies, the results demonstrated that two sessions per week were sufficient to improve the children's ability to perform daily activities.

A lower but consistent frequency of therapy can still positively impact the development of occupational skills, especially when combined with a therapeutic approach tailored to the child's specific needs. The results of Kolit and Ekici's (2023) study demonstrated that NDT therapy, combined with the CO-OP (Cognitive Orientation to Occupational Performance) approach, improved the occupational skills of children with cerebral palsy (CP), despite the relatively lower therapy frequency of twice per week for five weeks. This finding is crucial, as it shows that therapy effectiveness does not solely depend on intensity but also on the quality of the approach used. CO-OP, a cognitive-based approach focusing on problem-solving strategies and active involvement of the child in setting goals for daily activities, enhances both physical performance and the child's ability to manage daily activities independently. When combined with NDT, which focuses on correcting abnormal postures and movement patterns, this intervention yields a dual effect: improving physical performance while increasing the child's ability to consciously manage daily activities [29–31]

This suggests that despite lower therapy frequency, significant improvements are still possible, as the approach used is holistic, individualized, and functional. This model can be applied to treat occupational problems in children with other neurological disorders, such as autism spectrum disorder or developmental coordination disorder. In countries like Indonesia, where occupational therapy resources are limited, a lower-frequency therapy model based on appropriate strategies could offer a practical and cost-effective solution. Moreover, the CO-OP approach, which actively engages children in the therapy process, aligns with the values of independence and participation, which are key goals in occupational rehabilitation. Therefore, the combination of NDT and CO-OP not only improves functional ability but is also relevant for application to populations with similar needs, as long as the approach is adapted to the cultural context and availability of local services.

Conclusion

The findings from this systematic literature review demonstrate that the frequency of Neurodevelopmental Treatment (NDT) plays a significant role in enhancing the functional abilities of children with cerebral palsy (CP). Higher therapy frequency—ranging from three to five sessions per week—combined with a longer intervention duration of approximately six months, yields the most substantial improvements, particularly in balance, postural control, and gross motor function. Moreover, the integration of NDT with complementary therapeutic approaches contributes additional benefits to functional outcomes.

Although higher-frequency therapy tends to produce more rapid and pronounced improvements, lower-frequency interventions (e.g., twice weekly) still result in measurable gains. However, the progression may be slower or less marked compared to more intensive regimens. Consequently, determining the optimal therapy frequency should be individualized, taking into account the specific conditions, capabilities, and needs of each child.

NDT remains an effective and evidence-based approach for promoting functional development in children with CP. Future research should aim to refine our understanding of optimal therapy frequency and investigate additional influencing factors such as session duration, sample diversity, and the interaction of other therapeutic variables to further improve rehabilitation strategies and outcomes for this population.

References

1. McIntyre S, Goldsmith S, Webb A, Ehlinger V, Hollung SJ, McConnell K, et al. Global prevalence of cerebral palsy: A systematic analysis. Dev Med Child Neurol. 2022;64(12):1494–506.
2. Himmelmann K. Epidemiology of cerebral palsy. In: Dulac O, Lassonde M, Sarnat HB, editors. Handbook of Clinical Neurology. Amsterdam: Elsevier; 2013. p. 163–7. (Vol. 111)
3. Oskoui M, Coutinho F, Dykeman J, Jetté N, Pringsheim T. An update on the prevalence of cerebral palsy: a systematic review and meta-analysis. Dev Med Child Neurol. 2013;55(6):509–19.
4. Jahan I, Al Imam MH, Karim T, Muhit M, Hardianto D, Das MC, et al. Epidemiology of cerebral palsy in Sumba Island, Indonesia. Dev Med Child Neurol. 2020;62(12):1414–22.
5. Afifah F, Syafitri BAS, Manafe CJW, Amany Z, Aziri ZV, Wahyudi SM, et al. Cerebral palsy: a literature review. J Biol Trop. 2024;24(4):220–7.
6. Ramadhani AN, Romadhoni DL. Faktor biososial kualitas hidup pada anak cerebral palsy. J Kesehatan. 2021;14(2):[halaman artikel].
7. Khanna S, Arunmozhi R, Goyal C. Neurodevelopmental treatment in children with cerebral palsy: a review of the literature. Cureus. 2023;15(12):e.
8. Velde AT, Morgan C, Finch-Edmondson M, McNamara L, McNamara M, Paton MCB, et al. Neurodevelopmental therapy for cerebral palsy: a meta-analysis. Pediatrics. 2022;149(6):e2021055061.
9. Tsorlakis N, Evaggelinou C, Grouios G, Tsorbatzoudis C. Effect of intensive neurodevelopmental treatment in gross motor function of children with cerebral palsy. Dev Med Child Neurol. 2004;46(11):740–5.
10. Lee KH, Park JW, Lee HJ, Nam KY, Park TJ, Kim HJ, et al. Efficacy of intensive neurodevelopmental treatment for children with developmental delay, with or without cerebral palsy. Ann Rehabil Med. 2017;41(1):90–7.
11. Law M, Russell D, Pollock N, Rosenbaum P, Walter S, King G. A comparison of intensive neurodevelopmental therapy plus casting and a regular occupational therapy program for children with cerebral palsy. Dev Med Child Neurol. 1997;39(10):664–70.
12. Li M, Wang L, Yu S, Guo X, Xun B, Zhang Y. Effect of ultra-early intervention of NDT therapy on nerve and motor development in infants at high risk of cerebral palsy. Funct Neurol. 2023;61(4):419–25.
13. Khan AK, Arslan SA, Tanveer F, Jabbar S, Ashraf I, Anwar A, et al. Effects of neurodevelopmental therapy on gross motor function and postural control in children with spastic cerebral palsy: a randomized controlled trial. Pak Biomed J. 2022;5(2):298–304.
14. Acar G, Ejraei N, Turkdoğan D, Enver N, Öztürk G, Aktaş G. The effects of neurodevelopmental therapy on feeding and swallowing activities in children with cerebral palsy. Dysphagia. 2022;37(4):800–11.
15. Firmanto A, Sudiana IK, Mulyani EY. Perbedaan pengaruh pemberian latihan NDT dan NDT kombinasi sensori integrasi terhadap keseimbangan berdiri pada anak cerebral palsy. J Keterap Fisik. 2017;2(2):47–56.
16. Ungureanu A, Rusu L, Rusu MR, Marin MI. Balance rehabilitation approach by Bobath and Vojta methods in cerebral palsy: a pilot study. Children (Basel). 2022;9(10):1481.
17. Prasaja, Khomarun. Comparison between neurodevelopmental treatment (NDT) and the combination of NDT and sensory integration for improving standing balance in children with special needs. J Keterap Fisik. 2017;2(2):47–56.
18. Tekin F, Yarar F. Effect of neurodevelopmental treatment on fall risk and balance in children with spastic cerebral palsy: randomized controlled trial. Dev Neurorehabil. 2025;28(1):7–13.
19. Giulia L, Adolfo V, Julie C, Quentin D, Simon B, Fleury M, et al. The impact of neurofeedback on effective connectivity networks in chronic stroke patients: an exploratory study. J Neural Eng. 2021;18(5):056052.
20. Ruggeri P, Miehlbradt J, Kabbara A, Hassan M. Dynamic rewiring of electrophysiological brain networks during learning. Netw Neurosci. 2023;7(2):578–603.
21. Iftikhar L, Sattar A, Qaisar S, Altaf F, Fatima K, Shahzadi R, et al. Effectiveness of abdominal activation on motor control in diplegic cerebral palsy: a randomized control trial. Pak J Med Health Sci. 2024;18(1):11–3.
22. Cahyaningtyas W, Aryani P. Perbedaan pengaruh latihan trunk control dengan latihan trunk control dan latihan fungsional terhadap keseimbangan anak cerebral palsy. J Ter Fisik. 2021;6(1):32–40.
23. Suharni, Kristiana E, Ardiani YF. Pengaruh latihan fungsional terhadap aktivitas fungsional pada anak cerebral palsy usia 4–6 tahun. J Ter Fisik. 2020;5(1):43–9.
24. Adiguzel H, Kirmaci ZIK, Gogremis M, Kirmaci YS, Dilber C, Berktas DT. The effect of proprioceptive neuromuscular facilitation on functional skills, muscle strength, and trunk control in children with cerebral palsy: a randomized controlled trial. Early Hum Dev. 2024;192:106010.
25. Bar-Haim S, Harries N, Belokopytov M, Frank A, Copeliovitch L, Kaplanski J, et al. Comparison of efficacy of Adeli suit and neurodevelopmental treatments in children with cerebral palsy. Dev Med Child Neurol. 2006;48(5):325–30.
26. Sari FN, Oktaviani N. Pengaruh terapi wicara terhadap kemampuan bicara pada anak cerebral palsy di SLB Negeri Ungaran. J Ter Fisik. 2022;7(2):64–70.
27. Suharni, Yusuf K. Pengaruh terapi wicara terhadap kemampuan bicara anak cerebral palsy usia 4–6 tahun. J Ter Fisik. 2021;6(2):51–6.
28. Wati DF. Pengaruh terapi okupasi terhadap kemandirian aktivitas kehidupan sehari-hari pada anak cerebral palsy. J Ter Fisik. 2020;5(2):44–50.
29. Peny-Dahlstrand M, Hofgren C, Lindquist B, Bergqvist L, Himmelmann K, Opheim A, et al. The cognitive orientation to daily occupational performance (CO-OP) approach is superior to ordinary treatment for achievement of goals and transfer effects in children with cerebral palsy and spina bifida: a randomized controlled trial. Disabil Rehabil. 2023;45(5):822–31.

30. Wahyuni D. Pengaruh terapi okupasi terhadap aktivitas fungsional pada anak cerebral palsy. J Ter Fisik. 2021;6(2):44–50.
31. Madieu E, Gagné-Trudel S, Therriault PY, Cantin N. Effectiveness of CO-OP approach for children with neurodevelopmental disorders: a systematic review. Arch Rehabil Res Clin Transl. 2023;5(2):100260.

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