ScientificScholar®
Knowledge is power
Publisher of Scientific Journals

https://jhas-nu.in/

Journal of Health and Allied Sciences NU

Article in Press

Original Article

Active Participation-Neuro-Developmental Therapy on Gross Motor Function in Low Functioning Children with Cerebral Palsy: A Single-Blinded Randomized Controlled Study

Vinay Kumar[1], Ashish Padhan[1], Patitapaban Mohanty[2], Saumen Gupta[3], Shagun Agarwal[4]

[1]Department of Paediatrics, Sikkim Manipal Institute of Medical Sciences, Sikkim Manipal University, Gangtok, [2]Department of Physiotherapy, Swami Vivekanand National Institute of Rehabilitation Training and Research, Olatpur, Cuttack, Odisha, [3]Sikkim Manipal College of Physiotherapy, Sikkim Manipal University, Gangtok, [4]Department of Physiotherapy, School of Allied Health Sciences, Galgotias University, Greater Noida, India

ABSTRACT

Objectives: Evidence on the benefits of Bobath therapy or neurodevelopmental therapy (NDT) in children with cerebral palsy (CP) is available elsewhere. However, there is limited evidence for low-functioning children with cerebral palsy. The study aimed to evaluate the effectiveness of active participation in NDT (AP-NDT) compared to passive physiotherapy intervention (PPI) in promoting gross motor function in children aged 2 to 4 years with cerebral palsy at Gross Motor Function Classification System (GMFCS) levels IV and V.

Material and Methods: This single-blinded randomised clinical trial recruited 56 children with CP aged between 2 and 4 years with GMFCS levels IV (n=26) and V (n=30), were randomly allocated into two groups, AP-NDT group and PPI group, through block randomisation. Both the groups received intervention for 45 minutes a session, thrice a week for 12 weeks, and a carryover effect was seen after one month of cessation of training. Gross motor function measure (GMFM 66, 88) and paediatric evaluation disability inventory (PEDI) were the outcomes. Interaction effects of group versus time were computed using two-way repeated-measures analysis of variance (ANOVA).

Results: Among 56 children with CP recruited, 48 have completed the total 12-week intervention and four-week follow-up. A two-way repeated-measures ANOVA reveals a significant difference in GMFM [F (1,46) = 13.88 (GMFM 88), $p<0.001$; F (1,46) = 16.71, $p<0.001$]. However, PEDI did not show significant group versus time interaction effects across three-time points ($p = 0.102$ - 0.826). Post hoc power analysis using Cohen's d and Cohen's f confirmed the power >99.9%. Thus, limiting type-II error to less than 1%.

Conclusion: Active participation in NDT has demonstrated good clinical improvements in gross motor function when compared with passive physiotherapy intervention.

Keywords: Developmental therapy, Disability, Gross motor, Passive positioning, Task-oriented activities

INTRODUCTION

Children with severe forms of CP are usually recognised by their inability to achieve motor milestones especially lack of independent sitting and difficulty in controlling head and trunk posture by 4 years of age.[1–3] The absence of neck and trunk control with abnormal tonal variations in the appendicular system hampers the feedback loop due to high trunk repositioning error and affects their ability to choose appropriate equilibrium responses in anteroposterior and mediolateral directions.[4,5] These altered feedback loops cause dysfunctional somatic information encoding, leading to faulty internal representation for mapping sensation to action in children with CP, thereby preventing them from moving beyond the stability limit. Thus, they exhibit severe restrictions in their pre-ambulatory and exploratory skills.[6]

The Bobaths introduced and promoted neuro-developmental therapy (NDT) in the 1940s based on handling techniques to inhibit tone and spasticity, improve balance, and facilitate movement patterns.[7] Recently, NDT adopted "top-down" approaches based on neuroplasticity, where the child decides the goals and generates movements actively to learn real-life tasks.[8,9]

***Corresponding author:** Dr. Vinay Kumar, Department of Paediatrics, Sikkim Manipal Institute of Medical Sciences, Sikkim Manipal University, Gangtok, India. vinayphysio76@gmail.com

Received: November 03, 2024 **Accepted:** January 20, 2025 **Epub Ahead of Print:** April 02, 2025 **Published:** *** **DOI:** *** **Supplementary available on:** https://10.25259/JHS-2024-11-1-R1-(1647)

The activities in AP-NDT were based on neurophysiological principles, which aim to engage the child's attention by use of visual fixation while performing activities that increase vestibular outflow as it involves task-specific postures and movements.[7,10]

It is hypothesised that the AP-NDT approach of training trunk control will be more effective than passive physiotherapy intervention (PSI) in enhancing mobility behaviour and gross motor function in children with severe CP aged between 2 to 4 years. Hence, the objective of this study was to evaluate the effectiveness of the two training methods at the end of the 12-week training period and evaluate the retention effects at one-month follow-up after cessation of the training programme.

MATERIAL AND METHODS

The sample size for the prospective randomized clinical trial was estimated using G*Power ver. 3.1.9.7 software (Heinrich- Heine-Universität Düsseldorf, Düsseldorf, Germany; http://www.gpower.hhu.de/)[11] with Effect size (Cohen's d) = 0.7 derived from the outcome measure, GMFM of a similar previous study.[10] (Pre-intervention (GMFM) = 68.93 ± 18.20; Pre-intervention (GMFM) = 81.21 ± 16.83; Effect size = Group difference/Pooled standard deviation; Effect size = 81.21 – 68.93/$\sqrt{}$ $(18.2)^2$ + $(16.83)^2$/2; Effect size = 12.28/17.53).[10] By substituting ES with the level of significance as 0.05 (α error prob), 0.80 (Power (1-β err prob) in estimating priori sample size using the statistical test, the difference between two dependent means (matched pairs) of a two-tailed test, the estimated sample size in each group has to be, n=19. By considering a 30% drop-out rate (n=5.7), the final minimal required sample must be n=25 in each group after rounding off to the next whole number. Also, by using the statistical test, repeated measures analysis of variance (ANOVA), within-between group interaction, the estimated sample size with effect size, η^2 (0.06)/f(0.25) = medium effect size, with the level of significance as 0.05 (α error prob), 0.95 (Power (1-β err prob), three measurements and two groups in estimating priori sample size results in, total minimum required sample of, n=44. After considering 30% dropouts, the minimum sample required sample is n=28 in each group. From both the calculations, the minimum required sample to attain sufficient power was finalized to be, n=28 in each group, totalling to the total required sample of, n=56.

The ethical approval was obtained from the University Ethical Committee of Sikkim Manipal University, Gangtok, Sikkim, India. Assent was taken from each child and written informed consent was obtained from their caregiver/parents before the study. The study protocol is registered with the Clinical Trials Registry, India (CTRI), with unique reference no. REF/2021/12/049412. Written informed consent was obtained from their caregiver/parents before the study. The study adhered to the ethical guidelines of declaration of Helsinki, 2024 and ICMR, 2017 ethical guidelines.

52 children with cerebral palsy, aged between 2 and 4 years, with GMFCS levels IV (n=26) and V (n=30). Then, the recruited participants were randomly allocated to one of two treatment groups (group 1 - active participation NDT (AP-NDT) group; group 2 – Passive physiotherapy intervention (PPI) group) by block randomization using serially numbered opaque sealed envelopes (SNOSE). There were four blocks in a row, with the matrix design of 4 x 14, where 4 being rows. Each block contained 4 chits (2 chits for each group). The subjects were allotted to the group based on the randomly chosen chit by the caregiver/parents. Once the block was allotted, the next row block was opened. Thus, an equal number of subjects were assigned to each group over time. The parents were blinded to the intervention provided. Hence, single blinded study. The Consolidated Standards of Reporting Trials (CONSORT)[11] flow chart describing the details of the study is displayed in Figure 1.

Intervention

Task-oriented activities based active participation NDT (AP-NDT)

Task-oriented activities based on active participation NDT (AP-NDT) included a distributed practice order of activities starting with passive trunk elongation in all the planes. Visual stimulation was used to facilitate neck movements in prone, supine, and side-lying positions. The child was exposed to weight shifts separately for the upper limb and lower limb in closed chain positions combined with vestibular stimulation for initiation of protective reactions. Activities were designed in such a way that the child experienced limits of stability in all directions with a stable support surface. The blocked practice was used to practice the task sequence of transitioning from a supine position to a sitting position, sitting to pre-ambulatory activity, with the therapist's support using sensory queues. Differential engagement of upper and lower limbs in both open-chain and closed-chain activities was facilitated simultaneously using joint traction and approximation. This ensured the enhancement of weight-bearing capability in one limb and simultaneously performed reach-outs with the other. Lateral suspension, facilitation of trunk movement, prone on the elbow, supine to sit holding trunk with both hands, reaching in prone on the elbow, sitting and reaching, and figure of four witting and weight shifting were the treatment strategies used to execute AP-NDT.

Lateral suspension

The muscles in the trunk were activated through equilibrium reactions such as tonic labyrinthine reflex (TLR), lateral

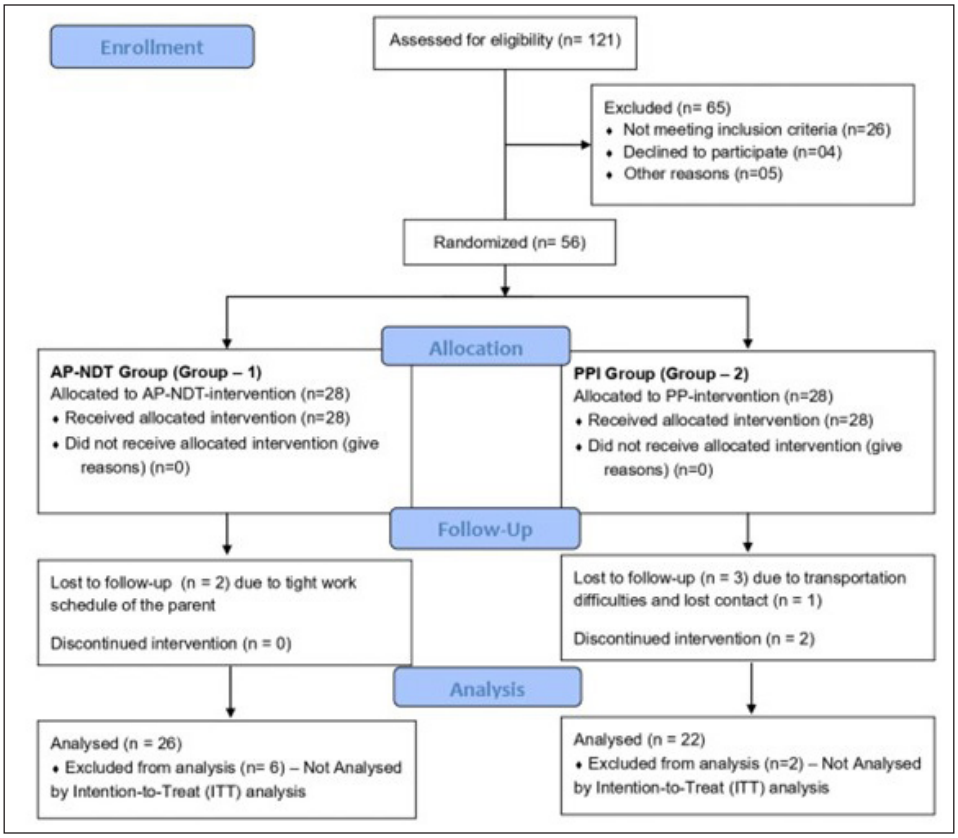

Figure 1: Consolidated Standards of Reporting Trials (CONSORT) flow chart describing the details of the study. AP-NDT: Active participation-Neurodevelopmental therapy, PPI: Passive physiotherapy intervention.

suspension, and ventral suspension. Emphasis was placed on the vestibular system by blindfolding the child to prevent distraction from the visual system. If the baby did not show an adequate response, massed practice was used to activate mobility. This was reinforced with gym ball activities to combine attitudinal reflex positions and elicit combined responses, as displayed in Figure 2a.

Facilitation of Trunk movement

Facilitation of trunk movements involved using a toy to attract attention. A rattle was shaken at the midline above the child, and once their attention was drawn to the sound, visual stimulation followed. Brightly coloured (yellow, red, and green) small plastic balls were illuminated with torchlight and moved in front of the child's face, leading to the right side and out of the child's reach [Figure 2b].

Prone on elbow

The prerequisites for the "Prone on Elbows" position include the stabilization of the pelvis, lifting the head, and moving the upper extremities. This position was practiced using a gym ball and on the floor. To facilitate neck movement, we used a bright-coloured plastic ball (yellow, red, and green) lit with a torch and moved it in front of the child in all directions. We then guided reaching movements using rattles in the sagittal and frontal planes. The therapist's hands were placed over both humerus of the child to control the movement, applying force towards the base of support from the lateral aspect of the humerus, as shown in Figure 2c.

Supine to sit holding trunk with both hands

After facilitating movements and holding posture while lying on the stomach and the side, the therapist placed their hands on the baby's trunk and slowly rotated the baby's upper body to one side, allowing the baby to push themselves up with one hand. The therapist kept the baby in this rotated position until the baby moved their head to the side. Once the baby's head was upright, the therapist continued to help the baby transition to a sitting position by stabilizing the baby's trunk with both hands, as shown in Figure 2d. The objectives of these positions were to encourage rotation of the trunk and pelvis, support weight-bearing on the baby's arms, help the

Figure 2: (a) Lateral suspension; (b) Facilitation of trunk movement; (c) Prone on the elbow; (d) Supine to sit holding trunk with both hands; (e) Reaching in prone on the elbow; (f) Figure of four sitting and weight shifting.

baby straighten their head to the side, and activate the oblique abdominal muscles.

Reaching in prone on the elbow

When working on activities that involve moving each arm separately and twisting the trunk, the child's position was such that they bore weight on one elbow while reaching out with the other hand. The therapist's hands were placed over the humerus (upper arm bone) on the weight-bearing side to support the movement, while the other hand supported the humerus to initiate the child's movement, as pictured in Figure 2e.

Sitting and reaching

The therapist manually facilitated active neck movements while providing visual stimulation to the child in a supported sitting position. The child's pelvis was held in a single cross-legged position to prevent rotation while the therapist supported the child's trunk and placed one hand on the abdomen and another on the child's chin to support the head and trunk. These supported activities included reaching movements in the transverse plane and were based on principles of weight shifting at the pelvis, trunk elongation, and optimal trunk alignment.

The figure of four sitting and weight shifting

The child was placed in a four-sitting position on the floor. The therapist sat in a long sitting position with their lower limbs stretched out and placed behind the child, as shown in Figure 2f. One of the therapist's hands supported the child's abdomen, while the other hand supported the child's chin.

The caregivers watched every session of the child and were trained to carry on with the same management programme as demonstrated in the centre. Hands-on training was given to the caregivers with emphasis on the proper placement of the child. This method was expected to engage the caregivers and enable them to become the carry-on therapy provider for their child. Care was taken to impart the therapy programme with maximum comfort to the child.

Passive Physiotherapy Intervention (PPI): Passive physiotherapy intervention (PPI) consisted of regular stretching maneuverers for tight muscles, regular passive positioning approaches to inhibit tone and active assisted and passive movement of limbs through the range of motion.

Participants of both groups performed each of these activities 10 times with 2-3 minutes rest in between each activity for a total duration of 45 minutes. The therapist administered the interventions in the clinic and taught the caregivers, allowing them to perform under supervision. The primary caregiver

of the child administered the exercise on non-clinic days. This created an environment of active engagement of the caregiver or mother in rehabilitating the child. The number of supervised sessions for the 12-week intervention programme

Special care was taken to ensure that the child was seen one hour before or after feeding time to prevent regurgitation or discomfort. The intervention was given six days a week for both groups. Outcomes were assessed at the end of 12 weeks and after a follow-up one month at 16 weeks.

Outcome measures:

Gross Motor Function Measure: Gross motor function measure (GMFM 66) is a commonly used activity-capacity measure evaluated for use in children with cerebral palsy above 6 months of age. In this clinician-rated activity limitation measure, capacity is measured in five domains: lying, rolling, sitting, standing, and running.[9]

Paediatric Evaluation Disability Inventory: The Paediatric Evaluation Disability Inventory (PEDI) is a performance-based capability measure validated for use between 0 – 8 years of age. Self-care, Mobility, and Social Function are the domains over which performance in functional skills are measured. An additional domain that reflects responsibility for performing complex tasks is also given. Each domain can be measured independently using a computerized version of the tool (PEDI-CAT). The scoring is provided in terms of percentile and T scores (Fragala-Pinkham, 2020).

Data analysis

Data were analysed for 48 participants who were regular for follow-up. Descriptive statistics is used to summarize the results for all the variables. The normality of the data was ascertained by Shapiro-Wilk's test. Independent t-test was used to compare groups at baseline. Repeated measures analysis of variance was computed to compare scores on GMFM and PEDI across three-time points. Interaction effects of group versus time were computed using two-way repeated measures ANOVA. Effect size (Cohen's d) of classified as 0.20 = small, 0.50 = medium, and 0.80 = large for reporting pre-post interaction changes. Effect size was assessed using partial η^2 and classification of partial η^2 was done by Cohen's description of η^2 effect size as $\eta^2(0.01)/f(0.1)$ = small, η^2 $(0.06)/f(0.25)$ = medium, and η^2 $(0.14)/f(0.40)$ = large. Statistical Package for the Social Sciences (SPSS) version 20 was used for the analysis.

RESULTS

Among 56 children with CP recruited, 48 have completed the total 12-week intervention and four-week follow-up. The demographic dimensions of children with cerebral palsy recruited and their distribution among various GMFCS and socio-economic levels are tabulated in Supplementary Table 1. AP-NDT and PPI groups with time interaction among the outcome measures are tabulated in Table 1. There exists a significant difference among overall GMFM 66, GMFM 88, and GMFM-Domain A (lying and rolling) and Domain B (sitting). Tables 2 and 3 display the timeline comparisons for GMFM score and PEDI within and between the groups. Effect size (Cohen's d) of 3.44 (GMFM 88) and 3.66 (GMFM 66) were reported pre-post intervention changes within AP-NDT. Similarly, effect size (Cohen's f) calculated from η^2 for GMFM88 and GMFM 66 have 0.55 and 0.60, respectively. Post hoc power analysis using Cohen's d and Cohen's f

Table 1: Active participation-neuro-developmental therapy and passive physiotherapy intervention groups with time interaction among the outcome measures.

Outcome measure		Baseline to post 12 weeks of intervention		F	P*	η2
		AP-NDT (n=26)	PPI (n=22)			
GMFM 88		25.39 ± 3.02	22.74 ± 3.28	13.88	<0.001	0.232
GMFM 66		29.69 ± 2.12	27.64 ±2.30	16.71	<0.001	0.266
GMFM Dimensions	Lying & rolling	58.73 ±4.75	73.12 ± 4.37	33.22	<0.001	0.419
	Sitting	32.55± 5.43	36.22 ±4.99	21.31	<0.001	0.317
	Crawling & kneeling	8.68 ±4.49	9.84 ± 4.13	1.85	0.180	0.039
	Standing	1.69±2.85	5 ± 2.62	1.68	0.200	0.035
PEDI Dimensions	Daily activity	39.04 ± 9.22	43.53 ± 0.73	2.79	0.102	0.057
	Mobility	42.05 ± 1.27	44.75 ± 1.14	0.65	0.426	0.014
	Social/Cognition	42.59 ± 1.65	43.76 ± 1.52	0.05	0.826	0.001

Note: AP-NDT: Active participation-Neuro-developmental therapy, PPI: Passive physiotherapy intervention, GMFM: Gross motor function measure, PEDI: Paediatric evaluation of disability inventory; All values in mean and standard deviation unless stated otherwise; * Two-way repeated measures analysis of variance (ANOVA) - Group X Time interaction effects; F: Ratio of variance between groups to the variance within groups; P*: P* value; η2: (eta-squared) - effect size.

Table 2: Timeline comparisons for gross motor function measure score within and between active participation - neuro-developmental therapy and passive physiotherapy intervention groups.

Group	Time	AP-NDT	PPI	P-value**
GMFM 88	Baseline	15.67 (10.57-20.78)	18.68 (13.13 - 24.23)	0.979
	12th week	25.39 (19.32-31.46)	22.69 (16.09 - 29.29)	0.035
	16th week	25.04 (18.95-31.13)	22.61 (15.99 - 29.23)	0.035
	p-value*	<0.001	<0.001	-
GMFM 66	Baseline	21.89 (20.26 - 29.61)	24.94 (17.59 - 26.19)	0.235
	12th week	29.69 (23 - 32.27)	27.64 (25.43 - 33.95)	0.043
	16th week	29.49 (23.01 - 32.23)	27.62 (25.25 - 33.74)	0.043
	p-value*	<0.001	<0.001	-
GMFM A (Lying & rolling)	Baseline	48.23 (38.71-57.76)	54.61 (44.26-64.97)	0.948
	12th week	73.12 (64.33-81.91)	58.72 (49.16 - 68.269)	<0.001
	16th week	72.72 (63.54-81.91	58.72 (48.73-68.702)	<0.001
	p-value*	<0.001	<0.001	-
GMFM B (sitting)	Baseline	19.154 (9.42 - 28.89)	29.01 (18.42 - 39.59)	0.223
	12th week	36.218 (26.17 - 46.27)	32.24 (21.62 - 43.47)	<0.001
	16th week	34.815 (24.83 - 44.79)	32.24 (21.62 - 43.47)	<0.001
	p-value*	<0.001	<0.001	-
GMFM C (Crawling & kneeling)	Baseline	5.02 (1.74 - 11.78)	8.12 (-0.77 - 15.46)	0.098
	12th week	9.84 (1.54 - 18.15)	8.67 (-0.34 - 17.70)	0.683
	16th week	9.53 (1.33-17.73)	8.57 (-0.35 - 17.48)	0.683
	p-value*	<0.001	0.891	-
GMFM D (Standing)	Baseline	3.65 (0.18-7.47)	0.82 (-3.34 - 4.98)	0.087
	12th week	5.00 (0.28-10.28)	1.69 (-4.05 - 7.43)	0.041
	16th week	5.07 (0.32-10.46)	1.96 (-3.89 - 7.82)	0.044
	p-value*	<0.001	<0.001	-

Note: AP-NDT: Active participation-Neuro-developmental therapy; PPI: Passive physiotherapy intervention; GMFM: Gross motor function measure; Descriptive statistics are expressed in mean with (95% confidence interval); *: Repeated measures analysis of variance (ANOVA); **: Independent t-test.

Table 3: Timeline comparisons for paediatric evaluation of disability inventory (PEDI) within and between active participation - neuro-developmental therapy and passive physiotherapy intervention groups.

PEDI	Timeline	AP-NDT	PPI	P-value**
Daily Activity	Baseline	37.73 (36.25 - 39.21)	35.45 (33.84 - 37.10)	0.081
	Post 3 month	43.53 (41.83 – 45.24)	39.04 (37.91 - 40.90)	0.032
	Follow-up	43.53 (41.83 - 45.24)	39.04 (37.91 - 40.90)	0.032
	p-value*	<0.001	<0.001	
Mobility	Baseline	42.23 (40.35 - 44.10)	40.27 (38.23 - 42.31)	0.162
	Post 3 month	44.75 (42.46 - 47.07)	42.04 (39.53 - 44.55)	0.064
	Follow-up	44.75 (42.46 - 47.07)	42.05 (39.53 - 44.55)	0.064
	p-value*	<0.001	<0.001	
Social/ Cognition	Baseline	38.46 (34.87 - 42.05)	36.68 (32.79 - 41.58)	0.503
	Post 3 month	43.76 (40.70 - 46.82)	42.59 (39.26 - 45.91)	0.062
	Follow-up	43.76 (40.70 - 46.82)	42.59 (39.26 - 45.91)	0.062
	p-value*	<0.001	<0.001	

Note: AP-NDT: Active participation-neuro-developmental therapy; PPI: Passive physiotherapy intervention; PEDI: Paediatric evaluation of disability inventory; Descriptive statistics are expressed in mean with (95% confidence interval); *: Repeated measures analysis of variance (ANOVA); **: Independent t-test.

confirmed the power >99.9%. Thus, limiting type-II error to less than 1%.

DISCUSSION

The treatment approach for children with CP is primarily focused on the Improvement of GMF score.[12] In this study, the AP-NDT group showed improvement in GMFM score and dimensions A and B, thus proving that the children learned to initiate and sustain antigravity postures. Dimension C (dimension kneeling & crawling) did not show significant improvement statistically. However, many children (n=15) transitioned to a better quality of movement in dimension C. Moreover, it was not expected that there would be a change in dimensions D and E in these lower GMFCS categories. 33% of children improved in sitting, 4 % in crawling and 2% were able to stand with support in the AP – NDT group but similar improvements were not evident in the PSI group. Although not measured, the degree of stiffness in muscles

and voluntary contractions also improved. Our findings were inclined with Labaf *et al*. report, where they documented the improvement in four dimensions (A, B, C & D) of the GMFM following NDT except dimension E.[12] AP-NDT is favourable in enhancing the typical movement patterns,0 6-weeks of training with AP-NDT significantly improves the overall score of GMFM ($p < 0.001$) along with trunk control and balance.[10]

The performance measure scores in dimensions of self-care, mobility and social cognition were not statistically significant despite the improvement in mobility scores. The reasons could be that PEDI is a normed score measure and currently uses norms not based on the Indian population. Secondly, the activities over which the children are rated were not practised during the rehabilitation programme. Thirdly, caregivers of low-functioning children do not expect certain functional activities to be practised and hence most of the children will not be allowed to practise those activities. Lack of carry-over to other functional tasks which have never been practised also states that engagement in rehabilitation could be a passive activity rather than an active one.[13]

In previous research, participants formed a homogenous group as they were recruited based on functional classification rather than impairment-based severity classification. The participants were randomised to improve the validity of the programme. There was no significant difference between the AP-NDT and SPI in baseline assessments on any of the outcome measures suggesting that the randomisation was appropriate. AP-NDT used here is well designed so that it can be easily transferred from the therapist to the caregiver to reduce dependency. Also, it can be facilitated as a family-centred programme with the hope that compliance and adherence to the programme will continue.[14]

Although assistive technology was not a part of this study, the AP-NDT along with assistive devise can aid in comfort, pressure distribution and normalising tone as compared to compensatory approaches only.[15] The effect sizes in gross motor function achieved in this study were large (η^2=0.3-0.42) which suggests that the intervention programme is appropriate and have shown good clinical improvements in lower-functioning CP.

Active participation in NDT imparted to children with CP in a hybrid mode maintains functioning after the cessation of the training programme however, this improvement should be combined with the appropriate introduction of assistive technology like seating devices which can improve adherence to therapy, reduce caregiver burden and prepare children with cerebral palsy for academic pursuits. The study cohort was disrupted due to the waxing and waning scenario of COVID-19, which led to attrition in sample size.

This research has a few limitations. The study's scope was limited by its small sample size and the fact that participants were recruited from a single location. However, to our knowledge, this represents the first investigation into the effects of Active Participation-Neuro-developmental Therapy on gross motor function in low-functioning children with cerebral palsy from low- and middle-income countries (LMICs). Although the sample size was restricted, the study maintained sufficient statistical power (>90%) to minimize type II error. While participants were drawn from one site, they were recruited from a recognized tertiary care teaching hospital, potentially offering broader representation. These results can be considered preliminary findings to inform future research in this area.

CONCLUSION

Task-oriented activities based on NDT intervention performed intensively for a minimum of three months duration is generalizable to individuals with CP in GMFCS IV & V. The task-oriented activities neuro developmental treatment (TAO NDT) has shown maintenance of gross motor function in the domain of lying and sitting over and above the standard intervention programme at the one-month follow-up after cessation of a supervised rehabilitation programme.

Ethical approval: The research/study approved by the Institutional Review Board at The University Ethical Committee, of Sikkim Manipal University, Gangtok, Sikkim, India, number REF/2021/12/049412, dated 28th September 2021.
Declaration of patient consent: The authors certify that they have obtained all appropriate patient consent.
Financial support and sponsorship: Nil.
Conflicts of interest: There are no conflicts of interest.
Use of artificial intelligence (AI)-assisted technology for manuscript preparation: The authors confirm that there was no use of Artificial Intelligence (AI)-Assisted Technology for assisting in the writing or editing of the manuscript and no images were manipulated using AI.

REFERENCES

1. Wu YW, Day SM, Strauss DJ, Shavelle RM. Prognosis for ambulation in cerebral palsy: A population-based study. Pediatrics 2004;114:1264-71.
2. Rosenbaum PL, Palisano RJ, Bartlett DJ, Galuppi BE, Russell DJ. Development of the gross motor function classification system for cerebral palsy. Dev Med Child Neurol 2008;50:249-53.
3. Ali MS. Impact of core stability education on postural control in children with spastic cerebral palsy. Bull Fac Phys Ther 2019;24:85-9.
4. Samuel AJ, Solomon J, Mohan D. Postural sway in dual-task conditions postural sway in dual-task conditions between spastic diplegic cerebral palsy and typically developing children postural sway in dual-task conditions. Int J Heal Rehabil Sci 2013;2:91-7.

5. Carlberg EB, Hadders-Algra M. Postural dysfunction in children with cerebral palsy: Some implications for therapeutic guidance. Neural Plast 2005;12:221-8.
6. Sansare A, Arcodia M, Lee SCK, Jeka J, Reimann H. Individuals with cerebral palsy show altered responses to visual perturbations during walking. Front Hum Neurosci 2022;16:977032.
7. Zanon MA, Porfírio GJM, Riera R, Martimbianco ALC. Neurodevelopmental treatment approaches for children with cerebral palsy. Cochrane Database Syst Rev 2018;2018.
8. Te Velde A, Hons Ba, Morgan C, Finch-Edmondson M, McNamara L, Hons Bp, *et al*. Neurodevelopmental therapy for cerebral palsy: A meta-analysis. Pediatrics 2022;149:e2021055061.
9. Zanon MA, Porfírio GJM, Riera R, Martimbianco ALC. Neurodevelopmental treatment approaches for children with cerebral palsy. Cochrane Database Syst Rev 2015;2017.
10. Sah AK, Balaji GK, Agrahara S. Effects of task-oriented activities based on neurodevelopmental therapy principles on trunk control, balance, and gross motor function in children with spastic diplegic cerebral palsy: A single-blinded randomized clinical trial. J Pediatr Neurosci 2019;14:120-6.
11. Peacock JL, Kerry SM, Balise RR. Writing a research protocol. In: Presenting medical statistics: From proposal to publication. 2nd edition. Croydon, United Kingdom: Oxford University Press; 2017. p. 32-4.
12. Labaf S, Shamsoddini A, Hollisaz MT, Sobhani V, Shakibaee A. Effects of neurodevelopmental therapy on gross motor function in children with cerebral palsy. Iran J child Neurol 2015;9:36-41.
13. Rivera-Rujana DM, Muñoz-Rodríguez DI, Agudelo-Cifuentes MC. Reliability of the gross motor function measure-66 scale in the evaluation of children with cerebral palsy: Validation for Colombia. Bol Med Hosp Infant Mex 2022;79:33-43.
14. Piggot J, Paterson J, Hocking C. Participation in home therapy programmes for children with cerebral palsy: A compelling challenge. Qual Health Res 2002;12:1112-29.
15. Leonard JAJ, Esquenazi A, Fisher S V, Hicks JE, Meier RH 3rd, Nelson VS. Prosthetics, orthotics, and assistive devices. 1. General concepts. Arch Phys Med Rehabil 1989;70: S195-201.

How to cite this article: Kumar V, Padhan A, Mohanty P, Gupta S, Aggarwal S. Active Participation-Neuro-Developmental Therapy on Gross Motor Function in Low Functioning Children with Cerebral Palsy: A Single-Blinded Randomized Controlled Study. J Health Allied Sci NU. doi: 10.25259/JHS-2024-11-1-R1-(1647)

Supplementary Table 1: Demographic dimensions of children with cerebral palsy recruited				
Demographic dimensions		**AP-NDT (n=26)**	**PPI (n=22)**	**p-value****
Age (months)		35.15 ± 8.28	34.68 ± 8.72	0.940
Gender [M/F (%)]		21(80.8) / 5 (19.2)	16 (72.7) / 6 (27.3)	
Weight (kg)		10.54 ± 1.84	10.32 ± 1.62	0.664
Height (cm)		87.23 ± 7.24	88.59 ± 9.13	0.568
Head circumference (cm)		44.65 ± 3.1	44.32 ± 2.78	0.697
Arm circumference (cm)		15.12 ± 1.42	14.64 ± 1.56	0.272
GMFCS	GMFCS-IV [n (%)]	8 (30.76)	10 (45.45)	-
	GMFCS-V [n (%)]	18 (69.26)	12 (46.15)	-
Type of CP	Spastic diplegia [n (%)]	4 (15.4)	5 (22.7)	-
	Spastic quadriplegia [n (%)]	21 (80.8)	14 (63.6)	-
	Ataxic quadriplegia [n (%)]	1 (3)	1 (4.5)	-
	Athetoid quadriplegia [n (%)]	-	2 (9)	-
Socio-economic status*	Lower class [n (%)]	1 (3.8)	-	-
	Upper Lower [n (%)]	3 (11.5)	3 (13.6)	-
	Lower Middle [n (%)]	9 (34.6)	15 (68.1)	-
	Upper Middle [n (%)]	13 (0.5)	3 (13.6)	-
	Upper Class [n (%)]	-	1 (4.5)	-

Note: AP-NDT: Active participation-neuro-developmental therapy, PPI: Passive physiotherapy intervention, GMFM: Gross motor function measure, PEDI: Paediatric evaluation of disability inventory, GMFCS: Gross motor functioning classification system, *Socio-economic status ascertained by modified Kuppuswamy scale, **Independent t-test, ±: Mean ± SD; Figures in brackets represent percent.