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Effects of Functional Training with and Without Dynamic Cycling Activity on Spasticity and Ambulation in Children with Spastic Diplegia Cerebral Palsy

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Author`s Contribution

[1] [2] Substantial contributions to the conception or design of the work for the acquisition, analysis or interpretation of data for the work, [4] Final approval of the version to be published, [1] [2] [3] [4] Agreement to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

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A B S T R A C T

Background: Cerebral palsy (CP) is a collection of disorders that impede an individual's capacity to execute voluntary movements and sustain equilibrium and body position. Cerebral palsy (CP) is widely recognized as the prevailing motor disability observed during childhood. The term "cerebral" affects the functions, structures, or processes associated with the brain.

Objective: To compare the effects of functional training with and without dynamic cycling activity on spasticity and ambulation in children with spastic diplegia.

Methodology: Sixty-two males and females having GMFCS levels II-III and Modified Ashworth Scale Grade (1, +1, and 2) with pre-diagnosed, aged 3-6 years were participated in this study. The study was conducted in Physical Therapy Department, Allied Hospital Faisalabad from February to October 2023. Group A received conventional physical therapy and functional training without dynamic cycling activity, while Group B received conventional physical therapy and functional training along with dynamic cycling activity. Spasticity and ambulation were assessed using Modified Ashworth Scale and Gross Motor Function Measure (GMFM) respectively at baseline and 12th week. Data was analyzed using SPSS version 24.

Results: The findings of study were originate to be significant for all the outcome variables in both groups. The results of intragroup analysis (Friedman test) and intergroup analysis (Mann- Whitney U test) obtained value is 0.001 ($p< 0.05$) for all variables.

Conclusion: Conventional physical therapy and functional training along with dynamic cycling activity showed more significant results for spasticity and ambulation.

Keywords: Dynamic cycling, cerebral palsy, Mobility limitation.

Introduction

Cerebral palsy (CP) is a collection of conditions that impede an individual's capacity to execute voluntary movements and sustain equilibrium and body position. Cerebral palsy (CP) is widely recognized as the prevailing motor disability observed during childhood. The term "cerebral" pertains to the functions, structures, or processes associated with the brain. Palsy refers to a condition characterized by muscular weakness or difficulties in muscle utilization.[1]

The GMFCS describes gross motor function in CP children, focusing on self-initiated motions like sitting and walking. The Classification of Gross Motor Function Scheme classifies cerebral palsy children and youth into five levels.

"Level I" often have no trouble walking. “Level II” Children Walk in most settings and climb stairs holding onto a railing. Level III GMFCS Hand-held mobility devices are used by most indoor children. Level IV GMFCS. [2]

Cycling is one of the many therapies used to accomplish these goals. Pedaling is a streamlined locomotor design as a result. Walking and riding show signs of same brain architecture and both need reciprocal motor coordination. Dynamic cycling improved in two dimensions (standing, walking), heart rate, and cardiopulmonary fitness more than static cycling. Dynamic cycling improved perturbations, which helped youngsters develop anticipatory posture control and motor learning. [3]

Up until now, there hasn't been a thorough analysis of how well cycling works to enhance functional performance in kids with cerebral palsy. Our goal was to ascertain whether cycling therapies may enhance physical functions and lessen activity restrictions in kids with cerebral palsy. The study's justification is that when children with cerebral palsy mature from childhood to adolescent, their gross motor abilities deteriorate. Equilibrium, practical ability, and cardiovascular endurance are all enhanced by dynamic cycling exercise. A small number of studies suggest that this approach increases muscular tone and strength to prevent injuries to the joints and to preserve balance and flexibility. To the best of our knowledge, there has been limited research available to analyze the impacts of functional training with dynamic cycling in spastic diplegia cerebral palsy and there is limited research available about dynamic cycling effectiveness on ambulation in CP. So, this study will assist the physiotherapist by providing clinical insights on long term effects of functional training along with dynamic cycling on spasticity and ambulation in children with spastic diplegia cerebral palsy.

Methodology

Randomized Controlled Trial was conducted at Physiotherapy department of Allied Hospital, Faisalabad after the 9 months (February to October 2023) with ethical approval Number (REC-UOL-548-10-2023). The total sample size was 62 that is 31 allocated in each group and it is calculated by open Epi-tool.[4]

The study included Diagnosed children with spastic diplegic cerebral palsy [5], GMFCS levels III and Modified Ashworth Scale Grade(1 and +1), Age 3 to 6 years [6], Adequate range of motion of hips, knees and ankles to allow pedaling [7], Having Tricycles at home [8], Ability to participate effectively in rehabilitation for up to 45 minutes. [9], Good to fair selective motor control.[10]

Patients with Chromosomal abnormalities 5, Hip replacement that causes severe pain and would prevent the child from participating in cycling intervention [7], Unable to remain in a comfortable position to use the cycling equipment for up to30 min, Visual/Auditory Impairment, Current pulmonary disease or asthma and taking oral steroids for an acute episode in the past 6 months [7], Uncontrolled epilepsy [11], Cognition delay are excluded.

Group 1: Conventional physical therapy and functional training without dynamic cycling activity: Conventional physical therapy (20 Minutes Activity): Prolonged extending of tense muscles, such as the gastrosoleus, hamstrings, and adding muscles of the hips. Length as well as Duration: two minutes every during therapy practice. Ten sets of reclined stretching were done, each lasting ten seconds. Five minutes of kneeling while using the top limbs. Seating: Reach outs- forward, sideways for 5 minutes. Sit down to Standpoint activity was performed under supervision for 20 minutes. [12] Functional training (25 Minutes Activity): The main groups of muscles were warmed through stretching at the beginning every workout. Practical muscular conditioning was performed through a closed-chain workout that included ankle raises and lowers on a set of blocks, sit-to-stands, and leg raising movements, along with forward and diagonal lifts or step-downs. Intense workouts were carried out to a customized greatest number of cycles in order to enhance the endurance and power of the muscles and encourage motor acquisition. This exercise regime was performed in 15 minutes.[13] Progressive resistance training exercises for trunk and lower limb muscles 50 percent of repetition maximum for 5 minutes 3 times a week for 12 weeks. Stretching exercises 60 seconds of 3stretches, 3 times a week for 12 weeks. Flexibility exercises include range of motion exercises, for 5 minutes10 repetition at trunk and lower limb joints.

Group 2: Conventional physical therapy and functional training including dynamic cycling activity: Conventional Physical Therapy (25 to 30 Minutes Activity): The procedure of aerobics for conventional physical therapy remained the similar as conventional group plus this session was include 5 to 10 minutes Trunk and back strengthening exercises to prepare the child for riding a dynamic cycle. [12] Functional training involving dynamic cycling activity (30 Minutes Activity) The protocol of exercises for functional training was the same as conventional group plus dynamic cycling activity as described Riding a dynamic cycle The baby's maximal capability began to increase at the end of the period, and intervals of rest in between, and it was progressively increased to thirty minutes requiring fewer break times. The kids' ankles were strapped in place.[12] Precaution: The feet of the children were secured by straps. For

security reasons, the kids received knees protectors or helmets. Encouragement was given by the parent and the therapist time to time.[12] The activity was carried out individually at 3 sessions per week for 12 consecutive weeks, 30 minutes with rest intervals each cycling session.

The data was entered and analyzed using SPSS Version 24. The numerical data like age was presented in the form of mean ± SD. Categorical Data like gender group: male and female was presented in the form of frequency (Percentage). After checking the normality of data, the data was not normally distributed, Friedman test was used to determine mean difference of Gross motor function and spasticity in both experimental and control groups. Mann Whitney test was applied to compare the outcomes at baseline and at 12th week. P- Value of less than and equal to 0.05 was considered significant.

Results

The descriptive statistics of age, the lower limit of age was 3 years and the upper limit was 6 years. For Group-A, the respondent's age had mean value of 4.26 ± 1.064, while for Group-B had mean of 4.52 ± 1.092.

Friedman test was applied for within group analysis of GMFM-88 Dimension D (standing), Dimension E (Walking, running & jumping) and modified ashworth scale for hamstring and plantar flexors. The values of median IQR, mean ranks and p-value of both group A and B were mentioned. Assessment had been done at baseline and 12th week. (Table I)

The between group analysis using Mann-Whitney test showed statistically significant difference in GMFM-88 Dimension D (standing), Dimension E (walking, running & jumping) and Modified Ashworth scale for hamstring and plantar flexors at 12th week while not significant at baseline. The values of median IQR, mean ranks and p-value were mentioned. Assessment had been done at baseline and 12th week (Table II)

Discussion

The current study examined the properties of functional training with cycling activity on spasticity and ambulation in children with spastic diplegia The results of this study demonstrated significant improvements in spasticity reduction and ambulation in both Experimental and Control groups, however, the difference was more pronounced in the

Table I: Friedman Test for GMFM-88 Dimension. Analysis of Group A

Variables	Assessment	Median (IQR)	Mean Rank	p-value
GMFM-88 Dimension D (Standing)	At Baseline	20.0 (9.0)	5.13	<0.001
	At 12th Week	26.0 (4.0)	6.44	
GMFM-88 Dimension E (Walking, running & Jumping)	At Baseline	30.0 (16.0)	6.74	<0.001
	At 12th Week	33.0 (16.0)	7.69	
MAS- Hamstring	At Baseline	4.0 (1.0)	3.26	<0.001
	At 12th Week	3.0 (1.0)	1.92	
MAS- Plantar flexors	At Baseline	4.0 (1.0)	2.97	<0.001
	At 12th Week	3.0 (1.0)	1.85	
Analysis of Group B				
GMFM-88 Dimension D (Standing)	At Baseline	20.0 (9.0)	5.11	<0.001
	At 12th Week	30.0 (5.0)	6.47	
GMFM-88 Dimension E (Walking, running & jumping)	At Baseline	30.0 (16.0)	6.74	<0.001
	At 12th Week	45.0 (17.0)	7.68	
MAS- Hamstring	At Baseline	4.0 (1.0)	3.52	<0.001
	At 12th Week	3.0 (1.0)	1.92	
MAS- Plantar flexors	At Baseline	4.0 (1.0)	3.19	<0.001
	At 12th Week	2.0 (1.0)	1.37	

Experimental Group.

Duygu Turker et al., in 2023 investigated the benefits of practical electrical motivation cycling (FES-C) keeping fit on gross motor function, gait, muscular strength, in that who are ambulatory in addition to traditional physical therapy. Group A completed FES-C training, while the Control group started receiving traditional physical rehabilitation. Measurements were taken at the time of birth, eight weeks into the treatment, and sixteen weeks into the treatment. The study's conclusion demonstrated that FES-C, when used in conjunction with traditional physical therapy, is superior to traditional physical therapy for improving prime functional activity, increasing strengthening of muscles, and lowering energy consumption in CP child.[14] Despite the differences of present study in

Table II: Mann-Whitney Test for GMFM-88 Dimension.

Variables	Assessment	Group A Mean Rank	Group B Mean Rank	Median (IQR)	Z-value	p-value
GMFM-88 DimensionD (Standing)	At Baseline	31.50	31.50	20.00 (9.00)	0.000	1.000
	At12th Week	26.03	36.97	28.00 (6.00)	-2.393	0.017
GMFM-88 Dimension E (Walking, running& Jumping)	At Baseline	31.50	31.50	30.0 (16.00)	0.000	1.000
	At12th Week	23.37	39.63	40.0 (16.50)	-3.551	<0.001
MAS- Hamstring	At Baseline	31.50	31.50	4.0 (1.0)	0.000	1.001
	At 12th Week	38.50	24.50	3.0 (0.25)	-3.364	0.001
MAS- Plantar flexors	At Baseline	31.50	31.50	4.0 (1.0)	0.000	1.000
	At12th Week	40.29	22.71	3.0 (1.0)	-4.015	<0.001

methodology regarding short term effects, the findings of the previous study align with the observed improvement in gross motor function in the experimental group of the current study.

Because dynamic cycling and the kinematic pattern of gait, which include repetitive metrical motor strain, are comparable, it has become popular to use it to help children with cerebral palsy improve their lower extremity ambulation, strength, abidance, and function. [15] In the current study, there was an improvement in lower extremity ambulation, including standing, walking, running, and leaping, 12 weeks following therapy. Dynamic cycling has been demonstrated to improve cycling performance in CP patients both immediately and over time by strengthening the muscles in the lower branches of the body([9]). Even though the outcomes of present study are equivalent through these two situation reports, however the unique contribution of current study lies in the investigation of dynamic cycling as an adjunct to functional training, showing promising results.

J. Riad et al. theorized that the observed reduction in spasticity and improved ambulation can be attributed to neuroplasticity and motor learning mechanisms induced by both functional training and dynamic cycling. The combination of these interventions may provide a more holistic approach to addressing the motor impairments associated with spastic diplegia. Dynamic cycling helped children become more restless, which led to the development of anticipatory postural control. With continued use, there may also be a motor literacy impact. [16] Regardless of difference in interventions on same condition the present study results are in parallel with previous study in improving ambulation and decreasing spasticity.

An RCT conducted by Patitapaban Mohanty et al., in 2015 aimed to evaluate the effects of conventional exercises, dynamic cycling, and static cycling on children with cerebral palsy's cardiovascular health, balance, ambulation, and walking ability. Each of the three groups started a traditional activity.

Additionally, experimental groups 1 and 2 entered the protocols for stationary and dynamic cycling, respectively. While every group demonstrated enhancement in GMFM-66, the self-motivated pedaling group outperformed the control group in terms of improvement. According to the findings of this study, brisk cycling combined along with traditional trainings enhances circulatory durability, equilibrium, ambulation, and practical skills more than conventional exercises alone.[17] Although there is difference in age spam and treatment allocation groups but the results from this study provided significant affirmation to current study findings that application of dynamic cycling have additional effect in enhancing functional outcomes.

Functional exercise permits for reiteration of motor-powered chore to initiative ability accession. My goals are to improve my ability to walk, exercise my exceptional talent, become more independent, and participate more actively in daily activities.[18] The partial body weight support (PBWS) system is used in both functional training and dynamic cycling. It works to lessen the strain on the lower limbs, promoting upright posture and a more natural gait. The findings of current study aligned with the observed improvement in ambulation and balance as in previous literature.

The study did not provide detailed information about the characteristics of the participants, such as definite cause, or severity of Spastic Diplegia Cerebral Palsy. The presence of heterogeneity within the participant group may have influenced the outcomes and limited the ability to draw definitive conclusions. This might have limited the evidence by not including article written in other languages that may have been eligible for conclusion. Limited clinical area for study is involved. Further studies on other technique in combination with dynamic cycling activity neededto find the effects on low back pain. In future, research should be conducted to explore the effects of dynamic cycling activity in rehabilitation of other musculoskeletal conditions. Further research can be done by using other outcome measures. Further studies should carry out to assess low back pain by different screening tools and instruments

Conclusion

The findings of this study showed that both conventional physical therapy and functional trainingwithout dynamic cycling and conventional physical therapy and functional training with dynamiccycling activity were effective activity on spasticity and ambulation in children with spastic diplegia. However, conventional physical therapy and functional training with dynamic cycling activity therapy showed more significant results.

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