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RESEARCH ARTICLE

# Effects of Stationary Cycling on Spasticity and Range of Motion in Children with Diplegic Cerebral Palsy: A Quasi Interventional Study

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**ABSTRACT**

**Background:** Literature shows that cerebral palsy becomes challenging disability with the passage of time. Various treatment protocols are used to treat balance and coordination problems during rehabilitation programs however effective techniques are still needed to address spasticity and limited range of motion.

**Objectives:** To determine the effects of stationary cycling on spasticity and range of motion in diplegic cerebral palsy children.

**Methods:** An interventional study design (Quasi study design) was conducted in Rising Sun Mughalpura branch and Compass Schools for Special Education Lahore in 6 months from Feb 2019 to Aug 2019, after approval of synopsis. 68children with Spastic Diplegic Cerebral Palsy meeting inclusion criteria were enrolled in the study. Sample size was estimated using formula for Sample Size determination in health studies version 2.0.21 WHO. The static bicycle was used as an intervention tool. Two readings were taken before and after treatment. The data was analyzed by using IBM SPSS 20. Qualitative variables age, weight, gender and height were expressed as percentages. As the data found was parametric with a homogenous impression, paired sample t test was used to compare mean score at pre-post levels for ashworth scale and range of motion at knee and ankle joints. A p value less than 0.05 were taken as significant. Ashwroth Scale was used for spasticity and for Range of Motion goniometer was used.

**Results:** The paired sample statistics of pre-post testing of Ashworth Scale Score for calf muscles (M= 1.02, SD= 0.79), while for hamstring muscles (M= 1.13 SD= 0.84) with the significant p value 0.00. Knee and ankle range was (M=9.70, SD= 0.54) and (M=0.82, SD= 2.69) respectively, with a significant p value 0.00 for both.

**Conclusion:** It is concluded that stationary cycling has significant role in decreasing spasticity and increasing range of motion in children with diplegic spastic cerebral palsy

**Key words:** Ashworth Scale, Diplegic Spastic Cerebral Palsy, Physical Therapy, Stationary Cycling.

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## Introduction:

Cerebral palsy is categorized as a group of non-progressive damage to immature brain leading to movement and posture disorders resulting in activity limitation.(1) It is characterized by impairment in perception, sensation, communication, cognition, behavior and various musculoskeletal disorders. In European countries, the incidence is as high as 2-3/1000 live births and among this, 40%is due to low weight and preterm babies.(2)

A study conducted in Pakistan, regarding prevalence of CP children visiting physiotherapy center showed 70-75 %, diagnosed with symptoms of disturbed tone, posture and locomotion. There is no single specific cause of constellation of symptoms known as CP. Most important factors may include birth asphyxia (that is having history of late cry for > 5 minutes after birth), birth trauma, drug abuse, and maternal infections, prematurity and intracranial infections. The most common type of CP is Spastic Cerebral Palsy, which is in almost 75% of the total cases, including in quadriplegic (40%), hemiplegic (21%), and diplegic 39%.(3)

Children with cerebral palsy show low level of physical fitness. Associated impairments that are seen with cerebral palsy are balance issues, coordination, endurance, cardiovascular capacity, pulmonary capacity and overall functional level decline. Clinical specialists and other physiotherapists agree that to maintain muscle strength and cardiopulmonary capacity of cerebral palsy children, it is important to provide maximum level of circulation to children for their physical activity and function.(4) Although there is limited evidence regarding intensity of exercise, still, now a days, tough and aggressive exercise is discouraged in patients with cerebral palsy. Recent scientific debate is on the use of cardiopulmonary fitness for treatment of aforementioned

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impairments in cerebral palsy children.(5) There is running debate that if these fitness type exercise can play role in reducing spasticity and range as well, because these two factors are important to boost function.(6)

Stationary cycling is one aforementioned cardio exercise that may have impact on function overall. Stationary cycling does not require sophisticated coordination and balance. This can enable children to work on high demand exercise of higher intensities because the energy required for balance and coordination is cut off.(7) Cycling can involve multiple group of muscle at a single time. For example, primary movers and antagonists of ankle, knee and hip can be involved at the same time for strength and endurance training.(8) Although children of cerebral palsy can incorporate cycling immediately and independently, however, the difference comes in pattern of muscle activation. There may also be difference in joint mechanics and pedal patterns as compared to those who have not cerebral palsy. There will be difference in response, carrying out and termination pattern of children with cerebral palsy and those of without cerebral palsy.(9)

A study trial in 2017 on task specific training impacts and functional effects in children with cerebral palsy was done with cycle and elliptical. Children both the unilateral and bilateral impairments were included. The improvement was measured by gait speed and cadence length before and after the complete sessions of cycling or elliptical. There was overall improvement in specific measures such as tone of muscles, range and function; however, gait was not significantly different. This would be due to the deficit of dose and training.(9) In 2008, conducted an experimental study concluding that ‘’Rhythmic arm cycling suppresses hyperactive soleus H-reflex amplitude after stroke.’’ However they observed that this suppressive effect is more obvious in neurologically intact participants and is greater when the movement numbers is increased. They proposed that rhythmic arm cycling may potentially be used as a rehabilitation technique to reduce exaggerated reflexes such as those occurring in spasticity.(10)

Many literatures had shown the results in the form of pedals of stationary cycling usage as strengthening exercise after conventional physical therapy treatment that it increased lower limb muscular strength, walking ability, cardiovascular fitness/endurance, eye-hand co-ordination and overall improvement in gross motor functions in spastic CP children. These studies suggested that strengthening exercises, as stationary cycling, did not have negative effect on spasticity of muscles in spastic CP children.(11, 12) Rationale of this study was to find out stationary cycling as a physical therapy intervention as an additional tool to wedge standing and manual stretching rehabilitation to decrease spasticity and increase joint range of motion in spastic diplegic cerebral palsy children, so that CP child can use this intervention as a playful activity and can manage himself his spasticity and joint range of motion of lower limbs without experiencing any pain of wedge standing or manual stretching.

**Methods:**

This study was carried out at Rising Sun (Mughalpura branch) and Compass Schools for Special Education (Lahore Cantt) in 6 months from Feb 2019 to Aug 2019. Total 68 children aged 7-15 years with Spastic Diplegic Cerebral Palsy scoring on Ashworth Scale of 1, 1±, 2 were enrolled in the study by convenient sampling technique. Subjects with command following problems and significant lower limb contractures were excluded. Sample size was calculated by using formula

$$n = \frac{Z^2_{1-\frac{\alpha}{2}} P(1-P)}{d^2}$$

where margin of error was 0.08 and significance level was 95%. (Sample Size determination in health studies version 2.0.21 WHO). $P_o$ is the proportion of children with spastic diplegic cerebral palsy = 17%. (13) The static bicycle was used as an intervention. Two readings were taken before and after treatment. Written informed consent was obtained from the parents and institute. Ethical approval for the study was obtained from Research ethics committee of University of Health Sciences (UHS/t.DPT/337). Therapy was given for 20 minutes one session to each related spastic CP child for 5 days per week for 4 weeks. The data was entered and analyzed by using IBM SPSS 20. Qualitative variables age, weight, gender and height were expressed in frequency and percentages. To check the normality of data, Shapiro - wilk test was applied, and all data was found normal because p-value was greater than 0.05 for all variables. As the data found was parametric with a homogenous impression, paired sample t test was used to compare mean score at pre-post levels for Ashworth Scale and Range of Motion at Knee and Ankle joints.

**Results:**

In our study, table 1 shows out of 68 CP children, 50 (73.5%) of participants were male and 18 (26.5%) were females, with highest frequency 10-12 years of age group was 46 (67.6%) while the

most common cause of cerebral palsy was birth asphyxia as 47 (69.1%) were pre-mature delivery the rest of above mentioned variable's detail is given table No.1

Table 2 shows Ashworth scale score for calf and hamstring muscles before and after cycling with mean and standard deviation values 1.85 ± 0.75 , 0.82 ± 0.38 and 1.95 ± 0.81 , 0.82 ± 0.38. The same table also shows range of motion values (Goniometer) of mean and standard deviation for knee terminal extension and ankle dorsiflexion before and after cycling as 21.2±3.13, 11.5±60 and 2.9±1.81, 6.7±2.15 respectively.

**Table no. 1 shows the frequency and percentages of age group of children and birth asphyxia.**

| Variables | Attributes | Percentage (Freq) |
|---|---|---|
| **Age Group of Children** | 7-9 years | 23.51% (n=16) |
| | 10-12 years | 67.60% (n=46) |
| | 13-15 years | 8.82 (n=06) |
| **Birth Asphyxia** | Premature | 69.12% (n=47) |
| | Term | 26.50% (n=18) |
| | Post Mature | 4.43% (n=03) |

**Table no. 2 Change in Ashworth scale calf and Hamstring muscles, and Range of Motion values for knee terminal extension and ankle dorsiflexion, before and after cycling**

| Variables | Assessment | Mean± SD | p-value |
|---|---|---|---|
| **Ashworth Scale For Calf Muscles** | Before Cycling | 1.85 ± 0.75 | <0.01 |
| | After Cycling | 0.82 ± 0.38 | |
| **Ashworth Scale For Hemistrings Muscles** | Before Cycling | 1.95 ± 0.81 | <0.01 |
| | After Cycling | 0.82 ± 0.38 | |
| **Range of Motion of Knee Extension - Terminal** | Before Cycling | 21.25±3.13 | <0.01 |
| | After Cycling | 11.54±2.60 | |
| **Range of Motion of Ankle Dorsiflexion** | Before Cycling | 2.94±1.81 | <0.01 |
| | After Cycling | 6.76±2.15 | |

## Discussion:

It was evaluated the effect of static cycling intervention after conventional physical therapy on 16 spastic diplegic cerebral palsy children in 2017 by conducting RCT. Results proves that static bicycle is a safe and effective means of strengthening exercise for cerebral palsy children, it improves strength of anti-gravity muscles and increase cardiovascular endurance without increasing the muscle tone in these children. This study supports our recent study as our study shows that improvement in range of motion. Lower limb muscles especially calf and hamstring muscles further more level of spasticity was decreased in all lower limb joints and range of motion significantly improved as the results shows that p value was <0.01.(12)

Primary outcome was short term and secondary outcome was long term improvement data was analyzed after three months and was based on the ability of participating in physical activity of daily living, bicycling or involvement in recreational activities or compliance with treatment measured by attendance.(13) A study was done by Toovey R, Spittle AJ, et al in 2019 and they concluded that Current two wheel bicycle abilities preparing for kids with CP in Australia shows highly variable. Development and testing of bicycle abilities specific result measures and interventions and guidance for therapists on thought of environmental and individual variables are justified results are somehow supported to current study as bicycle improve range of motion in spastic CP child however we did not included environmental variables in recent study.(14)

A study was conducted by Toovey R, Reid SM et al on ability of independently ambulant children with cerebral palsy to ride a two-wheel bicycle in which they concluded that an extent of freely ambulant youngsters with CP do gain complex motor skill ability of riding a two-wheel bike, however a significantly little proportion of at any age can ride as compared to their regularly developing peers. In the event that they do figure out how to ride, they do as such at a later age. For further examination into motor-skill learning approaches for ambulant children with CP, while working intimately with families to engage kids and their guardians, and understand their points of view on what impacts figuring out how to ride a bike this study strongly correlate with our study as this study proved child were able to ride a bicycle with minimal limited range of motion and decrease in level of spasticity.(15)

Another study was done in 2019 by Afzal F, Manzoor S et al and they concluded that gross motor function measure, trunk stability, standing time and walking distance have significant effects of activity in combination such as Treadmill, Stationary cycling with modifiable seat and resistance, strengthening exercises with manual resistance, Functional training, quadriceps build up training, standing activity and walking training on children with athetoid cerebral palsy results strongly correlate with the recent study but the

techniques were different as well as population is different. This reference study included athetoid CP child while we included only diplegic CP child. (16)

Literature shows that a study was conducted in 2017 by Pritchard-Wiart L with the Current rehabilitation practices for title of "children with cerebral palsy focus and gaps" Published in Physical & occupational therapy in pediatrics and they concluded that Cycling has been accounted for to be a famous action among youngsters with and without handicaps. A noticeable element of the writing about figuring out how to ride a bicycle was numerous youngsters with inabilities had picked riding a bicycle as an objective of treatment. The way that every one of the kids had picked the objective themselves was thought to assume a significant job in the accomplishment of the gathering. This study correlate with the recent study however with little conflict our study support spastic and range of motion on a single child while previous study proved social, functional and recreational activities between the groups of children.(17) Future studies should focus on evaluate long term effects of these techniques. Additionally, there is need to replace or at least add recreational and sports related activities in order to achieve results in cerebral palsy children. This can increase compliance of children with treatment plan and can be reason of overall mental and psychosocial support in cerebral children. Furthermore, Promotional seminars should be conducted by targeting audience such as parents having cerebral paralyses children so that they themselves can support and encourage their children to take part in useful recreational activities.

**Conclusion:**

It is concluded that the static cycling has significantly role in decreasing spasticity and increasing range of motion in diplegic spastic cerebral palsy children.

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**Conflict of Interest:** None

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**Author Contribution:**

**Ghani HM:** Conception or design of the work.
**Razzaq M:** Critical revision of the article for important Intellectual.
**Safdar N:** Statistical expertise
**Umer Bilal:** Statistical expertise
**Tariq F:** Data collection.