

An Updated Review On Stationary Cycle Effects In Children With Cerebral Palsy

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DOI: 10.47750/pnr.2022.13.S08.460

Abstract

The spastic muscle in children with CP usually consumes more energy and oxygen during exercise than the usual muscle. Stationary cycling and its effect on children with cerebral palsy is a novel topic in rehabilitation. The stationary cycle is a promising rehabilitation method to address various issues in children with cerebral palsy. To date, only a few studies have been conducted in this area. This will be the first review of the effects of stationary cycling on children with cerebral palsy. Medical databases were searched for retrieving higher levels of evidence such as RCT, systematic review and clinical trials till 2022 from inception. Only 11 articles could retrieve based on inclusion-exclusion criteria. Most studies showed promising results that cycling training could improve muscle strength and endurance. Improvements in functional activities could not be concluded due to heterogeneity in results in a different study.

Keyword: Cerebral palsy, Stationery cycle, cycle ergometer, lower limb training

INTRODUCTION

Cerebral palsy is a neurodevelopmental disorder. Motor symptoms such as poor muscle power, abnormal tone, agonist-antagonist muscles co contractions and deficient selective voluntary motor control result from injury to the infant/fetal brain.[1,2]

The spastic muscle in children with CP usually consumes more energy and oxygen during exercise than the usual muscle.[3] Due to these neuromusculoskeletal issues standing and walking activities are severely affected. Additionally, sensory deficits, perceptual deficits, and Defective anticipatory postural corrections mechanism resulting from abnormal muscle co-contraction and vestibular deficits will cause Postural instability in CP children. These multiple factors further contribute to abnormal gait.[4,5]. Furthermore, as children with CP reach adolescence, there is a drastic decrease in their independence and a sedentary lifestyle due to the above-mentioned motor disturbance. This will further lead to poor Cardiorespiratory fitness compared to similar age group.[6-7]. According to new data, in a day, at least 60 minutes of physical activity (moderate to vigorous intensity) should be done by children aged 5 to 17 years.[8,9]

literatures reported the stationary cycle as a promising rehabilitation method to address various issues in children with cerebral palsy. [10] Stationary cycling was found to be helping in addressing motor symptoms as well as the cardiorespiratory system. Static cycling is more convenient and easy for physically challenged children with limitations and difficulty performing traditional gym-based programmes.[11] However, we need to find how effective stationary cycling is and can be used as one of the leading rehabilitation strategies for children with cerebral palsy to improve their function. Presently, this review aims to find the effect of stationary cycling in children with cerebral palsy to improve their function and the recent trends in this field.

METHODOLOGY

AIM OF THE STUDY

To find the effect of stationary cycling in children with cerebral palsy to improve their function.

DESIGN: Literature review

SEARCH STRATEGY:

This Literature search is done in PubMed, Scopus, and web of sciences to retrieve articles related to the rehabilitation of cerebral palsy using a stationary cycle. The available article was included from the beginning of time till 2022 march.

INCLUSION CRITERIA

- The study, which includes rehabilitation using a stationary cycle for children with CP

- The articles published till march 2022
- Systemic review, RCT & Clinical trials were added

EXCLUSION CRITERIA:

- Manuscript, Unpublished data, Pilot studies, Case studies. And Review articles

KEYWORDS USED: Cerebral palsy, stationary cycle, balance, cycle ergometer, FES, virtual cycling

RESULT

Based on the search strategies used, 11 articles were selected to find the effect of cycling.

Sl. No	AUTHOR / YEAR/ STUDY TYPE	AIM OF THE STUDY	METHODOLOGY	RESULT
1.	Catelli AM et al.[12] 2019 A systematic review with meta-analysis.	This study aimed to analyse the effects of the cycle ergometer on the gross motor function of children with cerebral palsy by the Gross Motor Function Measure (GMFM-66) scale.	Inclusion criteria -RCT Database searched- article Comparison of bicycle ergometers for children with cerebral Pubmed (Medline), physiotherapy evidence database (pedro), scielo and embase.Outcome - GMFM66	No statistics significant increase in GMFM66 value, unrelated to clinical improvement. Great heterogeneity in studies related to this field and, despite the increase in value in the group that used bicycle ergometers
2	Chen CL et al.[13]2012 RCT	Assess the effects of a novel home-based virtual cycling training (hvct) program for improving muscle strength in children with spastic cerebral palsy (CP).	Inclusion criteria: children who are diagnosed with CP of GMFCS level of 1-2Age 6-12 years. Exclusion criteria: chromosomal abnormalities, progressive neurological disorder or severe concurrent illness or disease not typically associated with CP Outcome: isokinetic dynamometer and the Bruininks-Oseretsky Test of Motor Proficiency (BOTMP) and GMFCS scores. The hvct group performed hvct program for 40 min/day 3 times per week for 12 weeks.	Protocol does not improve gross motor function, it enhances knee muscle strength in children with CP. The protocol obtains larger gains in the knee flexor than in the knee extensor
3.	EL Armstrong et al[14] 2019 A systematic review and meta-analysis:	To determine the effectiveness of cycling in children with cerebral palsy to improve function and activity limitation;	6 databases were searched till February 2019. The articles included were randomized/ quasi randomized controlled trials and pre-post studies were also included in the study. A total of 533 articles were identified and nine studies were conducted using data from 282 participants.	Improved hamstring strength and cardiorespiratory fitness reported . Cycling can improve children's strength, balance and total athletic performance; However, the optimal amount of training has not yet been determined.
4.	EG Fowler et al.[15]2010 Randomized controlled trial.	The purpose of this study was to see how a stationary cycling intervention affected strength of. The muscle, locomotor endurance, walking speed, and gross motor function.	This was a single-blind RCT. This study included 62 children who is ambulating. Age: spastic diplegic CP of age 7 -18 years. GMFCS: I to III. Cycling or control groups were allocated to participants at random. Intervention : 30 sessions for 12 weeks.	Following outcomes were improved significantly from baseline to postintervention in the group who did cycling. 1)peak knee flexor moments at 30 degrees 2)The 600 Yard Walk Run Test 3) peak knee extensor moments at 120 degrees 4) GMFM-66,. Only the control group showed improved peak knee flexor moments at 120 degrees/s For either outcome, no significant differences in change scores were detected between the cycling and control groups.
5.	CL Chen et all.[16] 2013 RCT	RCT- study to learn the effects of a novel hvct program on bone density for children with children with spastic cerebral palsy.	27 ambulatory children with spastic CP Age: 6–12 years, randomised to the hvct (n013) or control groups at random (n014). Before and after the 12-week intervention, outcome measures of motor function (GMFM-66), muscular strength (curl up scores and isokinetic torque of knee extensor and flexor muscles), and lumbar and distal femur bone's areal bone mineral density (abmd) Conducted.	According to the analysis of covariance, hvct group had a larger distal femur areal Bone Mineral Density(abmd) and isokinetic torques at knee extensors and flexors than the control group post treatment. However, there was no difference in the post treatment scores of curl-up, GMFM-66 and also lumbar abmd
6.	H Williams et al.[17]2007	The aim of this study is to regulate whether a muscle strengthening exercise program on static equipment	There were total of 11 cerebral palsy children included in the study, in which 10 were females, 1 male of age ranging from	The outcomes showed a substantial improvement in GMFMS-66.

		like an exercise bike will improve the ability to stand and walk in Young children with non-ambulatory CP	11-15 years. The mean age was 12y 7mo those who were non-ambulant. GMFCS level 4 or 5, with use of static cycle. Among those 3 had dyskinetic quadriplegia, 7 had spastic quadriplegia and one had spastic diplegia. 6 weeks of exercise (3 sessions per week), and a 6-week follow-up period. Outcomes : GMFM-66 and GMFM88.	Cycling ability improved significantly for frequency of pedalling, speed and resistance.
7.	Diane L. Damiano, Christopher J. Stanley, Laurie Ohlrich, and Katharine E. Alter.[18] 2017 RCT	This is a randomized control trial whose objective was to evaluate and compare the effectiveness of a motor-assisted bike and a novel option, an elliptical, in improving inter limb reciprocal coordination through intensive speed-focused leg training in children with cerebral palsy.	There were total of 27 children with bilateral cerebral palsy. The age included here was ranging from 5-17 years, these were randomized into home-based exercise which was for 12 weeks of 20 minutes, 5 days per week. The minimum was 40RPM, where the resistance was added when the target was gained. The main result is the fastest spontaneous cadence of self-selection regarding device and walking speed. Secondary endpoints included knee muscles strength and measurement of selective control and functional mobility.	Cadence increased on trained but not untrained devices, indicating task specialization and greater exercise capacity. Neither the mean gait speed nor the parent-reported functional mobility increased in either group. Both improved their knee extensor strength. In selective control, there was an interaction between group and time, with scores slightly rising for the ellipse and decreasing for the cycle, probably due to tighter limb coupling during cycling.
8.	N Özen et al. [19] 2021. RCT	The goal of this study was to analyse the efficacy of functional electrical stimulation (FES) bicycle therapy on motor function, gait pattern, spasticity, daily living activities, and aerobic capacity in children with cerebral palsy (CP) to sham stimulation and conventional treatment.	The study comprised patients with cerebral palsy who had botulinum toxin type-A injections in their lower limbs and who had GMFCS levels I – III. 25 patients were randomly allocated to one of 3 treatment groups for four weeks: FES-cycling and standard therapy; Sham stimulus FES-cycling and standard treatment; and Standard treatment. OUTCOMES : Modified Ashworth Scale (MAS), Modified Tardieu Scale (MTS), Paediatric Functional Independence Measure (weefim), GMFCS, 6-minute walk test.	The MAS, MTS, weefim, GMFM-88 and 6-minute walk test. Improved significantly in all groups. GMFCS levels did not alter in any of the groups. In terms of any clinical evaluation parameter. There was no significant difference between the groups at the end of the trial.

DISCUSSION

This literature review is conducted to find the effect of the stationary cycle in cerebral palsy and to find the recent advances of the same in Children with CP. There are fewer studies, specially RCT, done in this field. The result from each article we tried to discuss and draw a common final conclusion in this section. Effects of the cycle ergometer on the gross motor function of children with cerebral palsy by the Gross Motor Function Measure (GMFM-66) scale.

Amanda Marques Catelli et al: studies show that the cycle ergometer has no significant impact on the gross motor function when GMFM-66 assesses it. At the same time, it has some effects on muscle strength, increased density of bone minerals and also functional activities such as standing and walking. The cycle ergometer was used in the lower limbs, in repetitive motions, and with the progression of endurance, which improved muscular strength in the lower limbs. Because of the variety of applications for cycle ergometers, the research did not find a substantial improvement in their utilisation (aerobic and resisted exercise).[12] Evidence suggests that aerobics does not enhance features like gait speed, resistance to walking, or aerobic fitness.

In a review of exercise programs conducted by Ryan et al., they discovered that endurance training does not increase any component of activity or engagement in persons with CP; in the short term, it actually improves muscle strength in children, adolescents, and young adults and in medium term children and adolescents. The time period of the cycle ergometer intervention is a crucial factor to consider in this research. For any physical activity, The typical suggestion in children with cerebral palsy is 3 months, which allows them adequate adaption time. The variability of the studies in terms of treatment length might have influenced the outcome of the GMFM meta-analysis.[12,20]

In 2012, Chia-Ling Chen et al. studied home-based virtual cycling training in ambulatory children with cerebral palsy to see the effect on muscle strength. Enhancement of Muscle was observed. The technique is a good and valuable method to increase knee muscle strength by 19–41%, particularly knee flexors. 12-week hVCT programme increased the isokinetic strength of knee muscles compared with the control group. Yet, the two groups had no variation in gross motor function (as assessed by the Bruininks-Oseretsky Test of Motor Proficiency). Along with progressive-resistance training of lower-limb muscles, Cycling allows for extensive and recurrent training. As a result, the hVCT can seize the acquired non-use of the affected limb. These data imply that, compared to regular physical exercise, the hVCT programme improves muscular strength more than motor function. The hVCT increased the muscular strength of the knee flexor in comparison with the knee extensor, particularly at low angular velocities. The explanation might be that hVCT might activate the knee's flexor muscles more than the knee's extensor muscle in children with CP, particularly at low angular velocities.[13]

In 2019, a systematic review was conducted to measure the efficacy of cycling therapy in children with cerebral palsy for improving functional performance. Nine studies were included, which overall contained 282 participants. Different studies utilised various modes of cycling intervention, such as recumbent bikes with lower limb loading functions, dynamic and stationary cycling, virtual reality cycling and cycling with postural support. The intervention programmes were as follows. It ranged from 1 month to 6 weeks. The result suggested that the cycle intervention can improve gross motor function. Muscle strength improvement, as well as cardiorespiratory improvements, were seen, but the evidence is poor. Hamstring strength and balance improvements were noted too.[14]

In the year 2010, Eileen G Fowler et.al directed an RCT. With the aim of finding the effect of stationary cycling on different components such as walking speed, the endurance of locomotion and strength of the muscle. This was a phase one RCT with blinding only a single level. Spastic diplegic CP of ages 7 to 18 were part of the study. The participants were GMFCS level 1 to 3. Significant improvements in locomotor endurance, strength and gross motor function were noted post-intervention.[15]

C.-L. Chen & C.-Y et.al, 2013 conducted an RCT: The hVCT regimen used in this study was demonstrated to be an efficient and effective means of increasing aBMD. Repetitive movement and progressive endurance training using hVCT showcased improved strength in the muscle. Moreover, it is proven in the study that bone density can also be increased with this method. Unfortunately, the effect on motor function improvement didn't improve when measured with GMFM-66.[16]

In Non-ambulant CP children, Heather Williams did an experimental study to identify the static bicycling effect on functional ability. His study result was concluded positive, stating the treatment can improve function in children with CP who are GMFCS level IV and V. increasing performance in Standing and walking in the children who underwent this training was evident and promising. An increase in the pedalling speed exposed that can increase muscle power and endurance.[17]

Diane L. Damiano et.al 2017 has done this RCT, which has stated that children with speed-focused training may be able to activate their muscles on and off more quickly as required to accomplish alternate lower limb exercises. Higher neuronal input from the brain to muscle can be noted during higher resistance. Compared to treadmill walking, cycling puts less compressive force on the joint. In turn, early and severe joint degeneration is reported in CP, which discontinues them from walking. In this contest, cycling is shown as one of the best training strategies that will not worsen joint degeneration.[18]

Natalya Özen et al, conducted a study in 2021 to find how FES cycling affected individuals with spastic diplegic CP who had received Botulinum toxin. In this investigation, FES was used on the quadriceps, hamstrings, tibialis anterior, and gastrocnemius muscles on both sides. No difference was noted in GMFCS levels between groups pre and post-therapy. All the patients in the research were able to walk (assisted or unassisted), and the score was higher when measured with GMFM-88. Bilateral ankle MAS were also improved following the treatment.[19]

The stationary cycle can improve strength, especially the knee flexors, while comparing it to the knee extensors, trunk control, and endurance. The important one is that it enhances the areal bone mineral density (BMD). It is also a timely intervention compared to the treadmill since it has less joint stress. It has little statistical relevance, but from the clinical point of view, the stationary cycle has a much better impact on CP children because once the lower limb muscles are strengthened, there can be a progression for gait training.

CONCLUSION

The stationary cycle can improve children's strength and bone mineral density (BMD). Furthermore, it is a timely intervention and more effective than treadmill training. Joint degeneration was found to be less when treated; thus, it may be considered a long-term rehabilitation strategy in children with CP.

CONFLICT OF INTEREST

Nil

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