High Intensity Interval Training Versus Moderate Intensity Training on Gait and Energy Expenditure in Children with Spastic Cerebral Palsy: A Mini Review

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Abstract

Children with cerebral palsy (CP) have significantly reduced physical fitness, with both aerobic and anaerobic capacities being notably lower than in typically developing (TD) children. They also use more energy when walking and move at slower speeds due to impaired motor control, balance issues, and inefficient gait. Exercise intensity is a key factor in determining energy expenditure and training effectiveness. Both high-intensity interval training (HIT) and moderate-intensity training (MIET) can improve cardiovascular health and aerobic fitness, but their effects on children with CP need further exploration. Children with CP also have unique energy requirements influenced by the severity and type of motor impairment, which affects muscle function and total energy expenditure usually lower than in TD children. Ambulatory children with CP expend more energy while walking and at slower speeds. Due to impaired motor control, they often show poor gait, balance, and a higher fall risk, necessitating intensive therapy. However, traditional static balance tests may not accurately reflect dynamic gait stability. So, this study was conducted to compare between the effect of high intensity interval training and moderate intensity training on gait and energy expenditure in children with spastic cerebral palsy.

Key words: ***High Intensity Interval Training, Moderate Intensity Training, Gait, Energy Expenditure, Spastic Cerebral Palsy.***

Introduction

Cerebral palsy (CP) is a neurodevelopmental condition marked by irregularities in muscle tone, mobility, and motor abilities, resulting from harm to the developing brain. The clinical characteristics of this condition develop progressively, and the exact CP syndrome may only become identifiable at 3–5 years of age, although indicative signs and symptoms may manifest at an earlier age [(1)]. It is a non-progressive disorder arising from neurodevelopmental defects in an immature brain, resulting in motor deficits and balance difficulties that impede children's everyday activities and social interactions [(2)]. It is not a singular illness but a complex clinical condition arising from harm to the developing brain. Despite the condition being non-progressive, its clinical manifestation evolves as the brain develops [(3)].

Numerous children with cerebral palsy have diminished cardiorespiratory endurance, muscular strength, and engagement in regular physical exercise. Decreased cardiorespiratory endurance and muscle weakness significantly increase the chances of adverse health outcomes and premature death from cardiovascular and all causes [(4)].

Management encompasses neurological rehabilitation (tackling muscle tone abnormalities and formulating physical and occupational therapies) as well as the diagnosis and treatment of co-morbidities (such as epilepsy, cognitive impairment, and disturbances in vision, hearing, growth, and gastrointestinal function). Consequently, management is interdisciplinary, with the treating physician collaborating with a team of rehabilitative, orthopaedic, psychological, and social care experts [(1)].

Children with cerebral palsy have less aerobic exercise capacity and a heightened oxygen expenditure for daily activities in comparison to normally developing peers, with oxygen cost escalating alongside the severity of impairment. The repercussions may include weariness and the persistence of a low level of physical activity [(5)]. Additionally, they commonly exhibit compromised motor control, which significantly impacts several facets of gait and balance, including walking speed and reactive balance control. functional stability and postural balance in standing or sitting [(6)].

Moreover, a consequence of motor impairments is heightened energy expenditure during ambulation. In comparison to healthy children, walking energy expenditure encompasses both the energy utilised per unit of time, termed energy consumption (ECS), and the energy expended per unit of distance, known as energy cost (EC), which is determined by dividing ECS by walking speed. The energy cost (EC) of walking is considerably elevated (about 40%) in children with cerebral palsy (CP) compared to normally developing (TD) children, and this increased energetic demand is believed to impact everyday functioning. In addition to heightened energy consumption when walking, research indicates that children with cerebral palsy have inferior fitness levels compared to typically developing youngsters [(7)].

The gait of children with cerebral palsy may be compromised due to abnormal musculoskeletal development caused by a lesion in the developing brain. Neuromuscular deficits such as muscular weakness, compromised motor control, and diminished range of motion (ROM) are frequently addressed by physical therapy. Nonetheless, the absence of continuous advancements in motor function necessitates the creation of new evidence-based training approaches to effectively enhance rehabilitation in cerebral palsy [(8)].

Exercise programs may be particularly efficacious in enhancing aerobic capacity in children with cerebral palsy. High-intensity interval training (HIT) has consistently demonstrated enhancements in function and elicited superior physiological and health-related improvements in both healthy individuals and those with varied medical conditions [(9)].

DISCUSSION:

The findings stated that both high intensity interval training and moderate intensity training have a positive impact on gait parameters and energy expenditure in children with spastic cerebral palsy, While each approach led to improvements in specific phases of the gait cycle.

Children in the HIT group exhibited significant improvements in initial swing and mid stance, which are key phases for limb advancement and weight transfer. These outcomes may be attributed to the greater neuromuscular and metabolic demands of HIT, which has been shown to improve both aerobic and anaerobic capacity in youth with motor impairments [(10)]. The burst-rest nature of HIT stimulates fast-twitch muscle recruitment and enhances motor control through repetitive high-demand effort, which can be particularly beneficial in children with cerebral palsy [(11)].

In contrast, those who underwent MIET showed greater improvement in terminal stance, a phase responsible for forward propulsion. This suggests that consistent, moderate-intensity exercise may help optimize muscle coordination and endurance, supporting more efficient push-off mechanics [(12)]. MIET has long been associated with improvements in cardiovascular function and overall mobility in children with spastic CP, especially when delivered over sustained periods [(13)].

Interestingly, there were no significant changes in knee joint kinematics between the groups during stance or swing phases. This aligns with previous studies indicating that gait kinematics may be more resistant to change over short training durations or may require complementary interventions such as strength training, flexibility training or orthotic management [(14)]. While gross motor performance may improve, more subtle joint-level adaptations often demand longer-term strategies.

These results emphasize the importance of individualized rehabilitation plans. While HIT may be more effective for enhancing dynamic phases of gait and improving cardiovascular fitness, MIET may benefit those requiring gradual adaptations and improved postural control. Given the safety and feasibility of both interventions, physical therapists can consider combining or alternating these modalities based on the child's functional goals, tolerance, and motor abilities [(15)].

CONCLUSION:

On the basis of this study, it could be concluded that both high intensity interval training and moderate intensity training have a positive impact on gait parameters and energy expenditure in children with spastic cerebral palsy, While each approach led to improvements in specific phases of the gait cycle such as initial swing and mid stance in the high intensity interval training group, terminal stance in the moderate intensity training group, and no significant differences were observed in knee angles during the stance and swing phases. These findings suggest that both training modalities are beneficial, with distinct effects that may guide individualized rehabilitation planning.

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