6th International Conference on Research in EDUCATION, TEACHING and LEARNING
17-19 February 2023 Barcelona, Spain

# Physical Activity Effects on Gait in children and adolescents. A Review

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## Abstract

This review's primary objective was to locate research that examined how physical exercise affects children's and teenagers' gaits. The PubMed database was used for the search. Only 4 studies out of 95 met the inclusion criteria. Filters applied: Free full text, Clinical Trial, Meta-Analysis, Randomized Controlled Trial. Selection criteria; studies including an exercise intervention program for gait improvement. A total of 149 participants were enrolled in various exercise intervention programs with a gait improvement focus, ranged in age from 9 to 18 years old. The length of the exercise intervention programs ranged from 12 weeks to 6 months. In general, there aren't many studies focusing on how physical activity affects children's and adolescents' gait, and they all only have a small subject enrollment. This makes it necessary to conduct additional research using larger subject populations and various physical activity intervention programs in order to determine which is the most successful.

**Keywords:** adolescents**;** effects; children; physical activity; gait.

## 1. Introduction

The combined function of the neurological, musculoskeletal, circulatory, and respiratory systems is required for walking, making it a tremendously difficult undertaking. Numerous authors have studied the fact that how healthy children's lower limb motions alter with age. Results from studies on space and time parameters (Hillman, Stansfield, Richardson, and Robb, 2009), articulation cinematics (Cığalı, Uluçam, & Bozer, 2011; Smith, Loue, & Brink, 2016; Sutherland, Olshen, Cooper, & Woo, 1980), muscle activity (Agostini et al., 2010), and articulation dynamics (Chester, Tingley, & Biden, 2006; Chester - Wrigley, 2008; Cupp, Oeffinger, Tylkoeski, - Gage, 1999; Ganley & Powers 2005), it is advised that children from

the ages of 4 to 13, eventually develop movement patterns that are nearly identical to those of the mature in adults. The individual's ability to walk shows their health state and is one of the most important factors in determining and increasing their quality of life (Deconinck et al., 2006; Thomann & Dul, 1996). Physical examination includes evaluating the gait, which can aid in examining a variety of abnormalities and physical issues (Andriacchi & Alexander, 2000). Also gait evaluation is a crucial clinical component and tool for evaluating healthy or unhealthy gait patterns. It may be used to facilitate treatment-related decision-making and evaluate the potential outcomes of therapies that apply to enhancing these characteristics (Phinyomark et al., 2016; (Naili et al., 2017).

When people walk improperly as a result of a condition or impairment, gait analysis is crucial, and the appropriate mode of locomotion should always serve as the baseline for comparison. Young people who are still developing typically have issues with their gait. (Smith et al., 2016; Agostini et al., 2015; Van Hamme et al., 2015). However, even extremely preterm children who are usually growing and enrolled in primary school are more likely to have a range of long-term effects, including changes in cognitive processes including executive and attentional functioning and motor development. (Aarnoudse-Moens et al., 2009; Mulder et al., 2009; Lemola, 2015; Goyen & Lui, 2008; de Kieviet et al., 2009). One difficulty in understanding the development of walking is the lack of a reference database for kids that should be pertinent and age-appropriate, as demonstrated by Chester et al. (Chester et al., 2007).

## 2. Objectives

Primary objective of this paper was to find studies that examined how physical exercise affects children's and teenagers' gaits.

## 3. Methods

The PubMed database was used for the search. Keywords used were: adolescents; effects; children; physical activity; gait. Filters applied: Free full text, Clinical Trial, Meta-Analysis, Randomized Controlled Trial. Selection criteria; Studies including an exercise intervention program for gait improvement in children; Studies in the 10 recent years.

## 4. Results

Only 5 studies out of 95 met the inclusion criteria.

1. Steinberg N et al., 2017 (Research Report)
2. Jafarnezhadgero et al., 2018 (Randomized controlled trial)
3. Horsak B et al., 2019 (Single blinded, randomized controlled trial

4. Molina-Garcia et al., 2022. (A non-randomized controlled trial)

*Table 1: Selected studies according to publication year showing research type, number of subjects enrolled, subjects age, duration time of the intervention and type of intervention*

| ID and research type | Subject number | Subjects age | Intervention duration | Type of intervention and methodology used |
|---|---|---|---|---|
| **1. Steinberg N et al., 2017** Research Report | 20 Children | Mean age 10.7 ± 1.7 | **6-months** | A twice-weekly training session was attended by the participants (1 hour each). The intervention was created to be similar with the exercise elementary and high school program. Each session began with a 10-minute warm-up (which may have included three sets of 15 skip rope repeats and three sets of 10 jumps onto a Swedish ladder and back to the floor), followed by stretches and flexibility drills. Distance running (for at least 5 to 10 minutes) was performed after strengthening activities for various muscle groups (such as the stomach, shoulder girdle, and lower extremity muscles), balance exercises, agility exercises, and coordination exercises to increase the kids' aerobic endurance. to inspire participants to take responsibility for their own actions. They were told to add an additional 30 to 45 minutes of weight-bearing exercise outside of the program, preferably once a week. |
| **2. Jafarnezhadgero et al., 2018** Randomized controlled trial | 28 males | 9–14 years old children with genu varus | 16 weeks. | There were four main phases in the corrective exercise continuum (CEC) that was employed. SMR methods were applied to the gluteus medius, medial hamstring, and vastus medialis muscles in both limbs to complete the first phase. With the use of static and dynamic stretching methods, phase two involved lengthening. Isolated strengthening exercises and positional isometric methods were used throughout the third period. The integration phase was in phase four. (the last 2 weeks, 3 sessions per week). A two-legged exercise with little stability challenge might serve as an illustration of an integrated dynamic movement. (such as two-legged wall squat). An experienced physiotherapist who followed a specified procedure instructed the experimental group in Self-myofascial |

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| | | | | release (SMR) methods. |
| **3. Horsak B et al., 2019** Single blinded, randomized controlled trial | 51 participants | 10-18 years old subjects were randomized to EP group (n=26) & control group (n=25). | 20 months September 2015 to May 2017 | A 12-week term, twice weekly, 60-minute sessions of a progressive group exercise program. Under the guidance of a physical therapist, the exercise program comprised a warm-up, strength exercises for the knee and hip muscles, and neuromuscular activities for the lower extremities and core muscles. |
| **4. Molina-Garcia** et al., 2022. A non-randomized controlled trial | 50 children | 10.77 ± 1.24 years, 31 girls) with overweight/ obesity was allocated to an exercise group (EG) (*n* = 25). Control group (CG) (*n* = 25) | 13-week exercise program | The exercise regimen was built around basic movement techniques, strength training, and aerobic activity. The parameters were evaluated through a 3D analysis, spatial-temporal (such as cadence, stance and support times, step length, and stride breadth) and kinematic (such as hip, pelvic, knee, and ankle angles) characteristics were assessed in a lab setting. The control group maintained their regular lifestyle routine. |

## 5. Discussion

A total of 149 participants were enrolled. Subjects age ranged from 9 to 18 years old. Various exercise intervention programs were used with a gait improvement focus. The length of the exercise intervention programs ranged from 12 weeks to 6 months. Regarding the studies part of this review, we summarized the main issues as follow:

The goal of the Steinberg N et al., 2017 publication was to investigate the impact of an intervention program for weight control that emphasizes locomotion on the biomechanical traits of overweight children. The findings of this study revealed that, in comparison to children who were overweight and had participated in a regular weight-management intervention program, the group of overweight children who had received specific gait movement exercises had improved their foot pressure (at the heel, medial midfoot, lateral midfoot, and lateral forefoot), as well as their temporal parameters (cycle length, stance phase time, relative stance phase, and swing phase time). Given that there was no change in BMI between the pre- and postintervention periods in the children who were overweight and received the locomotion-emphasis exercises (GRP2), it is assumed that the improved gait pattern resulted from improved proprioception, postural balance ability, and ankle-foot muscle strength. These children were then able to run and walk more effectively while exerting less weight on their feet. The second study (Jafarnezhadgero et al., 2018, study), was a paper investigating of the effects of a 16-week corrective exercise continuum (CEC) program on the 3-D joint angles of the dominant and non-dominant lower limbs while

walking in children with genu varus. According to the experimental group's findings, CEC reduced the peak ankle dorsiflexion angle, peak foot internal rotation angle, peak knee internal rotation angle, peak hip abduction angle, and peak hip external rotation angle in the dominant lower limb. In contrast, following the training regimen, the dominant limb's peak knee external rotation angle increased. Peak ankle inversion, eversion, foot internal rotation, knee internal rotation, peak hip abduction angle, and peak hip external rotation angle were all reduced for the non-dominant lower limb by CEC. The third paper the Horsak B et al., 2019 study, on the other hand, was a single-blinded, randomized controlled trial study that examined the effects of a lower extremity exercise program on gait biomechanics and clinical outcomes in children and adolescents with obesity. It sought to determine whether a 12-week exercise program that promotes dynamic knee alignment and includes hip abductor and knee extensor strength exercises will positively affect changing gait biomechanics in children and adolescents. The exercise program was able to boost muscle strength, particularly in the hip abductors, according to the results. Children in the exercise program group also walked less quickly and with less pelvic dip while accepting their weight during the follow-up. Self-reported changes in knee function, pain, or discomfort were not seen. The last review research, Molina-Garcia et al., 2022, was a non-randomized controlled experiment designed to examine whether 13 weeks of integrative neuromuscular training may enhance the spatiotemporal and kinematic aspects of gait in children with overweight/obesity. Strength training, cardiovascular exercise, and simple movement patterns were the foundation of the workout program. In a lab context, the kinematic (hip, pelvic, knee, and ankle angles) and spatial-temporal (cadence, stance and support times, step length, and stride width) aspects of the parameters were investigated. The control group carried on with their usual way of living. Results from the exercise intervention demonstrated that, in contrast to the control group, which increased these metrics substantially during walking, the training group maintained their baseline posture and single-limb support periods. Additionally, compared to the control group, which exhibited an increase, the exercise group was able to maintain the maximal foot abduction angle at a baseline level during the stance phase. All the other spatiotemporal and kinematic characteristics showed no further unusual changes.

## 6. Conclusions

Studies on the effects of physical exercise on children's and teenagers' gait were generally few. There is evidence to support the good effects of combined dietary and exercise/exercises stressing locomotion on the movement characteristics of children who are overweight, according to Steinberg N et al., 2017. Also in Jafarnezhadgero et al., 2018 the exercise intervention program (CEC therapy) reduced excessive foot, knee, and hip external rotations during walking in children with genu varus, demonstrating the importance of this program in the improvement of walking kinematics in kids with a knee varus. On the other hand, Horsak B et al., 2019 study findings revealed that, despite the modest impacts of an exercise regimen, the exercises can be a useful short-term option to halt the development of lower extremity

biomechanical malalignments. Additionally, the results demonstrated that the exercise program did not result in any additional clinical complaints or worsen knee health outcomes. Furthermore Molina-Garcia et al., 2022 research, used a 13-week integrative neuromuscular training program for children who are overweight or obese prevented the evolution of several biomechanical abnormalities that occur when they walk. The results of this study point out the beneficial effects of exercise on the gait biomechanics of children and adolescents with overweight and obesity, which may ultimately help this population prevent musculoskeletal disorders and maintain a high level of mechanical efficiency while walking. All the reviewed studies supports the idea that physical exercise improves children's and teenagers' gait, and have leading to greater coordination, balance, and overall movement quality. Running, leaping, and participating in sports are additional activities that can assist kids and teenagers in developing the motor skills required for efficient and effective gait patterns. It is significant to remember that the effects of exercise on gait might differ based on a person's age, degree of fitness, and mobility issues. Overall, nevertheless, the research points to the fact that getting kids and teenagers to exercise regularly can have a positive impact on their gait patterns and general movement health. To conclude the selected studies had small participations subject number which makes it necessary to conduct additional research using larger subject populations and various physical activity intervention programs in order to determine which is the most useful intervention program.

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