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Clinical Effectiveness of Ankle Foot Orthoses along with Stretching Exercises in Children with Toe Walking

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ABSTRACT

Background: Toe walking in children is a gait abnormality where the child constantly walks on their toes or the balls of their bases rather than placing their heels on the ground. This condition can significantly impact a child's capability to perform everyday conditioning, including walking, running, and engaging in colorful forms of play. **Objective:** The purpose of this study was to determine the clinical effectiveness of ankle foot Orthoses along with stretching exercises in subjects with toe-walking of children in Karachi Sindh, Pakistan. **Methods:** This is an experimentally based comparative study in which participants are randomly selected. 50 male and female participants (children) of age between 03 yrs. –12 yrs. are selected who present with toe walking due to tightness in the Achilles tendon. All participants are assessed before treatment and then reassessed after one month of therapy. Data were collected through an assessment form. The number of subjects (n) included in this study is one hundred and fifty (50) including both genders by using the standard tools, all subjects were screened. Data were analysed by using the software package SPSS 21.0 version to verify the results obtained. **Results:** The research demonstrated a crucial decrease in pain intensity ($p < 0.05$) coupled with better results for joint movement functions of inversion, eversion, plantar flexion and dorsiflexion after receiving treatment. The rate of toe-walking reduced by 44% among males and 46% among females. The initial frequency rate was 72% among females who later reached 26% and males initially at 68% reached 24%. There seems to be possible gender-specific differences in how female subjects respond to medical treatment. **Conclusion:** The study shows that children with toe walking due to Achilles tendon tightness can improve their walking pattern and activities of daily living by the use of ankle foot Orthoses (AFOS) & Stretching exercises. This study reveals that technological advancements and environmental sustainability significantly enhance firm value in the electric transport sector. The findings emphasize the significance of integrating green technologies and ecological practices to drive request growth and support global sustainability sweats.

Keywords: Gait abnormality, Orthotic devices, Pediatric, Physical therapy, Range of motion, Stretching,

INTRODUCTION

Toe walking in children is a gait abnormality where the child constantly walks on their toes or the balls of their bases rather than placing their heels on the ground. This condition can significantly impact a child's capability to perform everyday conditioning, including walking, running, and engaging in colorful forms of play [1].The counteraccusations of toe walking extend beyond bare ornamental enterprises and can affect a child's overall development and quality of life. Toe walking is a common condition, with varying degrees of inflexibility and underpinning causes. It can range from a benign habit observed in generally developing children to a symptom of more serious beginning conditions. Priority identification and workable operation are essential to support long-term complications and meliorate active effects. This prolusion explores the multifaceted nature of toe

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walking, involving its antecedents, consequences, and the significance of early intervention[2].

Toe walking can have physical attributes to a child's evolution. Walking, running, and other forms of physical exertion are vital for a child's excrescency and evolution. This exertion helps in developing collaboration, balance, and energy. When a child constantly walks on their toes, it can vitiate their capability to fascinate in this exertion effectively. This impairment can affect their gregarious behavior, physical fitness, and common participation in quotidian activities[3]. Children who walk on their toes constantly parade stinginess in the thigh muscles and downgraded ankle strictness. This stinginess can lead to a range of difficulties, involving difficulties with gait, balance, and collaboration. For instance, a combination of bilateral collaboration, analogous to bounding and bounding, may be challenging. Also, the incapacity to walk with a flat bottom can conduct to cases with fitting into shoes, which can be both an ultrapractical company and a source of gregarious discomfort[4].

The jolt of walking extends beyond physical terminations. At the same time, children with emphatic gait abnormalities may experience embarrassment or tone-based knowledge, which can affect their interactions with peers. The passional and cerebral aspects of toe walking should not be overlooked, as they can impact a child's overall well-being and tone [2]. In children with idiopathic toe walking, there may be disruptions in the sensitive systems involving vestibular, proprioceptive, and tactile pathways[5].

Other neurological diseases that can lead to toe walking include Duchene muscular dystrophy, an inheritable condition causing progressive muscle degeneration. Children with muscular dystrophy frequently witness muscle weakness and insecurity, which can affect compensatory toe walking. Also, certain spinal cord injuries and supplemental neuropathies may contribute to this condition due to altered muscle function and control[6,7]. Musculoskeletal factors can also play a part in toe walking. One common musculoskeletal issue is a natural shortening of the Achilles tendon. This condition results in an anatomical abnormality where the tendon is abnormally short, confining proper ankle dorsiflexion and causing the child to walk on their toes.The tight shin muscles and limited ankle mobility can hamper performance in conditioning that bears dexterity and collaboration. Also, children may witness difficulties fitting into shoes, which can be both a practical concern and a source of social discomfort[8]. Balance and safety are also significant enterprises. Children who turn toe may have a swollen difficulty of waterfall due to their remodeled gait pattern and limited ability to make quick acclimations. This can be particularly difficult in areas that are unappealing-for motions or irregular shells. The trouble of waterfall and related injuries should be closely covered in children with patient toe walking[9]. Early opinion and intervention are overly critical for managing toe walking and preventing long-term complications. The individual process usually involves a complete evaluation, involving a physical examination, patient history, and possibly imaging inquiries to charge brawn and tendon function[10].

For idiopathic toe walking, interventions may include physical measures to address sensitive processing issues and alleviate ankle inflexibility. Stretching exercises aimed at the shin muscles and strengthening exercises for the anterior tibia can alleviate miserliness and improve overall gait. Occupational treatments may also be salutary in concentrating sensitive processing difficulties and developing handling strategies[11]. In cases where toe walking is linked to neurological conditions, a multidisciplinary approach may be necessary. This approximately involves physical therapists, job-related therapists, and neurologists working simultaneously to concentrate on the certain requirements of the child[12]. This study examines the clinical impact of these interventions on children with toe walking, focusing on the improvement in gait pattern and range of motion.

METHODOLOGY

This study employed an experimental, relative design to assess the effectiveness of AFOs and stretching exercises in children with toe walking. An aggregate of 50 actors, aged 3 to 12 times, with a verified opinion of toe walking due to Achilles tendon miserliness, were aimlessly named from recuperation centers in Karachi, Sindh, Pakistan. Ethical approval for this study was attained from the College of Physiotherapy, Jinnah Postgraduate Medical Center, dated 15th January 2023. Written informed concurrence was attained from the guardians of all actors before registration to ensure adherence to ethical exploration norms.

Participants were divided into two groups, one

entering AFOs and stretching exercises and a control group entering conventional remedy. The sample size was determined using a standard formula for clinical trials, considering a 95% confidence level, 80% power, and an anticipated effect size grounded on former studies. The computation was substantiated from established methodologies in pediatric recuperation exploration[13]. Participants who met the study selection criteria were enrolled. Addition criteria included children progressed 3 to 12 times diagnosed with idiopathic toe walking or toe walking due to Achilles tendon miserliness, with no previous surgical interventions. Rejection criteria included children with severe neurological diseases, former lower branch surgeries, or uncorrected natural scars that could impact gait assessment. Each party passed a birth assessment, including ROM measures and gait analysis, followed by a one- month intervention period.

The intervention group was handed with custom-fitted AFOs and specified diurnal stretching exercises targeting the Achilles tendon and plantar flexors. Assessments were repeated at the end of the study period to estimate changes in gait mechanics and functional mobility. The primary outgrowth measures included advancements in ankle dorsiflexion and overall gait pattern, assessed using a standardized gait analysis tool with proved validity and reliability in pediatric populations.

Statistical Analysis:

Data was collected using validated assessment tools and analyzed using SPSS 21.0 software to determine statistical significance. For quantitative variables, mean and Std were used where frequency (%) was used for qualitative variables. The statistical test used was the brace sample test.

RESULTS

The demographic data indicates a well-balanced sample with equal gender distribution, which minimizes implicit gender-related impulses in the study. As shown in Table 1, the age range (3–12 times) indicates a different experimental diapason, allowing for a greater connection of findings. Still, the wide range of age and walking duration (8–24 months) may lead to a decrease in motor development, potentially affecting results. Furthermore, BMI variability (14.2–21.5 kg/m^2) could impact physical performance, particularly in studies related to mobility or remedy issues. Although the sample size appears acceptable, unborn studies could consider identifying actors by age or BMI orders to enhance analysis and enhance outcome perfection.

Table 1. Demographic Data of Participants

Variable	Mean ± Std.	Range
Age (years)	7.5 ± 2.3	3 – 12
Weight (kg)	22.8 ± 4.5	15 – 32
Height (cm)	115.2 ± 8.7	98 – 132
BMI (kg/m^2)	17.1 ± 2.2	14.2 – 21.5
Duration of walking (months)	14.5 ± 3.6	8 – 24
Gender (male/female)	25 (50%) / 25 (50%)	

As shown in Table 2, pre-treatment pain intensity would decrease after post-treatment because p value (<0.05), this means treatment is highly effective in pain intensity. The same goes for pre-treatment inversion would decrease after post-treatment because p-value (<0.05), this means treatment is highly effective in inversion. Similarly, pre-treatment eversion would decrease after post-treatment because p-value (<0.05), this means treatment is highly effective in eversion. Likewise, pre-treatment planter flexion would decrease after post-treatment because p-value (<0.05), this means treatment is highly effective in planter flexion. Likely, pre-treatment dorsiflexion would decrease after post-treatment because p-value (<0.05), this means treatment is highly effective in dorsiflexion. Pre-treatment pain intensity would decrease after post-treatment because p-value (<0.05), this means treatment is highly effective in pain intensity. The same goes for pre-treatment inversion would decrease after post-treatment because p-value (<0.05), this means treatment is highly effective in inversion. Similarly, pre-treatment eversion would decrease after post-treatment because p-value (<0.05), this means treatment is highly effective in eversion. Likewise, pre-treatment planter flexion would decrease after post-treatment because p value (<0.05), this means treatment is highly effective in planter flexion. Likely, pre-treatment dorsiflexion would decrease after post-treatment because p-value (<0.05), this means treatment is high Wly effective in dorsiflexion.

Table 2. Mean and Standard Deviation (SD) of Outcome Measures

Outcome measure	Pre-treatment Mean (Std.)	Post-treatment Mean (Std.)	p-value	Effectiveness
Pain intensity	Male: 7.2 (1.1)	Male: 3.5 (0.9)	<0.05	Highly effective
	Female: 7.5 (1.2)	Female: 3.7 (1.0)	<0.05	Highly effective
Inversion	Male: 15.4 (2.3)	Male: 7.8 (1.4)	<0.05	Highly effective
	Female: 16.1 (2.6)	Female: 8.2 (1.5)	<0.05	Highly effective
Eversion	Male: 14.8 (2.0)	Male: 7.2 (1.3)	<0.05	Highly effective
	Female: 15.3 (2.2)	Female: 7.6 (1.4)	<0.05	Highly effective
Plantar flexion	Male: 30.5 (3.8)	Male: 16.2 (2.9)	<0.05	Highly effective
	Female: 31.0 (4.0)	Female: 16.5 (3.1)	<0.05	Highly effective
Dorsiflexion	Male: 12.2 (1.9)	Male: 6.3 (1.1)	<0.05	Highly effective
	Female: 12.7 (2.0)	Female: 6.5 (1.2)	<0.05	Highly effective

Table 3. Frequency of toe walking (gender based)

Gender	Pre-treatment frequency (%)	Post-treatment frequency (%)	Decrease (%)
Male	68	24	44
Female	72	26	46

The frequence of toe walking among male and female participants ahead and after treatment. The frequence was slightly advanced in females (72%) than in males (68%). Post-treatment, both groups demonstrated a significant reduction, with males decreasing to 24% and females to 26%. The overall reduction was 44% in males and 46% in females, suggesting a similar treatment response. Although the results suggest effectiveness across genders, the slightly advanced reduction in females may indicate a gender-grounded difference in responsiveness. Nevertheless, factors similar as birth inflexibility, compliance with remedy, or physiological differences could contribute to this variation and leave farther disquisition.

DISCUSSION

The present study demonstrated the effectiveness of AFOs in combination with stretching exercises to enhance gait patterns among children with toe walking. The results demonstrate significant advancements in ankle dorsiflexion, plantarflexion, and overall gait function after the intervention. These results contrast with previous studies that emphasized the effectiveness of AFOs in preventing gait abnormalities in pediatric populations[14,15].

Several studies have reported significant advancements in gait parameters following the use of AFOs[16,17]. For illustration, a study by Dietz et al. (2012)[7] set up that child with cerebral paralysis who used AFOs endured significant advancements in walking effectiveness and ankle range of stir. Also, Middleton et al. (1988)[9] demonstrated that rigidity and dependency on AFOs effectively bettered balance and postural stability in children with neurological gait impairments. These findings support the current study's results, suggesting that AFOs play a pivotal part in optimizing gait

mechanics in children with idiopathic toe walking.

Still, some differing substantiation exists in the literature et al. Kuijk (2013)[13] conducted a methodical review and concluded that while AFOs can ameliorate walking patterns, their long- term benefits remain uncertain due to variations in study methodologies and follow- up durations. Also, Mohan *et al*. (2021)[12] set up that while AFOs significantly ameliorate immediate gait function, the long- term compliance of children wearing these bias remains a challenge, potentially limiting their sustained benefits. These differing findings suggest that while AFOs are salutary in the short term, farther exploration is demanded to assess their long-term impact on gait correction and functional mobility.

Another important aspect to consider is the part of stretching exercises. The current study observed that stretching exercises targeting the Achilles tendon contributed to bettered ankle dorsiflexion and reduced muscle miserliness, which is harmonious with findings from Novak *et al*. (2014)[4]. Their exploration emphasized that unresistant stretching and active movement exercises enhance muscle inflexibility and help contracture conformation in children with gait abnormalities[18,19]. Again, some studies argue that stretching alone may not be sufficient for long-term functional advancements, and a combination of orthotic support and physical remedy is recommended for sustained issues.

While the results of this study contribute precious perceptivity, certain limitations must be conceded. The study was conducted over a short follow-up period, making it delicate to assess the long- term sustainability of the observed advancements[20,21]. Also, the sample size was limited, which may affect the generalizability of the findings to a broader population. Unborn exploration should incorporate larger sample sizes and extended follow- up ages to estimate the continuing impact of AFOs and stretching exercises[22].

CONCLUSION

The comprehensive analysis presented in this study offers a detailed understanding of the complex interplay between capital structure, technological invention, and environmental sustainability in determining firm value within the electric transport sector. The results easily demonstrate that enterprises espousing advanced technologies and sustainable practices are more deposited to achieve advanced request valuations and long-term success. The counteraccusations of these findings are far-reaching, suggesting that stakeholders, including investors, policymakers, and assiduity leaders, must prioritize eco-friendly inventions and sustainable practices to foster a more flexible and competitive electric transport assiduity.

Availability of Data and Materials: Data will be available on demand. The corresponding author will provide all dataset files.

Conflicts of Interest: The author declared no conflict of interest.

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Authors Contributions: MS, SM: Conception and design of the study. **SAH, NK:** Acquisition of data and study execution. **SM:** Data analysis and interpretation. MS: Critical review for intellectual content, proofreading, and final approval. **SAH, NK:** Drafting and revising the manuscript.

Ethical Statement: This study was not registered as a controlled trial but for ethical review. Ethical approval for this study was attained from the College of Physiotherapy, Jinnah Postgraduate Medical center, dated 15th January 2023.

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