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Comparison of Gait Parameters Between Individuals with Normal Arch and Flat Arch Conditions among Students at SD Negeri Daleman 01, Nguter, Sukoharjo

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Abstract

This study aims to compare gait parameters between the normal arch condition and the flat arch condition in students at SD Negeri Daleman 01, Nguter District, Sukoharjo. A flat foot, which is a common disorder characterized by the loss of arches in the feet, can interfere with walking pattern, cadence, timing, and speed. This study used a comparative approach with a cross-sectional observational analytic research design. The research sample consisted of students aged 7-12 years, with either a normal arch or flat arch condition. Gait parameters were measured using an instrument for assessing gait parameters. Data analysis involved tests for normality and hypothesis testing using the Mann-Whitney test. The results of the study showed a significant difference (p-value < 0.05) in gait parameters between the normal arch condition and the flat arch condition. Students with a normal arch condition demonstrated better gait parameters compared to those with a flat arch condition. Students with a flat arch condition tended to have shorter step lengths, wider step widths, longer ground contact time, and slower walking speeds compared to students with a normal arch condition. Based on the results of this study, it can be concluded that a flat arch condition potentially affects gait parameters in students at SD Negeri Daleman 01, with a p-value < 0.05. This information can be useful for relevant parties in monitoring and addressing gait parameter issues in students with a flat arch condition.

Keywords: gait parameters, flat arch condition, elementary school students

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Introduction

The background of this issue highlights the importance of foot conditions in children, especially the formation and development of the foot arches. Deficiency or abnormalities in the formation of the foot arches can lead to impairments in activities such as standing, walking, jumping, and running. One common disorder is flatfoot or flat arch.

Flatfoot is a condition where the arch on the sole is flattened, resulting in a visibly flat foot. The causes include congenital factors, weak foot muscles, obesity, and ruptures in the posterior tibial tendon (Munawarah, 2021). Factors that can affect foot arch abnormalities include age, gender, body mass index, and physical activity. There are several types and degrees of flat arch, such as flexible flatfoot and rigid flatfoot. Managing flatfoot may involve the use of orthotic devices, physiotherapy, and other medical interventions.

Sabita (2017) indicated that flatfoot in children aged 7-9 years can have negative effects on motor skills and child development. This can result in decreased balance, increased risk of falls, and decreased walking speed. Therefore, it is important to understand the differences in gait parameters between the normal arch condition and the flat arch condition in children.

A preliminary study conducted at SD Negeri Daleman 01 revealed that several students aged 7-12 had flat arch conditions. Therefore, this research aims to compare gait parameters between the normal arch condition and the flat arch condition in students at SD Negeri Daleman 01, Nguter District, Sukoharjo.

By understanding the differences in gait parameters between these two conditions, this study is expected to provide further insights into the impact of flat arches in children. The results of this research can be useful for the development of intervention programs or appropriate actions in addressing this issue in children with flat arch conditions.

Methods

This study utilized a comparative approach with a cross-sectional analytical observational research design. The study aimed to compare gait parameters between the normal arch and flat arch conditions in students at SD Negeri Daleman 01, Nguter, Sukoharjo. The research sample was selected through purposive sampling, including students aged 7-12 years, both male and female, who had either a normal arch or bilateral flat arch condition.

The instruments used included the Plantar Footprint to measure the condition of the foot arch and gait parameter instruments to measure gait parameters. Data collection involved instructing the subjects to walk, recording videos to calculate cadence, measuring stride length and step length using paper and ink, and measuring walking speed by multiplying stride length by cadence. Data analysis was conducted using normality tests and hypothesis testing using either the Independent Samples T-Test or the Mann-Whitney test, depending on the results of the normality test.

Results

The study was conducted on students of Daleman 01 State Elementary School, Nguter, Sukoharjo, with a total population of 147 students. From this population, a sample of 46 students was taken, consisting of 23 students with normal arches and 23 students with flat arches. A purposive sampling technique was used to select the sample.

In this study, the comparison of gait parameters between the normal arch condition and the flat arch condition in students will be discussed. Data analysis was performed to compare the gait parameters between the normal arch condition and the flat arch condition in students of Daleman 01 State Elementary School, Nguter, Sukoharjo.

Table 1. Average gait parameter

Rank					
	Variable	N	Min	Max	Mean
Cadence	Normal arch	23	65.00	120.00	89.652
	Flat arch	23	55.00	111.00	78.696
	Total	46			
Cycle_Time	Normal arch	23	1.000	1.846	1.369
	Flat arch	23	1.081	2.182	1.566
	Total	46			
Stride_Length	Normal arch	23	.470	.850	.640
	Flat arch	23	.340	.730	.525
	Total	46			
Step_Length	Normal arch	23	.210	.440	.327
	Flat arch	23	.170	.430	.284
	Total	46			
Speed	Normal arch	23	.210	.633	.411
	Flat arch	23	.421	.756	.568
	Total	46			

In table 1, there are differences in mean ranks between the "Flat Arch" and "Normal Arch" conditions for each gait parameter. The mean cadence for the normal arch condition is 89.652 steps/min, while for the flat arch condition, it is 78.696 steps/min, with a difference of 10.957 steps/min. The mean cycle time for the normal arch condition is 1.369, while for the flat arch condition, it is 1.566, with a difference of 0.198. The measurement of stride length has an average of 0.640 meters for the normal arch and 0.525 meters for the flat arch, with a mean difference of 0.114 meters. Stride length is the only parameter not influenced by other parameters. The synchronization of muscle activation and joint range of motion in the lower extremities affects the magnitude of stride length (Cahyaningrum, 2016). Step length has a mean of 0.327 meters for the normal arch and 0.284 meters for the flat arch, with a difference of 0.042. The mean speed for the normal arch is 0.568 m/second and for the flat arch, it is 0.411 m/second, with a mean difference of 0.157. Speed is a parameter that is highly influenced by other parameters such as stride length, cycle time, and cadence (Cahyaningrum, 2016).

The differences in mean ranks indicate significant differences in the average rankings between the "Flat Arch" and "Normal Arch" conditions for each gait parameter. All parameters show significant differences in mean ranks, indicating that there are differences in gait characteristics between the two conditions.

Table 2. Mann Whitney Test

Test Statistics					
	CADENCE	CYCLE_TIME	STRIDE_LENGTH	STEP_LENGTH	SPEED
Mann-Whitney U	151.000	152.000	137.000	172.000	153.000
Wilcoxon W	427.000	428.000	413.000	448.000	429.000
Z	-2.503	-2.482	-2.807	-2.036	-2.452
Asymp. Sig. (2-tailed)	.012	.013	.005	.042	.014

The hypothesis test using the Mann-Whitney test shows that there is a significant difference in gait parameters between the normal arch and flat arch conditions. The p-value < 0.05 indicates significance for all gait parameters (cadence, cycle time, stride length, step length, and speed). This indicates that the gait parameters of students with a normal arch condition are better than those with a flat arch condition.

Therefore, this study found a significant difference in gait parameters between the normal arch and flat arch conditions in students at SD Negeri Daleman 01, Nguter, Sukoharjo.

Discussion

The focus of this study on comparing gait parameters between normal and flat arch conditions in elementary school students reveals noteworthy findings. The observed gait parameters, including cadence, cycle time, stride length, step length, and speed, all exhibited significant differences between the two conditions. Notably, students with flat arches demonstrated distinct gait characteristics, such as shorter step lengths, wider step widths, longer ground contact time, and slower walking speeds compared to their counterparts with normal arches.

An insightful study by Dewi, K. G., et al. (2020), delves into the mechanisms underlying these differences in gait parameters. It highlights that variations in ground reaction forces (GRF) play a pivotal role. Individuals with flat arches often exhibit tendencies toward overpronation, leading to a medial shift in ground reaction forces during the stance phase

of walking. This overpronation, particularly during the push-off phase, results in unstable feet as rigidity is crucial for force transmission. Consequently, the feet struggle to maintain a rigid state while simultaneously adapting to the surface structure, impacting balance, especially during critical phases like heel strike transitioning to foot flat.

Balance emerges as a key factor in daily activities such as walking, standing, and running. While kinesthetic sensation in muscles, tendons, and joints contributes to balance, other factors also play pivotal roles. Decreased balance function can lead to compromised postural control, body alignment, and reflex control, impacting the efficiency of directed movements. Optimal balance enhances overall movement performance in daily life.

The significance of this research extends beyond the mere identification of differences in gait parameters. It underscores the broader implications of flat arch conditions on children's movement patterns and balance. Recognizing the potential consequences of impaired balance, such as decreased postural control and alignment, emphasizes the importance of preventive measures to mitigate the worsening of flat arch conditions and reduce the risk of injuries.

Prosthetics, orthotics, and physiotherapy emerge as crucial elements in addressing flat foot cases. Integrated tools and exercise programs provided by these disciplines are instrumental in improving body balance in such conditions, as highlighted by Antara (2020). This integrated approach underscores the importance of a multidisciplinary strategy to comprehensively address the complex interplay between flat arches, gait parameters, and overall movement patterns in elementary school children.

Conclusion and Recommendation

This study revealed significant gait parameter differences between elementary school students with normal arches and those with flat arches. Gait analysis demonstrated distinct patterns in cadence, cycle time, stride length, step length, and speed, highlighting the tangible impact of flat arches on children's walking. These findings align with previous research linking these differences to variations in ground reaction forces, particularly the tendency toward overpronation in individuals with flat arches.

Given the observed impact on gait parameters and balance in elementary school children, implementing early intervention programs, including exercises and physiotherapy, is crucial for preventing the progression of flat arch conditions and improving overall body balance.

A multidisciplinary approach involving prosthetics, orthotics, and physiotherapy is recommended. Tailored tools and exercise programs addressing specific challenges associated with flat arch conditions can provide comprehensive care for affected children. Raising awareness among parents, teachers, and healthcare professionals about the potential impact on children's gait and balance is essential, promoting early identification and intervention for timely support.

Furthermore, encouraging additional research to explore factors influencing gait and balance in children with flat arch conditions is vital. This could involve examining long-term effects, assessing the efficacy of different intervention strategies, and identifying other potential contributors to gait abnormalities. Engaging with the community, including schools and healthcare providers, to disseminate knowledge about the importance of gait analysis, early detection of flat arch conditions, and the benefits of preventive measures is key. Foster collaboration to implement effective strategies in educational and healthcare settings, ensuring a holistic and well-informed approach to addressing flat arch conditions in children.

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