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The relationship of flat foot with static balance and dynamic balance

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Abstract

Background: The foot is a part of the body that function is to support the body weight and to maintain balance while standing, but the foot also has many problems, one of which is flat foot, a type of flat foot caused by the flattening of the bone's curvature, which is the lack of arches on the soles of the feet. The weakness of the plantaris ligament, posterior and anterior tibial tendons, and intrinsic muscles, which maintain the medial longitudinal arch, are the cause of this foot deformity that can have an impact on health. Flat feet that occur in the community are often ignored and considered to be normal. Poor foot conditions will affect the fulcrum, one of the foot conditions that can affect the fulcrum is flat foot. When a child has the flat foot, the resulting fulcrum is also going to be bad, it will affect the balance.
Purpose: To ascertain how flat foot relates to both static and dynamic balance.
Method: A cross-sectional approach, specifically focusing on observational study. The study took place from June 2024, in MI Muhmmadiyah Gonilan, Surakarta. The independent variable was flat foot the dependent variables is a static balance and dynamic balance. Using purposive sampling and the Slovin formula, 108 participants were selected. Univariate statistical analysis was conducted, bivariate data analysis using Spearman rank test.
Results: The correlation coefficient value of 0.645 falls into the strong relationship category, while the correlation coefficient value of 0.207 is classified as a weak relationship. Additionally, the significance value of <0.05 indicates a statistically significant relationship between flat foot and both static and dynamic balance.
Conclusion: The analysis showed that while there was a correlation between flat feet and both types of balance, the degree of association was different. Flat feet had a very weak relationship with dynamic balance, while its relationship with static balance was stronger and more significant. Thus, it can be said that flat feet have more influence on static balance than dynamic balance.

Keywords: Balance; Dynamic; Flat Foot; Static.

INTRODUCTION

The foot is a terminal portion of a lower limb that bears weight and makes the human upright and performs activities like walking, running, and jumping. Feet enable ambulation with a bipedal gait and provide a static platform. Thisis due to the elastic arches or springs in the footknown as longitudinal arches (Rauf, Adnan, & Sadiq, 2022). These are segmented in nature to sustain stress and thrusts. During a walking cycle, a normal foot changes from a supple to a rigid position while the concavity of the sole is maintained (Setyaningrahayu, Rahmanto, & Multazam, 2020).

The important characteristic of this arch is its elasticity, owing to its height and the number of small joints between its parts. Because of their elastic properties, these soft tissues can spread ground contact reaction forces over a longer period, and thus reduce the risk of musculoskeletal wear or damage. Any alteration in these arches can cause pronated and supinated foot which can alter the person's balance (Octavius, Sugiarto, Handy, & Hartanto, 2020). Balance has often been used as a measure of lower extremity function and is defined as the process

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of maintaining the center of gravity within the body's base of support. For control of body alignment and the center of gravity over the base of support in an upright stance, the central and peripheral components of the nervous system interact constantly (Maharani, Wibawa, & Adiputra, 2020).

One of the many issues with the feet is flat feet, or flat foot, which is a form of flat foot brought on by the bones' curve growing flatter. The foot is a portion of the body that supports body weight and helps maintain balance while standing. This can happen as a result of foot and ankle injuries, balance disorders brought on by traumatic events, or changes in body attitude, such as deformities (shape changes) of the spine, pelvis, or lower extremities. Other causes include too much walking or standing, after an illness, or for other reasons that result in muscle weakening (Soni, Joshi, & Kulkami, 2022). The plantaris ligament, anterior and posterior tibial tendons, intrinsic muscles, and other supporting components of the medial longitudinal arch are weak, which can have an impact on health and result in this foot deformity (Hutagalung, Akhmad, & Irfan, 2023).

The prevalence of children who experience flat feet in the world is around 20%-30%, in America around 50% and in Indonesia it is still not clearly known. The results of research in Surakarta on children aged 6-12 years obtained 299 (27.5%) students had flat feet and 790 (72.5%) students had normal arches. Research in Bandung in children aged 6-10 years there were 129 (40%) experiencing flat feet and as many as 197 children (60%) did not experience flat feet (Azzahra, Purwaningastuti, & Citrawati, 2020). Flat foot consists of 2 types, namely unilateral flat foot and bilateral flat foot. Unilateral flat foot is flat feet found on one sole only, while bilateral flat foot can be on both soles. Flat feet that occur in the community are often ignored and considered normal. Poor foot conditions will affect the fulcrum, one of the foot conditions that can affect the fulcrum is flat foot. When a child has a flat foot, the resulting fulcrum is also not good, so it will affect the balance (Latifah, Naufal, & Astari, 2021).

Growth and development in children begins with body coordination, sitting, crawling, standing, and ends with walking. The ability to maintain balance is heavily dependent on bone density, muscle strength, and coordination in order to enable growth and development. Training agility, balance, and flexibility in children requires their capacity to do coordinated physical activities. Humans depend heavily on their ability to balance as well as on their five senses. In this instance, the fulcrum and the musculoskeletal system support the balance (Tahmasebi, Karimi, Satyati, & Fatoye, 2015).

Static balance is commonly assessed by instrumented measurements of ground reaction forces or non-instrumented means. static postural control can be assessed by having an individual attempt to maintain a stationary position while standing on either one or both feet. The common example of non instrumented static balance is an unipedal stance with eyes open and closed. Dynamic balance often involves the completion of a functional task without compromising one's base of support. Numerous tests have been developed to assess the dynamic balance. The star excursion balance test is the most sensitive test for dynamic balance (Haq, Dhari, Imania, & Fis, 2021).

Static balance and dynamic balance are the two types of balance. The capacity to keep one's posture and attitude constant is known as static balance. Dynamic balance, on the other hand, refers to the ability of the body to endure and maintain motion. If someone who has flat foot and experiences poor static and dynamic balance, this will affect activities such as walking, running, and standing. If a person has poor balance, it can make them prone to falling and experiencing obstacles when walking. Unusual arch development results in pain, easy injury, persistent deformity, and balance issues (Arafah, & Kumaat, 2018).

Humans are God's most perfect creation compared to other creatures, but there is a certain condition that this body can experience interference caused by something so that it does not function optimally. This condition is called human illness. Allah sends down a disease will also send down the cure for the disease. The hadith narrated by Imam Muslim:

لِكُلِّ دَاءٍ دَوَاءٌ، فَإِذَا أُصِيْبَ دَوَاءُ الدَّاءِ بَرَأَ بِإِذْنِ اللهِ

Meaning: "Every disease has a cure. If a medicine is in accordance with the disease then he will recover with the permission of Allah Subhanahu wa Ta'ala." (Narrated: Muslim).

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RESEARCH METHOD

A cross-sectional approach, specifically focusing on observational study. The study took place from June 2024, in MI Muhmmadiyah Gonilan, Surakarta. The independent variable was flat foot the dependent variables is a static balance and dynamic balance. Using purposive sampling and the Slovin formula, 180 participants were selected, who met specific inclusion and exclusion criteria.

The inclusion criteria required individuals with flat foot (diagnosed through clinical or radiographic methods), no history of injury or surgery to the feet and lower legs in the last 6 months, no neurological disorders that would impact their balance. While exclusion criteria involved individuals with a normal foot or high arch foot (pes cavus), have a vestibular disorder or other medical condition that may affect balance, use a walker such as a cane or orthosis.

Data obtained from the results of foot print test, standing stork and pediatrics balance tests. The measurement foot print tets starts with prepare white paper, paint/ink, and a flat surface, paint the soles of your feet with ink, stand upright on the paper for 5-10 seconds, then remove your feet slowly. Result are expressed by normal Arch: the center of the footprint narrows to about ⅓-½ of the total width. Flat foot: the footprint is almost complete with no mid-arch. High arch: the midfootprint is very narrow or not visible.

Standing stork starts with set up a stopwatch, a flat platform, and perform the test shoeless, stand up straight, hands at the waist, raise one leg, placing the palm on the inside of the knee of the fulcrum leg, stand on your tip toes and maintain balance, record the time until you lose your balance or drop your heel. Accumulated score results if >50 seconds is said to be good, 25-49 seconds is moderate and <24 seconds is poor.

The Pediatric Balance Test (PBT) questionnaire is an evaluation of static and dynamic balance in children, usually based on a modification of the Berg Balance Scale (BBS) which contains 14 questions from 7 assessment subjects listed. Statements are expressed with numbers 0-4. Accumulated scores are said to have good balance if the score is >25 and poor if <20. The analysis proceeded with a univariate test to determine the frequency distribution of respondents characteristics, followed by bivariate analysis using spearman rank test. All analyses were conducted using SPSS 24. This research has obtained permission from the Research Ethics Committee of the Muhammadiyah University Surakarta with number. 355/KEPK-FIK/VI/2024.

RESEARCH RESULTS

Table 1. Characteristics of Participants (N=108)

Variable	Results
Age (n/%)	
Age (Mean±SD)(Range)(Year)	(8.31±1.625)(6-12)
6-7	19/18.0
7-8	18/17.0
8-9	23/21.0
9-10	20/19.0
10-11	12/11.0
11-12	16.14.0
Gender (n/%)	
Male	57/53.0
Female	51/47.0

Tabel 1 shows characteristics of participants with a mean age and standard deviation (8.31±1.625) ranging from 6-12 years and most were male 57 (53.0%).

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Table 2. Spearman Rho Test

Variable	Correlation Coefficient	Sign. (2-tailed)
Flat foot - Static balance	0.645	0.000
Flat foot - Dinaymic balance	0.207	0.032

The table above shows that the correlation coefficient value is 0.645, which belongs to the strong relationship category, while the correlation coefficient value of 0.207 belongs to the weak relationship category. In addition, the significance value is <0.05, which indicates that there is a significant relationship between flat foot and static balance and dynamic balance.

DISCUSSION

According to the results of this study, the male gender is more than the female. Aside from the fact that girls' lateral and medial plantar arches have a larger angle (degree) than boys', boys are more likely than girls to have flat feet due to differences in anatomical structure (Antara, Adiputra, & Sugiratma, 2017).

The difference in the risk of flat foot in boys and girls can be explained by differences in the anatomical structure of the foot. Boys tend to have less flexibility in the plantar structures than girls, which makes them more prone to flat feet. In addition, boys tend to be more physically active, which can cause excess pressure on their foot arches (Cahyaningrum, Naheria, Cahyono, & Putri, 2023). That the medial and lateral plantar arch angles in girls are larger, which helps in maintaining the foot arch structure. In contrast, boys have a denser bone structure, but with less flexibility, which may lead to a higher risk of flat foot (Meidian, 2015).

In addition to anatomical factors, external factors such as physical activity, shoe type, and body weight also affect the incidence of flat feet. Children who wear shoes with hard soles and do not fit the anatomy of the foot are more at risk of flat foot. In addition, obesity is a significant risk factor, as the additional pressure on the foot can accelerate the collapse of the arch of the foot (Munir, & Irawan, 2021). The higher prevalence of flat foot in boys is in line with findings from previous studies.The developmental factor of age also needs to be considered, as younger children have more flexible ligamentous tissue, which may cause the arch of the foot to appear flatter, but will usually develop with age. These findings emphasize the importance of early screening for flat foot risk in children, especially boys, and the need for education regarding the use of appropriate footwear. In addition, interventions such as foot muscle strengthening exercises, balance training and regular check-ups can help prevent the negative impact of flat foot on static and dynamic balance (Kim, Lim, & Yi, 2015).

Age development plays an important role in flat foot risk, as younger children have more flexible ligaments, causing the arch of the foot to appear flatter, which generally improves with age. Early screening is therefore crucial, especially for boys, to identify potential problems early (Ghorbani, Yaali, Sadeghi, & Luczak, 2023). The importance of early screening especially in boys is based on several studies that show a higher prevalence of flat feet in this group compared to girls. Screening can be done through direct physical examination, gait analysis, or the use of tools such as a podoscope to evaluate the arch shape of the foot (Nisa, Aktifah, & Izzah, 2020).

The importance of education regarding the use of appropriate footwear cannot be overlooked, as shoes that support the foot structure can prevent the risk of flat foot. In addition, interventions such as foot muscle strengthening exercises, balance exercises and regular check-ups have been shown to be effective in minimizing the negative impact of flat foot on static and dynamic balance (Muhsin, & Ghazwan, 2023). Early detection allows for timely intervention, such as the use of orthotics, specialized exercises, or physical therapy, to prevent long-term complications such as foot pain, posture disorders, or joint problems. In addition, educating parents on the importance of choosing appropriate footwear for their children is also an important aspect of flat foot prevention (Zaidah, 2019). Unsupportive footwear can worsen the condition of flat feet, while shoes with good arch support can help in the development of healthy feet. Thus, a holistic approach that includes screening, intervention and education can minimize the risk of flat foot and support optimal foot development in children (Syafia, & Pudjiastuti, 2016).

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CONCLUSION

The analysis showed that while there was a correlation between flat feet and both types of balance, the degree of association was different. Flat feet had a very weak relationship with dynamic balance, while its relationship with static balance was stronger and more significant. Thus, it can be said that flat feet have more influence on static balance than dynamic balance.

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