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The relationship between flat foot and lower limb muscle strength in teenage basketball athletes

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ABSTRACT

Background: Teenage basketball athletes may experience problems with lower limb muscle strength, which can affect their performance due to factors such as the shape of the arches pedis, muscle length and shortness, fatigue levels, muscle contraction ability, and the presence of flat feet, where the medial arch is flattened against the ground. This study aimed to determine the relationship between flat feet and lower limb muscle strength in adolescent basketball athletes in Tabanan Regency.

Methods: This study's design was observational analytic with a cross-sectional study direction. It was conducted at junior high and high schools in Tabanan Regency and involved 62 teenage basketball athletes. The inclusion criteria were basketball athletes with flat feet aged 14-17, while the exclusion criteria were a history of fracture or lower limb injury. Lower limb muscle strength was measured using a leg dynamometer, while flat foot was assessed using a wet footprint test.

Results: The result of the association test using *Spearman's Rho Test* obtained a correlation coefficient value (r) -0.173, which means a unidirectional relationship with a very weak correlation level with a *p*-value=0.180 ($p<0.05$), which means there is no significant relationship.

Conclusion: There was no relationship between flat foot and lower limb muscle strength in teenage basketball athletes. The correlation coefficient value indicates a unidirectional relationship with a very weak correlation level.

Keywords: flat foot, lower limb muscle strength, teenage basketball athletes.
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INTRODUCTION

Sports are physical activities often carried out by the younger generation, especially teenagers. Basketball is one of the most popular sports games in the world. A basketball athlete must be able to carry out physical activity with high levels of mobilization during the match.[1] The anatomical shape of the foot influences ability in competition, one of which plays a role, namely the shape of the archus pedis. Archus pedis is one of the factors that influence the ability of basketball athletes in matches.[2]

Feet are part of the body's lower extremities that support daily life. The foot has a complex and flexible anatomy that serves as the body's base and adapts to uneven surfaces. Flat foot is one risk factor that influences the shape of the archus pedis.[3,4] Flat foot or pes planus or what is known as fallen arches is a condition where the medial longitudinal arch does not form an arch, there is a deformity in the heel valgus, and the medial talar protrudes so that the arch of the foot disappears and is characterized by a flattened arches pedis.[3,4,5] Changes in posture in flat foot conditions can cause problems related to changes in muscle activity, such as lower leg muscle stiffness or leg muscle weakness. The long-term effects of a flat foot are pain in the foot and ankles and instability and disturbances in the lower back and lower extremities.[2,5,6]

Lower limb muscle strength is the ability of the lower limb muscles to withstand loads during activity. Changes in posture in flat foot conditions can cause problems related to changes in muscle activity, such as lower limb muscle stiffness or muscle weakness.[7,8] Flat feet may increase tone and stiffness in lower extremity muscles and fatigue and cramps in lower extremity muscles due to overuse. Consequently, the appropriate management of flat feet is crucial. The long-term effects of flat feet are pain in the foot and ankles and instability and disturbances in the lower back and lower extremities.[5,8,9]

The relationship between flat foot and lower limb muscle strength is controversial today. A study shows a relationship between the height of the arches pedis or arch of the foot and leg muscle strength and leg muscle explosive power.[10] While one study explains the relationship between the height of the archus pedis and leg muscle strength.[11] The study results stated that there was no significant correlation between the height of the archus pedis and leg muscle strength.[11] A study explains the comparison of leg muscle strength in groups with normal feet and flat feet.[12] The results obtained from this study stated

that there was no significant difference between leg muscle strength in the groups with normal feet and flat feet.[12] research and scientific publications examining the relationship between flat foot and lower limb muscle strength are still very limited and rarely found in Indonesia. This research aims to find out whether there is a relationship between flat foot and lower limb muscle strength.

METHODS

This research used an analytical observational design with a cross-sectional study approach. The independent variable was flat foot, and the dependent variable was lower limb muscle strength. The control variables were age, physical activity, and BMI. The research will be conducted from May 9 to May 13, 2023 at the one Junior High School and 2 Senior High Schools in Tabanan regency, Bali, Indonesia.

The total research subjects in the study were 62 people. The inclusion criteria for this study were teenagers who were basketball athletes in the Tabanan Regency area, aged 14-17 years, with moderate to heavy physical activity, with a BMI = ≥17.0 – ≥ 34.0. Willing to be a research subject and fill out informed consent as approval to become a research sample. The exclusion criteria in this study were subjects experiencing musculoskeletal disorders such as fractures or injuries to the lower extremities, having a history of heart and respiratory disease, and subjects having normal foot and cavus foot.

The flat foot measurement procedure utilized a wet footprint test, wherein the sole was wetted with ink on white paper. The interpretation results were determined by drawing the foot axis line on the wet footprint test using Clarke's angle, with the categories of arch types based on Clarke's angle defined as follows: Normal foot (>42 degrees), Flat foot grade I (35-42 degrees), Flat foot grade II (30-34.9 degrees), and Flat foot grade III (<29 degrees). Lower limb muscle strength measurements in this study were conducted using a leg dynamometer, with the objective categories for assessing lower limb muscle strength categorized as good, fair, and poor based on gender-specific criteria. For males, good (>140), fair (110-140), and poor (<110). Meanwhile, for females, good (>120), fair (90-120), and poor (<90).

This research consists of two data analyses; the first is a univariate analysis that aims to present a general picture of age, BMI, physical activity, results of flat foot measurements (wet footprint test), and results of measurements of lower limb muscle strength (leg dynamometer). Second, bivariate analysis using the non-parametric *Spearman's rho* analysis method to determine the relationship between variables and their strength values.

The study passed the ethical feasibility test after being examined by the Research Ethics Commission of the Faculty of Medicine, Universitas Udayana/Sanglah Hospital Denpasar, under the reference number 545/UN14.2.2.VII.14/LT/2023. Additionally, informed consent from the survey participants was supplied, endorsing the sampling technique.

RESULTS

A comprehensive description of the 62 respondents who participated in this study was gathered. The following table shows the respondents' age, gender, BMI, physical activity level, lower limb muscular strength, and flat foot. The age range of the research subjects, which is 14 to 17 years old, is displayed in Table 1. Subjects aged 15 years were the age group with the largest number, with 19 respondents (30.6%), and the largest number of research subjects were male teenagers, with 46 respondents (74.2%). Subjects with a normal BMI category were the largest, with 31 respondents (50.0%). The highest level of physical activity was in the high physical activity category, with 36 respondents (58.1%). The largest number level of lower limb muscle strength in the poor category was 45 respondents (72.6%). In terms of subject characteristics in the flat foot variable, the largest sample obtained was in the heavy degree of the flat foot (flat foot grade III, < 29 0), with a total sample of 39 respondents (62.9%).

Table 2 shows the largest number of respondents was found in the lower limb muscle strength poor category, and those with a flat foot-heavy degree were 26 respondents (41.9%). Respondents with lower limb muscle strength in the poor category were in the flat foot with a mild degree, as many as 19 respondents (30.6%). Respondents with lower limb muscle

Table 1. Characteristic of 62 respondents

Characteristics	n (%)
Age	
14	16 (25.8)
15	19 (30.6)
16	12 (19.4)
17	15 (24.2)
Gender	
Men	46 (74.2)
Woman	16 (25.8)
BMI	
Underweight	8 (12.9)
Normal	31 (50.0)
Overweight	8 (12.9)
Obesity	15 (24.2)
Physical activity	
Moderate	26 (41.9)
High	36 (58.1)
Lower limb muscle strength	
Poor	45 (72.6)
Good	17 (27.4)
Flat foot	
Mild degree	23 (37.1)
Heavy degree	39 (62.9)

n, frequency

Table 2. Cross table flat foot with lower limb muscle strength

Flat foot	Lower limb muscle strength		Total
	Good n (%)	Poor n (%)	
Mild degree	4 (6.5)	19 (30.6)	23 (37.1)
Heavy degree	13(21.0)	26 (41.9)	39 (62.9)
Total	17 (27.4)	45 (72.6)	62 (100)

n, frequency; %, percentage

Table 3. Correlation of flat foot with lower limb muscle strength

Variable Correlation	Correlation (*r*)	*p*-value
Flat Foot on lower limb muscle strength	-0.173	0.180

strength in the good category for the flat foot in the mild degree were 4 respondents (6.5%), and respondents with lower limb muscle strength in the good category for the flat foot in the heavy degree were 13 respondents (21%).

Based on *Spearman's Rho* test in Table 3. The p-value for the flat foot with lower limb muscle strength is *p*-value = 0.180 ($p>0.05$). This proves no significant relationship exists between flat feet and lower limb muscle strength in teenage basketball athletes in Tabanan Regency. Based on the correlation coefficient value, the result is (r) = -0.173 and is negative, indicating a unidirectional relationship with a very weak correlation level.

DISCUSSION

The results of the bivariate analysis test using Chi-Square showed a p-value = 0.174 ($p> 0.05$), which means there is no significant relationship between flat foot and lower limb muscle strength in adolescent basketball athletes in Tabanan Regency. Several factors, both internal and external, can cause the absence of this relationship. Internal factors include the morphological shape of the foot and foot biomechanics. In contrast, external factors include footwear and environmental conditions such as temperature and humidity that the researcher has not controlled.

These results differ from research conducted by Aydog in 2005, which showed a significant relationship between the archus pedis and leg muscle strength and leg muscle explosive power.[10] However, this research is appropriate and in line with research conducted by Lizis in 2010, which states that there is no significant correlation between the height of the archus pedis and leg muscle strength.[13,14] The study also stated that arches pedis measurements were ineffective in determining variability in leg muscle strength in young adults.[15,16] Different research results can be caused or occur due to several internal and external factors. Internal factors that can influence include the morphological shape of the soles of the feet and biomechanics of the foot. In contrast, external factors that are thought to influence footwear and the environment, such as temperature and humidity, have not been controlled in this study.[3,5]

The study by Tudor in 2009 states that it is not easy to resolve the controversy regarding flat feet in one research study.[16] The condition of flat foot can occur possibly due to health problems such as feeling tired easily when doing activities such as walking or excessive physical activity.[5] Changes in posture in flat foot conditions can cause problems related to changes in muscle activity, such as lower leg muscle stiffness or leg muscle weakness.[5,17,18]

Research conducted by Naufal in 2021 also stated that there was no significant relationship between flat feet and activation of lower leg muscle strength in 12-year-old children.[11] In research conducted by Ridjal in 2016, which compared leg muscle strength between normal foot and flat foot, the results showed no significant difference in leg muscle strength values between the normal foot group and the flat foot group.[12]

Insufficient lower limb muscle strength, which research respondents dominate, can occur because a lack of leg muscle strengthening exercises influences it. A reduction in the quantity and size of muscle fibers as well as an increase in connective tissue and adipose tissue within the muscles might result from structural changes in the muscles.[18,19] Apart from physiological changes, teenagers also experience morphological changes.[12] Morphological changes that occur in the musculoskeletal system can result in reduced muscle size and loss of strength, flexibility, and endurance as a result of decreased activity.[12,19,20]

A study conducted by Feltner in 1994 stated that there was a change in hindfoot pronation in people who did isokinetic eversion/inversion exercises for eight weeks.[21] This shows that intensive strengthening exercises can increase the strength of the foot's intrinsic muscles, thus supporting the formation of the arch or arch in the foot.[21,22]

Exercises such as isometrics can slowly train leg muscle strength, foot muscles, and joint stabilization. With maximum and controlled intensity, it will be very good in supporting increased leg muscle strength.[22,26] Basketball athletes routinely do muscle-strengthening exercises, which cause basketball players to have higher muscle activity than untrained people.[12,25] There is a need for awareness among development organizations and trainers of teenage athletes to pay more attention to the risk of injury that may occur to their athletes. The goal is not to hurt the athlete in the short or long term.[28,29]

This research has the advantage of researching specifically teenage basketball athletes. In contrast, in Indonesia, very few studies have been done on the relationship between flat foot and lower limb muscle strength, so it can be used as input in research development. The weakness of this research was that the researchers did not pay enough attention to other factors, such as internal factors, namely the morphology of the shape of the feet, where the human body also has different variations both in size variations and morphological variations between each individual and other individuals and foot biomechanics. The choice of measuring instruments can also be considered to influence research results. In this study, researchers used a wet footprint test and leg dynamometer measuring instruments, which might be considered to influence the research results and can be used as input in further research.

CONCLUSION

Research and analysis studies have shown that there is no connection between adolescent basketball players' flat feet and lower limb muscle strength. A unidirectional association with a very low correlation level was revealed by the correlation coefficient value.

ETHICAL CLEARANCE

This research was ethically feasible, according to the Research Ethics Commission College of Medicine, Udayana University, with number 545/UN14.2.2.VII.14/LT/2023.

CONFLICT OF INTEREST

There are no competing interests in this investigation.

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AUTHOR CONTRIBUTIONS

NLKCPD prepares study designs, collects and processes data, and writes manuscripts. SAPT, IPYPP, and AAGAPN direct data collection and revise the manuscript.

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REFERENCES

1. Rosti R, Jumaking J, Aprilia RP. Hubungan kekuatan otot lengan dan kelincahan dengan kemampuan menggiring bola siswa ekstrakurikuler bola basket. Jurnal Stamina. 2022;5(8):362-371
2. Koeswandi AT, Muliani Y, Karmaya IN. Hubungan flat foot dengan chronic ankle instability pada atlet basket kelompok umur 14 tahun di klub basket elite bali dan merpati bali. Jurnal Medika Udayana. 2022;11(10):50-6.
3. Chen YC, Lou SZ, Huang CY, Su FC. Effects of foot orthoses on gait patterns of flat feet patients. Clinical biomechanics. 2010;25(3):265–70.
4. Schaefer JD. Supporting the Medial Longitudinal Arch: A Comparison Between Intrinsic and Extrinsic Musculature. Illinois State University; 2018.
5. Thanaya SAP, Jamaluddin CN. Comprehensiven physiotherapy program improves the medial longitudinal arch of a male adolescent with the bilateral flexible flat foot: A Case Report. Physical Therapy Journal of Indonesia. 2021;2(2):54-60.
6. Setyaningrahayu F, Rahmanto S, Multazam A. Hubungan kejadian flat foot terhadap keseimbangan dinamis pada pelajar di sman 3 malang. Physiotherapy Health Science. 2020;2(2):83-9.
7. Forriol F, Pascual J. Footprint analysis between three and seventeen years of age. Foot & Ankle. 1990;11(2):101–4.
8. Um GM, Wang JS, Park SE. An analysis on muscle tone of lower limb muscles on flexible flat foot. Journal of physical therapy science. 2015;27(10):3089-92.
9. Syafi'i M, Pudjiastuti SS. Beda Pengaruh Arkus Kaki terhadap Keseimbangan Statis Anak Usia 9-12 Tahun di SD Negeri Mojolegi, Teras, Boyolali. Jurnal Kesehatan. 2016;7(3):351-4.
10. Aydog ST, Özçakar L, Tetik O, Demirel HA, Hascelik Z, Doral MN. Relation between foot arch index and ankle strength in elite gymnasts: a preliminary study. British Journal of Sports Medicine. 2005;39(3):e13-.
11. Naufal AF, Fatmarizka T, Rahayu UB, Nafi'ah D, Latifah Y, Astari RW. Relationship between flat foot and lower limb muscle activation among 12-year-old children. Journal of Medicinal and Chemical Sciences. 2021;4(4):381–7.
12. Ridjal AI. Perbandingan kekuatan otot tungkai antara normal foot dan flat foot pada atlet basket. Makassar: Universitas Hasanuddin Makassar. 2016.
13. Liziz P, Posadzki, Smith TO. Relationship between explosive muscle strength and medial longitudinal arch of the foot. Foot Ankle Int. 2010;31(9):815–22.
14. Ayuningtiyas NP, Nugraha MH, Negara AA, Antari NK. The relationship between the medial longitudinal arch and lower back disability among vocational school dancer. Physical Therapy Journal of Indonesia. 2023;4(1):91-4.
15. Pfeiffer M, Kotz R, Ledl T, Hauser G, Sluga M. Prevalence of flat foot in preschool-aged children. Pediatrics. 2006;18(2):634–9.
16. Adhitya IPGSA, Kurniawati I, Sawa R, Wijaya TF, Dewi NP. The Risk Factors and Preventive Strategies of Poor Knee Functions and Osteoarthritis after Anterior Cruciate Ligament Reconstruction: A Narrative Review. Physical Therapy Research. 2023;26(3):78-88.
17. Mardiah A, Sari M. Pemeriksaan arcus pedis. Empowering Society Journal. 2022 Jan 7;2(3).
18. Tudor A, Ruzic L, Sestan B, Sirola L, Prpic T. Flat-footedness is not a disadvantage for athletic performance in children aged 11 to 15 years. Pediatrics. 2009;123(3):e386-e392.
19. Zhao X, Tsujimoto T, Kim B, Tanaka K. Association of arch height with ankle muscle strength and physical performance in adult men. Biol Sport. 2017;34(2):119–26.
20. Sagat P, Bartik P, Štefan L, Chatzilelekas V. Are flat feet a disadvantage in performing unilateral and bilateral explosive power and dynamic balance tests in boys : A school-based study. BMC Musculoskelet Disord. 2023;24(1): 622.
21. Takata Y, Sugimoto M, Iwamoto K, Kitsunai I, Sugiyama K, Kimura K. Medial longitudinal arch pad influences landing control of the lower limbs during single-leg jump-landing. Health. 2020;12(12):1610–9.
22. Sunantara AA, Mayun IG, Suadnyana IA. Hubungan kekuatan otot tungkai dengan kemampuan fungsional pada lansia di banjar jasan, sebatu, tegalalang, gianyar. Indonesian Journal of Physiotherapy Research and Education. 2022;3(1).
23. Feltner ME, MacRae HS, MacRae PG, Turner NS, Hartman CA, Summers ML, Welch MD. Strength training effects on rearfoot motion in running. Medicine and science in sports and exercise. 1994;26(8):1021-7.
24. Kim EK, Kim JS. The effects of short foot exercises and arch support insoles on improvement in the medial longitudinal arch and dynamic balance of flexible flatfoot patients. Journal of Physical Therapy Science. 2016;28(11):3136-9.
25. Alahmri F, Alsaadi S, Ahsan M, Almousa S. The effect of isokinetic hip muscle strength on normal medial longitudinal arch feet and pes planus. Journal of medicine and life. 2022;15(9):1164–9.
26. Fourchet F, Kuitunen S, Girard O, Beard AJ, Millet GP. Effects of combined foot/ankle electromyostimulation and resistance training on the in-shoe plantar pressure patterns during sprint in young athletes. Journal of sports science & medicine. 2011;10(2):292.
27. Haq AN, Rizki Imania D. Pengaruh short foot exercise dan tibialis posterior strengthening terhadap keseimbangan dinamis pada penderita flat foot remaja : Narrative Review. Journal Physical Therapy UNISA. 2021.
28. Gondo AA, Faadhilah N, Nurjanati DA, Ramba Y, Abdullah MM. The Efficacy of dynamic stretching exercise versus strengthening exercise on longitudinal medial arch in flat feet: Randomized controlled trial. Journal of Indonesian Physiotherapy. 2019;1(1):1-6.
29. Palaguma R, Dinata WW, Effendi H, Susanto N. Kekuatan otot tungkai dan kelincahan terhadap kemampuan bertahan atlet bola basket putra. Journal Power of Sports. 2023;6(2):94-102.