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Analysis of Agility Performance and Lower Limb Explosive Power Based on Foot Arch Variations in Regional-Level Football Players

Dadan Resmana[1], Raisa Ganeswara[1], Abdul Gani[1], Bambang Kridasuwarso[1], Taufik Rihatno[2], Samsudin[2], Shela Ginanjar[3]

[1]*Program Studi Kepelatihan Kecabangan Olahraga, Fakultas Ilmu Keolahragaan dan Kesehatan, Universitas Negeri Jakarta, Indonesia*
[2]*Program Studi Pendidikan Jasmani, Fakultas Ilmu Keolahragaan dan Kesehatan, Universitas Negeri Jakarta, Indonesia*
[3]*Program Studi Pendidikan Jasmani, Kesehatan, dan Rekreasi, Fakultas Ilmu Keolahragaan dan Kesehatan, Universitas Negeri Jakarta, Indonesia*

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Abstract

The arch of the foot is a biomechanical structural element that can affect the physical performance of athletes in sports that require dynamic movements such as soccer. The arch of the foot, both normal and flat, contributes to the efficiency of movement and load distribution when running, jumping, and changing direction suddenly. Therefore, this study aims to analyze the differences in agility performance and vertical leg muscle explosive power in regional-level soccer players based on variations in the shape of the arch of the foot, namely normal and flat. The method used is an observational study involving regional-level soccer players aged 19–22 years who have participated in regional-level competitions. Agility measurements were carried out using an 8×5 meter back and forth running test, while vertical jumping ability was assessed through a vertical jump test using the Vertec tool. The results of the study with the t-test showed that there was no significant difference between the normal and flat-footed groups in either the agility variable (p = 0.141) or the vertical jump (p = 0.121). The conclusion of this study shows that there is no significant difference between regional level soccer players with normal and flat foot arch types in terms of agility and vertical jumping ability.

Keywords: *football, injury, athlete, foot, leg.*

INTRODUCTION

Physical performance variables such as agility and lower limb explosive power are crucial in supporting athletic success, particularly in competitive sports like football (Bin Shamshuddin et al., 2020; Bogalho et al., 2022). Agility refers to

Correspondence author: **Dadan Resmana**, Universitas Negeri Jakarta, Indonesia.
Email: dadanresmana@unj.ac.id

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an individual's ability to move quickly and efficiently change direction, while vertical jumping reflects the strength and power of the lower limb muscles (Baptista et al., 2019; Young et al., 2022). Previous studies have identified several factors that can influence agility and lower limb explosive power, including body composition, neuromuscular condition, muscle strength, and technical execution (Bashir et al., 2022; Cetin et al., 2020; MH et al., 2021). Moreover, biomechanical factors, including foot anatomical structure, have also been highlighted as contributing elements in optimizing these movement functions (Contarli & Cankaya, 2022; Radovic et al., 2024).

The foot arch plays an essential role in load absorption, pressure distribution, and maintaining stability during movement (Mckeon et al., 2014). There are three primary categories of foot arch: normal arch, flat foot, and high arch, each with distinct biomechanical characteristics (Filho et al., 2023; Moreno-Barriga et al., 2023). Previous research has concluded that these morphological variations may influence movement efficiency and the risk of sports-related injuries (Cheng et al., 2022; Setiawan et al., 2023; Zhou, 2023). Our study highlights that such arch variations are present among collegiate-level athletes (Resmana et al., 2024).

Several studies have indicated that flat foot conditions may lead to imbalanced load distribution, disrupt dynamic stability, and increase the risk of injury (Şahin et al., 2022). Other research suggests that adolescents with flat feet tend to demonstrate lower physical performance compared to those with normal foot arches (Febriyanti et al., 2024; Ramadhani & Romadhoni, 2024). However, contrasting findings highlight that neuromuscular adaptations and technical proficiency may compensate for non-ideal foot morphology, thereby allowing athletes to maintain optimal physical performance (Prvulović et al., 2021).

Empirical data on foot arch characteristics and their relationship to physical performance among regional-level football athletes remains scarce. At this developmental stage, coaching programs often emphasize technical and tactical aspects of the game, while biomechanical factors, such as foot anatomical structureare frequently overlooked in athlete identification and development processes. Furthermore, no morphological mapping of foot types among local football players currently exists to support the design of training programs tailored

to individual biomechanical needs. Understanding how foot morphology influences performance would allow coaches to develop more targeted training regimens and injury prevention strategies. Therefore, this study aims to analyze whether there are significant differences in agility and vertical jump performance between football players with normal and flat foot arches.

METHODS

Research Procedurs

Participant height was measured using a stadiometer, while body weight and Body Mass Index (BMI) were assessed using the Omron Carada Scan Body Fat analyzer. Vertical jump performance was measured using the Vertec jump test. The first step involved recording the participant's standing reach height with one arm fully extended upward. Subsequently, participants from both groups were instructed to perform a vertical jump, aiming to touch the highest vane they could reach on the Vertec device. The vertical jump height was calculated by subtracting the standing reach height from the maximum height reached during the jump.

Agility was measured using the 8 × 5 meter shuttle run test. Prior to the test, two pairs of photocell timing gates (Smart Speed, Fusion Equipment, AUS) were installed at the 0-meter and 8-meter marks along a predetermined flat and controlled testing area. Point A was marked by the first set of photocells as the starting line, and point B was marked by the second set, located 8 meters away. Participants from both groups were instructed to perform five consecutive sprints back and forth between points A and B, with the goal of covering the total distance as quickly as possible.

Participants

This study employed an observational method involving 12 regional-level football players, consisting of 6 players with normal foot arches and 6 players with flat foot arches. Both verbal and written explanations were provided to all participants, outlining the objectives, benefits, and procedures of the research. All participants were instructed to complete an informed consent form if they agreed to take part in the study. The research protocol was approved by the Research Ethics Committee of Universitas Negeri Jakarta under approval number: No:

612/UN39.14/PT.01.05/V/2025.

Data Analysis

The data presented in this study are expressed as mean values and standard deviations. To identify potential differences in physical performance between players with normal and flat feet, a one-way analysis of variance (ANOVA) was employed. The statistical analysis was conducted using SPSS software version 22. A significance level was set at $p < 0.05$ to ensure systematic, valid, and scientifically appropriate interpretation of the data.

RESULTS

Table 1 presents the mean and standard deviation of anthropometric data for both research groups. Based on the descriptive analysis and statistical tests, no significant differences were found between the normal foot arch group and the flat foot group across all measured variables ($p > 0.05$). The average age of participants with normal arches was 20.09 ± 1.94 years, while the flat foot group had an average age of 20.32 ± 2.10 years ($p = 0.321$). The mean body weight in the normal arch group was 62.86 ± 5.83 kg, compared to 63.12 ± 6.17 kg in the flat foot group ($p = 0.421$). The height of the normal foot group averaged 172.76 ± 2.92 cm, while the flat foot group averaged 172.04 ± 3.15 cm ($p = 0.352$). Similarly, Body Mass Index (BMI) results showed comparable values between groups, with an average of 20.8 ± 1.6 kg/m² in the normal foot group and 20.7 ± 1.3 kg/m² in the flat foot group ($p = 0.376$).

Table 1. Anthropometric Data

Variable	Group		*P-Value*	Sig.
	Normal Foot	Flat Foot		
Age (y)	20,09 ± 1,94	20,32 ± 2,10	0,321	Not Significant
Body Weight (kg)	62,86 ± 5,83	63,12 ± 6,17	0,421	Not Significant
Body Height (cm)	172,76 ± 2,92	172,04 ± 3,15	0,352	Not Significant
BMI (kg/cm^2)	20,8 ± 1,6	20,7 ± 1,3	0,376	Not Significant

Table 2 shows the mean and standard deviation of physical performance data of the two research groups. Based on the results of descriptive analysis and statistical tests, no significant differences were found between the group with normal feet and the group with flat feet in all measured variables ($p > 0.05$). The results of the physical performance analysis showed that there were no significant differences between the groups with normal feet and flat feet in terms of agility or vertical jump ability ($p > 0.05$). The average agility time in the normal foot group was 10.91 ± 0.87 seconds, while the flat foot group showed an average time of 11.02 ± 1.09 seconds ($p = 0.141$). Likewise, the results of the vertical jump measurement showed an average value of 58.9 ± 2.8 cm for the group with normal feet and 59.1 ± 3.1 cm for the group with flat feet ($p = 0.121$).

Table 2. Physical Performance Data

Variable	Group		*P-Value*	Sig.
	Normal Foot	Flat Foot		
Agility (s)	10,91 ± 0,87	11,02 ± 1,09	0,141	Not Significant
Vertical Jump (cm)	59,1 ± 2,8	58,9 ± 3,1	0,121	Not Significant

DISCUSSION

This study aimed to analyze the differences in agility performance and lower limb explosive power among regional-level football players based on the characteristics of their foot arch. Such analysis is crucial given that foot structure plays a significant role in the biomechanical efficiency of movement, particularly in actions requiring acceleration, rapid direction changes, and jumping ability in football (Silva et al., 2023; Wrang et al., 2022). Additionally, this study is among the first to examine the relationship between foot arch characteristics and specific physical performance among regional-level football players.

Our findings indicate that there were no statistically significant differences in agility or vertical jump performance between players with normal foot arches and

those with flat feet. Although the flat foot group recorded a slightly slower agility time (11,02 ± 1,09 detik) compared to the normal arch group (10,91 ± 0,87 detik), the p-value of 0.141 suggests that the difference was not statistically significant (p > 0,05). A similar trend was observed in vertical jump performance, where the flat foot group exhibited a slightly lower jump height (58,9 ± 2,8 cm) than the normal arch group (59,1 ± 3,1 cm), with a p-value of 0,121.

Regarding agility performance, our findings align with previous studies that have concluded athletes with flat feet do not experience significant differences in agility compared to those with normal arches (Ghorbani et al., 2025; Kennedy et al., 2023). Prior research suggests that agility is more strongly influenced by neuromuscular components and the specificity of training received by the athlete than by structural characteristics of the foot, indicating that morphological variations in foot arches have limited impact on agility performance (Tudor et al., 2009).

Regarding vertical jump performance, our results are consistent with several previous studies which found no significant differences in vertical jump height between athletes with flat feet and those with normal foot arches(Moharkar & Thakur, 2023; Yu et al., 2024). Earlier research posits that vertical jump performance is more affected by neuromuscular factors and the functionality of major muscles such as the gastrocnemius medialis, soleus, tibialis anterior, and peroneus longus, rather than by the static morphology of the foot arch (Contarli & Cankaya, 2022). The coordinated eccentric and concentric contractions of these muscles are key in generating vertical propulsion force (Radovic et al., 2024).

The foot arch generally provides athletes with advantages in terms of balance and stability (Moreno-Barriga et al., 2023). Additionally, athletes with normal foot arches tend to have a lower risk of injury compared to those with flat arches (Tong & Kong, 2013). However, our study showed no statistically significant differences between groups with normal and flat foot arch types, indicating that although flat feet are anatomically considered less ideal, this condition does not directly affect the body's ability to quickly and efficiently change direction or impact jump performance.

Although our study did not find a direct relationship between foot type and

physical performance, previous research suggests that foot arch shape should still be considered in the long term, particularly regarding injury risk (Bednarczyk et al., 2024). Prior studies have concluded that individuals with flat feet are more likely to experience foot pain, ankle instability, and lower limb musculoskeletal conditions such as knee and hip osteoarthritis (Cheng et al., 2022).

The limitations of this study include a small sample size, which does not represent the broader athletic population. Additionally, potential confounding factors such as training experience, movement technique, core muscle strength, or previous injury history were not strictly controlled. Furthermore, this study did not evaluate the dynamic characteristics of foot function during specific activities, making it less capable of explaining the more complex biomechanical relationship between foot arch structure and sports performance holistically. Therefore, further research with larger sample sizes and more comprehensive biomechanical approaches is highly recommended to gain a deeper understanding of the influence of foot arch type on athletic performance.

Our findings highlight that differences in foot arch type specifically between normal and flat feet do not significantly impact agility or lower limb explosive power among regional-level football players. Therefore, coaches and sports practitioners are encouraged to focus more on developing physical and technical qualities through appropriate training approaches, while continuing to monitor individual biomechanical conditions as a preventive effort against potential injuries.

CONCLUSSION

Based on the results and discussion of this study, it can be concluded that there are no significant differences between regional-level football players with normal and flat foot arch types in terms of agility and vertical jump performance. These findings suggest that foot morphology is not a primary determinant of the physical performance variables examined, given the dominant influence of other factors such as neuromuscular function, technique, and lower limb muscle strength. Nonetheless, the distribution of foot arch types among regional athletes indicates anatomical variability that should be considered in the context of sports development programs. Therefore, these results may serve as an initial reference for coaches and sports practitioners, emphasizing that foot arch shape should not be

used as the sole indicator of physical performance. This also highlights the need for further research using more comprehensive biomechanical and longitudinal approaches.

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