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RELATIONSHIP BETWEEN Q-ANGLE, FOOTPRINT, AND LEG MUSCLE STRENGTH ON DYNAMIC BALANCE OF BASKETBALL ATHLETES

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ABSTRACT
Basketball is a sport that requires accuracy in throwing the ball but also requires maximum foot movement, in basketball fast and agile foot movements are required, such as being able to stand and change direction quickly without losing balance, dynamic human foot movements must of course be based on good balance to create fast and powerful movement maneuvers, humans themselves naturally have different anatomical shapes both in length, width and height although still in the same large pattern, one of which is the flat foot shape and also the angle of the femur and tibia bones known as the Q-angle, the shape of the difference will affect the difference in tension produced in performing muscle contractions and also in more complex movements, namely kicking in a moving position such as or dynamic balance in more complex dimensions. This study aims to determine how the relationship between Q-angle, footprint, and leg muscle strength simultaneously affects dynamic balance in basketball athletes. This study uses multiple regression correlation analysis techniques, which are used to obtain a comprehensive picture of the relationship between dependent and independent variables as a whole, either simultaneously or partially. The results of the study obtained 56 research samples, after the analysis prerequisite test was carried out and met the normality, homogeneity and linearity test values, then continued with a hypothesis test which obtained the results that partially in this study obtained information that only muscle strength had a significant relationship to dynamic balance, with a correlation strength value of 0.789 which means it has a strong relationship. While Q-Angle and footrpint partially did not get significant test results. The results of the multiple regression test obtained the formula DB = 54.275 + 0.35QA + 0.141FP + 0.071 MS + e, where the Constant of 54.275 with positive parameters indicates that Q-angle, Footprint, and muscle strength will increase the dynamic balance value with an R Square value of .0702 which means that the three variables contribute 70.2% of the composition of dynamic balance and the rest is influenced by other factors or outside the regression variable equation studied. There is a simultaneous relationship between Q-angle, Footprint, and muscle strength towards dynamic balance.

Keywords: dynamic balance; footprint; strength; Q-angle

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INTRODUCTION

Basketball is a sport that uses pivot, run, jump and landing movements in an effort to win the game, dominant foot movements in defense to attack are important, this basketball sport is a sport that has intense mobility (Nugraha et al., 2023). Human movement is of course a complex movement that must have dynamic balance as its main element. Human movement is a problem that can be quite complicated to explain, the nonlinear relationship between muscle excitation and muscle force as well as biomechanics and anatomical structures are the components of human movement. Movements in basketball players including walking, running and jumping certainly require biomechanical functions in providing body balance, both when pushing forward, swinging, or jumping and placing the feet when landing. The performance of the musculoskeletal both in terms of strength and anatomical structure are aspects that contribute to this movement (Neptune & Vistamehr, 2019).

Q-angle is the angle formed from the intersection of two imaginary lines measured between the axial tendons m. quadriceps femoris and a line drawn from the Superior Anterior Iliaca Spina (ASIS) to the middle of the patella when the knee is in extension, Q angle is an important factor that needs to be considered in assessing knee joint function, a smaller Q angle can be associated with better dynamic balance and reduced risk of injury (Kurniawan, 2019) in a study The Q angle is an important parameter for assessing quadriceps muscle function and its effects on the knee (Unuvar et al., 2023). In addition to the Q-angle, the curve of the foot is one form of anatomical variation in the human body, a healthy foot arch (medial longitudinal arch) is very important for distributing body weight and absorbing impact during statistical and dynamic activities, while freezing can cause overpronation (the foot rotates inward), which can affect balance and stability, conversely, feet that are too pronated or supinated can also affect balance and stability (Megha Soni et al., 2021) (Arunakul et al, 2013) . In addition to the anatomical form factor, another factor that is the main point is the performance of the muscles that keep the body in a balanced position, leg muscle strength is one of the important instruments in the foundation between the base of support (BOS), line of Gravity (LOG) and also the center of Gravity (COG) on how the vestibular will respond to balance to be balanced by utilizing the strength of the muscles between several control components that support balance to maintain balance including the visual, vestibular, and somatosensory systems, biomechanics of balance (Widyaswari et al., 2024). This study aims to see the relationship between Q-angle, footprint, and muscle strength simultaneously on dynamic balance in basketball athletes.

METHOD

This study uses an observational approach with multiple regression correlation analysis techniques, which are used to obtain a comprehensive picture of the relationship between dependent and independent variables as a whole, either simultaneously or partially. The population in this study were basketball club players in Surakarta who used a total sampling technique in which the players taken were not injured (Ciftci & Kurtoğlu, 2023). The study was conducted in April 2024 with measurements of the Q-angle using a goniometer by measuring the angle between the SIAS and the patella and the Tibial tuberosity to the patella (Juriansari et al., 2020). Meanwhile, for measuring the footprint or archus of the pedis using a footprint test which was then continued with Clarke's Angle measurement, an examination carried out by calculating the angle of the tangent line formed by the first line connecting the medial edge of the first metatarsal caput and the heel and the second line connecting the first metatarsal caput with the peak of the medial longitudinal arch arch (Pita-Fernandez et al, 2015). Measurement of muscle strength using a Leg dynamometer, with three repetitions and the best value produced is taken. Dynamic balance measurement using the Y Balance test measuring instrument, Y (Y-Balance Test) has good validity and reliability. Its validity shows that this test can measure what should be measured, namely the body's balance ability. Its reliability is indicated by the ICC value between 0.80 - 0.85 (Merchant et al, 2020) (Schwiertz et al, 2019) where after measuring the respondent's performance score, the Y Balance Test (YBT) uses one of the following three calculations: Composite Value: ((Anterior+Posteromedial+Posterolateral)/(3 x leg length)) x 100 (Fratti Neves, 2017) (Kurniawan et al., 2019) (Linek, Sikora, Wolny, Saulicz, 2017).

RESULT

Table 1.
Respondent characteristics (n= 56)

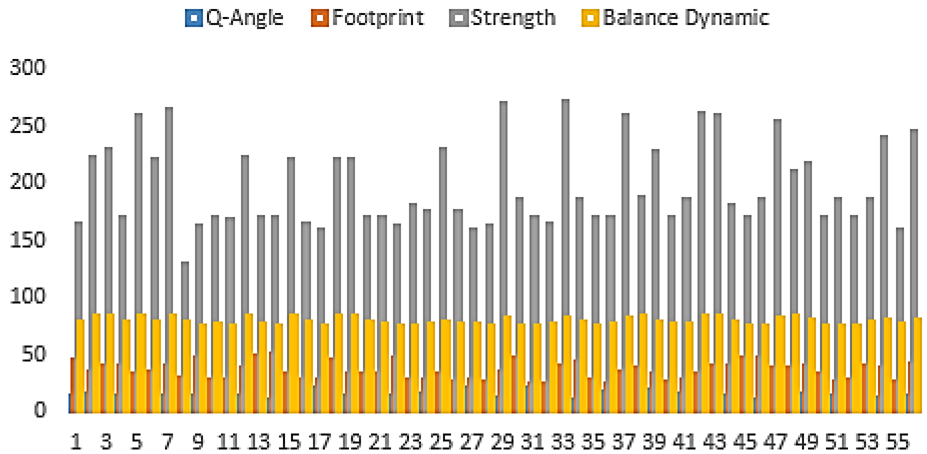
Respondent characteristics	f	%
Age		
15 – 17	18	32,1
18 – 20	38	67,9
Gender		
Male	32	57,2
Female	24	42,8

Table 2.
Partial correlation test between variables on dynamic balance (Pearson correlation test)

Variable	r	Sig.	Conclusion
Q-Angle	-0.041	0.767	Non Significant Negatif Correlation
Footprint	0.245	0.069	Non Significant Positive Correlation
Strength	0.785	0.001	Significant Positive Correlation

Table 3.
Results of multiple regression hypothesis testing (Anova test)

Variable	*Unstandardized Coefficients Beta*
Constants	54.275
Q-Angle	0.350
Footprint	0.141
Strength	0.071



Picture 1. Distribution of variable valuess

DISCUSSION

Table 1 above shows the frequency distribution by age, the largest being 18-20 years old, which is 38 respondents (67.9%). The results of the study showed that the frequency distribution by gender was mostly male with a total of 32 respondents (57.2%). Based on the results of the partial correlation test using the Pearson correlation test, the results showed that partially in this study, information was obtained that only muscle strength had a significant relationship with dynamic balance, with a correlation strength value of 0.789 which means it has a strong relationship. Q-angle and Footprint in the partial correlation test results did not get significant results, although from several research results from (Andika et al., 2021) they got the results of the relationship between Q-angle and dynamic balance in the elderly with a diagnosis of knee osteoarthritis with the Pearson test with a p result of 0.003 (p <0.05) with a correlation coefficient value of 0.476 (r> 0.05) which shows a strong relationship, but in this study the sample used was osteoarthritis sufferers with pain that caused dynamic balance movements. Another study by Denizoglu et al, (2019) found that the relationship between SLST and QA was not statistically significant in open and closed eye conditions ($r = -0.030$, $p = 0.782$; $r = 0.031$, $p = 0.774$; respectively). SLST scores did not differ between the third group in open and closed eye conditions ($p = 0.781$, $p = 0.790$, respectively).

Our study is to look at the relationship between Q angle and balance partially. Although there are studies in the literature that show a relationship between Q angle and balance, there are also studies that do not show a relationship (Kulli, 2019). Findings that are inconsistent with the results of this study also show a weak positive correlation between dynamic balance and Q angle, static measurements of Q angle may affect static balance results because statically measured angles have no biomechanical meaning and are not useful for dynamic activities. Furthermore, the Q angle continues to change during dynamic balance, which can be influenced by several factors. Abnormal Q angle values can increase lateral patellofemoral compressive forces during dynamic movements, which can cause problems such as anterior knee pain, joint instability, and patellofemoral pain syndrome (Daneshmandi et al, 2011) (Contarli, 2021).Meanwhile, Flatfoot is a complex foot deformity that is commonly seen in clinical practice. The flatfoot deformity is characterized by a combination of a collapse of the medial longitudinal arch, foot abduction at the talonavicular joint, and hindfoot valgus (subtalar joint eversion).the footprint in (Hyong & Kang, 2016) study also found no significant difference in dynamic balance ability based on foot shape in healthy students with normal, pronation, and supination feet. Meanwhile, research by (Rdzanek et al., 2022) found a correlation between the Clarke angle index value of the foot when standing upright with both feet and the length of the foot pressure path on the ground when standing upright with both feet.

Although there are differences in the results of this study, of course there are other influencing factors related to sample criteria or other factors that need to be studied further (Barati et al., 2013) (Kulkarni, 2022). Analysis of the research of Rizqillah and Sudaryanto (2025). in their research shows that although there is a correlation between flat feet and balance, it has a different level of relationship. Flat feet have a very weak relationship with dynamic balance, thus, it can be said that flat feet have a greater influence on static balance than dynamic balance.For muscle strength itself on dynamic balance based on the results of research from Widyaswari et al (2024) found that there is a relationship between cooling muscle strength and dynamic balance in skateboarders. Most samples showed strong muscle strength, resulting in good dynamic balance. Another study from Sundaram et al (2021) found that increasing muscle strength can affect the anterior YBT direction but there is no significant difference in the postero-lateral and postero-medial directions (Nguyen et al, 2009). The results of the multiple regression test obtained the formula $DB = 54.275 + 0.35QA + 0.141FP + 0.071\ MS + e$, where the constant of 54.275 with positive parameters indicates that Q-angle, Footprint, and muscle strength will increase the dynamic balance value with an R Square value of .0702 which means that the third variable helps 70.2% of the dynamic components and so on are influenced by other factors or outside the regression variable equation studied. The results of this study are in accordance with Unuvar et al (2023) with the results that there is a significant relationship between the Q angle and knee muscle strength and statistical balance. Muscle strength is an important factor in forming dynamic balance, this can be seen from the results of the regression test with two other variables, where muscle strength with Q-angel has a regression value equation of $\hat{Y} = 61.721 + 0.15\ X1 + 0.07\ X2$ and for muscle strength with the footprint $\hat{Y} = 64.06 + 0.03\ X1 + 0.06\ X2$.

CONCLUSION

There is a simultaneous relationship between Q-angle, Footprint, and muscle strength towards dynamic balance. Acknowledgements

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