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Differences in Ground Reaction Force (GRF) Between Unipedal and Bipedal Shooting Stance Among UiTM Seremban 3 Netball Players

Nur Allysha Hani Mohd Fakrul Hadi¹, Norhazman Noorhisham¹, Muhammad Mukhriz Jalani¹, Ahmad Ariff Razali¹, Muhammad Alif Aiman Mohd Ali¹, Muhamad Safiq Saiful Annur¹, & Muhamad Noor Mohamed^{1*}

¹Faculty of Sports Science and Recreation, Universiti Teknologi MARA Negeri Sembilan, Seremban Campus, Malaysia

*Corresponding author: muhamad_noor@uitm.edu.my

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I. INTRODUCTION

Netball is a high-intensity sport that involves repeated jumping, landing, cutting, passing, and shooting. Goal shooting is one of the most important skills in netball because successful shooting depends on technical accuracy, body control, and lower-limb stability. Previous research has shown that netball shooting involves specific kinematic patterns, and differences in skill level may influence shooting technique [1]. During shooting, players may use either a unipedal, single-leg stance, or a bipedal, double-leg stance. These stance positions may affect balance, stability, and ground reaction force. A unipedal stance reduces the base of support and places greater load on one limb, while a bipedal stance allows force to be distributed across both limbs. This is important because high ground reaction force and poor lower-limb control have been linked with injury risk in university-level netball players [2]. Although previous studies have examined netball shooting technique and lower-limb loading, limited research has directly compared ground reaction force between unipedal and bipedal shooting stances. Therefore, this study aimed to compare vertical ground reaction force during unipedal and bipedal shooting stances among university netball players. The findings may help coaches and athletes understand which stance places greater mechanical demand on the lower limbs.

II. METHODS

This study used a quantitative cross-sectional within-subject design. Four female netball shooters from UiTM Seremban 3 participated in the study. All participants played in the goal attack or goal shooter position and were right-leg dominant. Ground reaction force data were collected using an AMTI HF400-600 force plate. Each participant performed shooting trials using both unipedal and bipedal stances. The order of stance conditions was controlled to reduce testing bias. Vertical ground reaction force (Fz) was recorded and processed using AMTI NetForce/BioAnalysis software. The data were trimmed to a steady-state two-second window from 1.0 to 3.0 seconds. Ground reaction force values

were normalised to body weight (BW) to allow comparison between participants. The main variables analysed were mean Fz and peak Fz. Mean Fz represented average vertical loading during the shooting stance, while peak Fz represented the highest vertical force produced during the stance phase. Descriptive statistics were used to report mean and standard deviation. The Shapiro–Wilk test was used to check normality. A paired-samples t-test was then used to compare peak ground reaction force between unipedal and bipedal shooting stances. Statistical significance was set at $p < 0.05$.

III. RESULTS AND DISCUSSION

Mean Fz remained near static equilibrium (approximately 1.00 BW) for both stances, indicating similar average vertical loading during the steady-state shooting phase. In contrast, peak GRF differed between conditions. The unipedal stance showed higher peak Fz (1.025 ± 0.012 BW) compared with the bipedal stance (1.015 ± 0.008 BW). The Shapiro–Wilk test confirmed normal distribution for peak GRF (unipedal: $p = 0.612$; bipedal: $p = 0.151$). The paired-samples t-test revealed a significant difference in peak GRF between stances, $t(3) = 2.85$, $p = 0.046$, mean difference = 0.010 BW. The higher peak force during the unipedal stance reflects increased mechanical demand on the supporting limb due to the reduced base of support, requiring greater neuromuscular stabilisation. The bipedal stance distributes load across both limbs, resulting in lower peak force fluctuations and improved mechanical stability for shooting.

TABLE I
NORMALIZED GRF (BW) DURING STEADY-STATE SHOOTING PHASE

Variable	Stance	Mean	SD
Mean Fz (BW)	Unipedal	1.000	0.007
Mean Fz (BW)	Bipedal	1.001	0.005
Peak Fz (BW)	Unipedal	1.025	0.012
Peak Fz (BW)	Bipedal	1.015	0.010



Fig. 1 Peak GRF (BW) comparison between unipedal and bipedal shooting stances (mean $\pm$ SD).

The findings show that both unipedal and bipedal shooting stances produced mean vertical ground reaction force close to 1.00 BW. This indicates that the players maintained stable body-weight support during the steady-state phase of shooting. In other words, both stances allowed the shooters to control their body position before releasing the ball. This is important in netball because accurate shooting requires balance, postural control, and stable lower-limb positioning. A past study highlighted that netball goal shooting involves specific kinematic demands, and differences in body control are important for shooting performance. Although the average loading was similar between stances, the significant difference in peak GRF shows that unipedal and bipedal stances created different mechanical demands [1]. The higher peak GRF in the unipedal stance suggests that single-leg shooting places greater load on the supporting limb. This occurs because body weight is supported mainly by one leg, with a smaller base of support and greater demand for balance control. As a result, the ankle, knee, and hip must work harder to stabilise the body during shooting. This finding is consistent with others finding, who reported that single-leg and double-leg landing tasks create different lower-limb kinetic demands [3]. In contrast, the bipedal stance spreads the load across both legs, producing lower peak force and better mechanical stability. From an injury prevention perspective, this is important because higher ground reaction force and poor lower-limb kinematics have been linked with lower-extremity injury risk in university-level netball players [2]. Therefore, players who frequently use unipedal shooting should include balance training, lower-limb strengthening, and neuromuscular control exercises in their training programme.

IV. CONCLUSIONS

This study concluded that shooting stance significantly influenced peak ground reaction force among UiTM Seremban 3 netball players. Although mean vertical force remained close to 1.00 BW in both stances, the unipedal stance produced

significantly higher peak GRF than the bipedal stance. These findings suggest that the bipedal stance provides a more stable base for shooting, while the unipedal stance places greater mechanical demand on the supporting limb. Therefore, netball players who frequently use single leg shooting should include balance training, lower-limb strengthening, and neuromuscular control exercises to improve stability and reduce injury risk.

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