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Influence of Distance Manipulation on Shooting Kinematics and Accuracy Among Intermediate Basketball Players

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I. Introduction

Shooting accuracy in basketball is strongly influenced by biomechanical coordination across the upper-limb kinetic chain. As shooting distance increases, greater force production and refined proximal to distal sequencing are required to maintain optimal ball trajectory and release velocity [1][2]. Previous biomechanical investigations have shown that skilled players redistribute mechanical demand across the shoulder, elbow, and wrist joints when shooting from longer distances [1]. However, limited research has examined how intermediate-level players adapt their joint mechanics under increased distance constraints, particularly using accessible two-dimensional motion analysis tools. Understanding these adaptations is important because intermediate athletes are still refining movement consistency and joint coordination. Therefore, this study aimed to examine the influence of distance manipulation on shooting kinematics and shooting accuracy among intermediate-level basketball players.

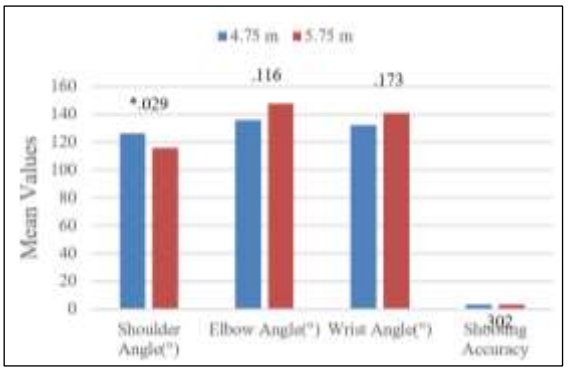
II. Methods

This study employed a quantitative within-subject experimental design to examine differences in free throw performance across two shooting distances. Six male intermediate-level basketball players aged between 18 and 24 years were recruited through purposive sampling. All participants had a minimum of two years of competitive playing experience. Eligibility criteria required participants to be free from upper-limb injury within the previous six months. Individuals with current musculoskeletal injury were excluded from participation.

Each participant performed free throws at two distances, 4.75 m and 5.75 m. Kinematic variables, including shoulder, elbow, and wrist angles during the ball release phase, were recorded using a two-dimensional video analysis approach. A smartphone camera was positioned perpendicular to the sagittal plane to capture movement. Video recordings were analysed using Kinovea motion analysis software. Shooting accuracy was assessed using a six-point outcome-based scoring system ranging from 0 to 5 [3]. A score of 0 was assigned for a complete miss, defined as an air ball. A score of 1 was given for a shot that contacted the backboard and rebounded out of the basket. A score of 2 was awarded for a shot that contacted the rim and rebounded out. A score of 3 represented a shot that contacted the backboard and entered the basket. A score of 4 was assigned for a shot that contacted the rim and entered the basket. A score of 5 represented a clean basket without contact with the rim or backboard. Each participant completed 10 attempts at each distance, yielding a maximum possible score of 50 points per condition. Paired-samples t-tests were conducted to examine differences in kinematic variables and shooting accuracy between the two shooting distances.

III. Results and Discussion

Figure 1 demonstrates clear biomechanical adjustments in response to increased shooting distance. A statistically significant reduction in shoulder angle was observed from 126.35° at 4.75 m to 116.02° at 5.75 m (p =.029), indicating greater shoulder flexion at the longer distance.



*$p < 0.05$

Fig. 1 Comparison between two distance conditions on shooting kinematics and accuracy

This finding suggests that intermediate players relied heavily on proximal joint contribution to generate the additional force required for increased release velocity. Previous research has indicated that greater shooting distances demand enhanced segmental coordination across the kinetic chain to maintain optimal ball trajectory and velocity [1]. However, when coordination efficiency is not fully

developed, athletes may compensate through increased activation of proximal joints, particularly the shoulder complex [1][2]. Additionally, increased shooting distance has been shown to alter upper-limb coordination patterns, emphasizing shoulder involvement as a primary regulator of release mechanics [2]. These findings align with the present results, suggest that intermediate players may adopt a shoulder-dominant strategy when faced with greater mechanical demands.

In contrast, although elbow angle increased from 135.90° to 147.60° and wrist angle increased from 132.25° to 141.07°, these changes were not statistically significant (p >.05). The absence of significant distal joint adaptation may indicate limited redistribution of mechanical demand across the elbow and wrist segments. From a biomechanical perspective, efficient long-distance shooting typically requires a coordinated proximal-to-distal sequencing pattern to maximise energy transfer and movement efficiency [4]. The current findings suggest that such coordination may not yet be fully developed in intermediate-level players. Instead of redistributing force progressively across joints, participants appeared to depend primarily on shoulder-generated torque.

Interestingly, shooting accuracy did not significantly decline with increased distance (p =.302), despite the greater mechanical demand. These findings suggest that proximal compensation was adequate to preserve short-term performance outcomes. However, continued reliance on shoulder-dominant movement strategies may reduce mechanical efficiency and increase movement variability over time, particularly under fatigue. Proficient shooters demonstrate a more balanced distribution of joint contributions and controlled release mechanics, whereas less skilled players exhibit greater movement variability and stronger proximal dominance during the shooting motion [3].

Collectively, the findings highlight a developmental distinction in shooting mechanics. While intermediate players can maintain performance accuracy, their biomechanical adaptation to longer distances appears less refined compared to elite coordination models. These results reinforce the importance of technical training interventions aimed at enhancing distal joint synchronization to improve overall shooting efficiency and long-term consistency.

IV. Conclusions

Distance manipulation significantly influenced shoulder kinematics but did not significantly affect elbow angle, wrist angle, or shooting accuracy among intermediate-level basketball players. The findings indicate that intermediate athletes primarily adapt to increased shooting distance through proximal joint compensation rather than coordinated redistribution across the entire kinetic chain. This study contributes to the understanding of developmental differences in basketball shooting biomechanics and supports the practical application of low-cost two-dimensional video analysis for performance assessment in applied sports settings.

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