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Lower-Limb Kinematics During Instep Kicking Between Adolescent and College Rugby Players

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I. INTRODUCTION

Instep kicking is an important technical skill in rugby because it contributes to place kicking, clearance kicking, and territorial play. The skill requires coordinated movement of the hip, knee, and ankle to generate ball speed while maintaining kicking accuracy. Kicking performance depends on a proximal-to-distal sequence, where force is transferred from the larger proximal segments to the distal segments before ball contact. This pattern has been well described in soccer kicking biomechanics, where effective kicking involves coordinated approach, support-leg placement, hip motion, knee extension, and foot-ball contact mechanics [1]. Although soccer kicking has been widely studied, rugby kicking has received less biomechanical attention. Rugby place kicking is a sport-specific skill because the kicker must control both distance and accuracy under different match demands.

Recent rugby research has shown that lower-limb biomechanics may differ across skill levels, suggesting that technical proficiency influences how players coordinate the kicking limb during performance [2]. This issue is especially important when comparing adolescent and college players, as younger athletes may still be developing musculoskeletal strength, neuromuscular control, and movement consistency. Adolescent rugby players may show different kicking patterns from college players because of differences in growth, maturation, training exposure, and technical experience. These factors may influence joint angles, segment coordination, kicking velocity, and movement control during instep kicking. Despite this, direct comparisons of lower-limb kinematics between adolescent and college rugby players remain limited. Therefore, this study aimed to examine and compare lower-limb kinematic variables during instep kicking between adolescent and college rugby players.

II. METHODS

A quasi-experimental, between-groups design was employed. Male adolescent rugby players (14–17 years) and male college rugby players (18–21 years), all right-foot dominant and with at least one year of playing experience, participated in the study. Instep kicking trials were recorded using a fixed two-

dimensional camera positioned in the sagittal plane. Kinematic analysis was conducted using Kinovea software to measure hip, knee, and ankle joint angles at key kicking events, including stand foot contact, ball contact and follow-through. Statistical analysis was performed using Jamovi software.

Descriptive statistics (mean and standard deviation) were calculated for all variables. Data normality was assessed using the Shapiro–Wilk test ($p < 0.05$). Due to violations of normality for most variables, Mann–Whitney U tests were used for group comparisons, while one normally distributed variable was analysed using an independent-samples t -test. Effect sizes were calculated using rank-biserial correlation (r_{rb}) for non-parametric tests and Hedges' g for the t -test.

III. RESULTS AND DISCUSSION

Descriptive statistics and group comparisons for lower-limb kinematic variables are presented in Table I. Shapiro–Wilk tests indicated that most variables deviated from normal distribution in both adolescent and college groups, justifying the use of non-parametric analyses. Significant differences were observed between groups for several kinematic parameters. Significant differences were identified between adolescent and college rugby players for several lower-limb kinematic variables during instep kicking (Table I). Ball contact timing differed significantly between groups, with college players demonstrating longer ball contact durations compared to adolescents. Knee flexion angle at ball contact and ankle flexion angle at stand foot contact were also significantly different between groups. No significant difference was observed for ankle flexion angle at follow-through ($p > 0.05$).

TABLE I
LOWER LIMB KINEMATIC VARIABLES DURING INSTEP KICKING

Variable	(Mean $\pm$ SD)	
	College	Adolescents
Ball Contact (ms)	116.65 $\pm$ 80.33	24.46 $\pm$ 8.81
Knee Flexion at Ball Contact ($^{\circ}$)	152.89 $\pm$ 20.81	174.93 $\pm$ 22.51
Ankle Flexion at Stand Foot Contact ($^{\circ}$)	171.86 $\pm$ 32.49	144.68 $\pm$ 13.06
Ankle Flexion at Follow-Through ($^{\circ}$)	133.54 $\pm$ 15.31	126.18 $\pm$ 10.93

Note: Values are presented as mean $\pm$ standard deviation. Group comparisons were performed using Mann-Whitney U tests for non-normally distributed variables and an independent-samples *t*-test for one normally distributed variable.

The findings showed that college rugby players demonstrated greater knee and ankle flexion than adolescent players during instep kicking. This suggests that college players may have more developed lower-limb coordination, likely due to greater training experience, stronger neuromuscular control, and higher technical maturity. In kicking actions, the hip, knee, and ankle must work together in a coordinated sequence to transfer force from proximal to distal segments. Therefore, greater joint flexion may reflect a more effective preparation and execution pattern during the kicking movement.

Overall, the results suggest that college rugby players demonstrate more advanced lower-limb kinematic patterns during instep kicking, particularly through greater knee and ankle flexion. These findings highlight the importance of technical training that focuses on lower-limb coordination, knee control, ankle positioning, and force transfer during kicking. For adolescent players, coaches should emphasise progressive kicking drills, strength

development, and movement control to support more efficient technique development and reduce potential injury risk.

IV. CONCLUSIONS

This study showed that adolescent and college rugby players differed significantly in several lower-limb kinematic variables during instep kicking. At key kicking events, college athletes showed increased knee and ankle flexion, indicating more effective movement patterns associated with experience and physical maturity. These findings provide coaches and practitioners with biomechanical insights for improving kicking performance and reducing injury risk among younger rugby players.

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