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COMPARATIVE ANALYSIS OF LOWER LIMB NEUROMUSCULAR PERFORMANCE IN SEAM AND NON-SEAM BOWLERS USING COUNTERMOVEMENT JUMP (CMJ) METRICS

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Abstract: The capability to generate explosive power in the lower limbs is crucial for cricket players, particularly fast bowlers. This study aimed to compare the lower limb neuromuscular performance between seam bowlers and non-seam bowlers using various countermovement jump (CMJ) metrics. A total of 38 male cricket players were classified into two groups: seam bowlers (n = 17) and non-seam bowlers (n = 21). Lower limb performance variables which is eccentric and concentric duration, work, maximum velocity, flight time, power, jump height force, rate of force development and contact time, were assessed using Micro gate GYKO, Italy. The results show significant differences between seam and non-seam bowlers in flight time, jump height, concentric work, maximum velocity, and maximum power, suggesting superior neuromuscular function in seam bowlers. These findings show the importance of specific training interventions to enhance performance in cricket athletes.
Keywords: Seam bowlers, Non-seam bowlers, Countermovement jump, Lower limb performance, Cricket biomechanics

1. Introduction

Cricket is a sport that demands high levels of lower extremity strength, endurance, and power, particularly among fast bowlers. Seam bowlers rely on explosive movements to generate high-speed deliveries, whereas non-seam bowlers, including spin bowlers, wicketkeepers, and batsmen, require different movement dynamics. The capability to generate power during movements such as sprinting, jumping, and landing plays a critical role in determining athletic performance (Balsalobre-Fernández et al., 2014).

The countermovement jump (CMJ) test is widely recognized as an effective method to assess neuromuscular function in athletes. CMJ metrics, including flight time, contact time, jump height, and power output, serve as indicators of lower limb strength and explosive capacity (Taylor et al., 2012; Anicic et al., 2023; McLellan et al., 2011; Hilmersson et al., 2015; Mike et al., 2017). Previous research has established CMJ performance as an objective marker of fatigue, muscle efficiency, and training adaptation in both individual and team sports (Malone et al., 2015; Jacobson et al., 2017; Quagliarella et al., 2011; Vanezis & Lees 2005).

Despite extensive research on CMJ metrics in sports, limited studies have examined differences in neuromuscular performance between seam and non-seam bowlers. Given the unique biomechanical demands of seam bowling, it is hypothesized that seam bowlers exhibit superior CMJ performance compared to their non-seam counterparts. Therefore, this study aims to compare various CMJ metrics between seam and non-seam bowlers to determine the specific neuromuscular adaptations associated with fast bowling.

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Objectives

The primary objectives of this study are:

1. To compare the flight time, contact time, and jump height between seam and non-seam bowlers.
2. To assess differences in eccentric and concentric durations between the two groups.
3. To evaluate eccentric and concentric work in seam and non-seam bowlers.
4. To compare maximum velocity and maximum power between the groups.
5. To analyze rate of force development, maximum force, and time to maximum force to determine neuromuscular efficiency in both groups.

2. Methods

2.1 Participants

Thirty-eight male cricket players were recruited for this study and categorized into seam bowlers (n = 17) and non-seam bowlers (n = 21). Non-seam bowlers included wicketkeepers, specialist batsmen, and spin bowlers. All subjects were university-level players representing Annamalai University in intercollegiate cricket tournaments (2022–23). Informed consent was obtained before data collection.

2.2 Data Collection and Analysis

Lower limb neuromuscular performance was assessed using Micro gate GYKO, Italy, a reliable and valid instrument for CMJ measurements. The testing procedure included a warm-up, familiarization session, and standardized CMJ trials. Data were analyzed using an independent t-test in SPSS (Version 16) with $p < 0.05$ level of significance.

3. Results

Statistical analysis are presented in Table 1.

Table 1: Comparison of CMJ Metrics Between Seam and Non-Seam Bowlers

Variables	Groups	N	Mean ± Standard Deviation	*t* value	*p* value
Flight Time (s)	Seam Bowlers	17	0.5356 ± 0.03441	**2.596**	**0.049**
	Non – Seam Bowlers	21	0.4893 ± 0.04463		
Contact Time (s)	Seam Bowlers	17	1.1074 ± 0.30143	0.095	0.924
	Non – Seam Bowlers	21	1.0978 ±0.31383		
Jump Height (cm)	Seam Bowlers	17	34.7406 ± 4.29611	**2.944**	**0.010**
	Non – Seam Bowlers	21	29.5952 ± 5.43064		
Eccentric Duration (s)	Seam Bowlers	17	0.4394 ± 0.14682	-0.017	0.986
	Non – Seam Bowlers	21	0.4405 ± 0.21602		
Concentric Duration (s)	Seam Bowlers	17	0.3129 ± 0.04483	1.187	0.243
	Non – Seam Bowlers	21	0.2933 ± 0.05480		
Eccentric Work (J/kg)	Seam Bowlers	17	-2.3153 ± 0.92134	-1.376	0.177
	Non – Seam Bowlers	21	-1.9729 ± 0.60704		
Concentric Work (J/kg)	Seam Bowlers	17	8.0653 ± 0.94299	**2.259**	**0.030**
	Non – Seam Bowlers	21	7.3167 ± 1.07056		
Maximum Velocity (m/s)	Seam Bowlers	17	2.8382 ± 0.18676	**2.553**	**0.015**
	Non – Seam Bowlers	21	2.6514 ± 0.25035		
Maximum Power (w/kg)	Seam Bowlers	17	56.4194 ± 6.58553	**2.904**	**0.006**
	Non – Seam Bowlers	21	49.6781 ± 7.51071		

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Maximum Force (N/kg)	Seam Bowlers	17	23.4388 ± 1.92984	-0.443	0.660
	Non – Seam Bowlers	21	23.8148 ± 3.03016		
Rate of Force Development (N/kg/s)	Seam Bowlers	17	24.6841 ± 26.81089	-0.337	0.738
	Non – Seam Bowlers	21	27.5800 ± 25.88601		
Time to Maximum Force (s)	Seam Bowlers	17	0.1771 ± 0.08630	1.122	0.269
	Non – Seam Bowlers	21	0.1448 ± 0.08970		

Table 1 explain that,

Flight Time & Jump Height:

- Seam bowlers exhibited a significantly greater flight time (0.5356 ± 0.03441s) compared to non-seam bowlers (0.4893 ± 0.04463s), with t(36) = 2.596, p = 0.049. This suggests that seam bowlers stay airborne longer, which could be linked to better lower-limb power and jump mechanics.
- Similarly, jump height was significantly higher in seam bowlers (34.7406 ± 4.29611 cm) than in non-seam bowlers (29.5952 ± 5.43064 cm), with t(36) = 2.944, p = 0.010. This indicates that seam bowlers generate greater vertical force, likely due to the nature of their sport-specific demands.

Contact Time:

- No significant difference was observed in contact time between seam bowlers (1.1074 ± 0.30143s) and non-seam bowlers (1.0978 ± 0.31383s), with t(36) = 0.095, p = 0.924. This suggests that both groups execute the landing phase of the jump similarly, without any notable biomechanical differences in ground interaction time.

Eccentric & Concentric Duration:

- Eccentric duration showed no significant difference between seam bowlers (0.4394 ± 0.14682s) and non-seam bowlers (0.4405 ± 0.21602s), with t(36) = -0.017, p = 0.986. This indicates that both groups execute the downward phase of the CMJ with similar timing.
- Similarly, concentric duration was not significantly different between seam bowlers (0.3129 ± 0.04483s) and non-seam bowlers (0.2933 ± 0.05480s), with t(36) = 1.187, p = 0.243. This suggests that both groups require a similar time to execute the upward propulsion phase.

Eccentric & Concentric Work:

- Eccentric work, which represents energy absorption during the downward phase, did not differ significantly between seam bowlers (-2.3153 ± 0.92134 J/kg) and non-seam bowlers (-1.9729 ± 0.60704 J/kg), with t(36) = -1.376, p = 0.177. This suggests similar force absorption capabilities in both groups.
- However, concentric work was significantly greater in seam bowlers (8.0653 ± 0.94299 J/kg) compared to non-seam bowlers (7.3167 ± 1.07056 J/kg), with t(36) = 2.259, p = 0.030. This suggests that seam bowlers generate more force during the propulsion phase, which is crucial for explosive movements.

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Maximum Velocity & Power:

- Seam bowlers exhibited significantly higher maximum velocity (2.8382 ± 0.18676 m/s) than non-seam bowlers (2.6514 ± 0.25035 m/s), with t(36) = 2.553, p = 0.015. This indicates that seam bowlers achieve greater movement speed during takeoff, enhancing their overall jump performance.
- Likewise, maximum power was significantly greater in seam bowlers (56.4194 ± 6.58553 w/kg) than in non-seam bowlers (49.6781 ± 7.51071 w/kg), with t(36) = 2.904, p = 0.006. This highlights the superior explosive strength of seam bowlers.

Time to Maximum Force, Rate of Force Development & Maximum Force :

- Maximum force did not show a significant difference between seam bowlers (23.4388 ± 1.92984 N/kg) and non-seam bowlers (23.8148 ± 3.03016 N/kg), with t(36) = -0.443, p = 0.660. This suggests that peak force production capabilities are similar in both groups.
- Rate of force development (RFD), which represents how quickly force is generated, also showed no significant difference between seam bowlers (24.6841 ± 26.81089 N/kg/s) and non-seam bowlers (27.5800 ± 25.88601 N/kg/s), with t(36) = -0.337, p = 0.738. This suggests that both groups have comparable neuromuscular explosiveness.
- Time to maximum force, which measures the time required to reach peak force, was also not significantly different between seam bowlers (0.1771 ± 0.08630s) and non-seam bowlers (0.1448 ± 0.08970s), with t(36) = 1.122, p = 0.269.

4. Discussion

The results of this study suggest that seam bowlers demonstrate superior lower limb neuromuscular performance compared to non-seam bowlers. Significant differences were observed in flight time, jump height, concentric work, maximum velocity, and maximum power, indicating greater explosive strength in seam bowlers. This finding aligns with previous research suggesting that athletes involved in high-intensity, explosive activities tend to develop superior power outputs (Thomas et al., 2017).

However, contact time, eccentric duration, and force-related parameters did not differ significantly between the groups. This may indicate that both seam and non-seam bowlers engage in lower limb loading patterns, but seam bowlers exhibit more efficient force application through the stretch-shortening cycle. Research by Komi (1984) supports this observation, indicating that training adaptations in explosive sports enhance stretch-shortening cycle efficiency, leading to improved power output and performance.

5. Conclusion and Recommendations

The findings of this study demonstrate that seam bowlers possess superior lower limb neuromuscular performance in key areas such as flight time, jump height, concentric work, maximum velocity, and maximum power. These results show the importance of explosive strength and power in seam bowling, reinforcing the role of an efficient SSC in performance optimization. However, the lack of significant differences in contact time, eccentric duration, and force-related parameters suggests that both seam and non-seam bowlers share similar lower limb loading mechanics but differ in force application efficiency.

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