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Countermovement Jump Performance in Elite Senior Male Kabaddi Players: A Cross-Sectional Study

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Abstract

Objective: The aim of the study was to assess the peak power and relative peak power output between raiders and defenders in professional kabaddi players using the counter movement jump test. ***Method:*** A total of 16 professional male kabaddi players, evenly split into 8 raiders, and 8 defenders with an average kabaddi experience of 6 years (aged 22.5 ± 3.1 years, height 175.1 ± 6.3cm and weight 78.7 ± 0.5kg) participated in this study. A counter movement jump test on a force platform was performed to determine their power output values along with their whole-body composition analysis. All players have played in national, international, or pro league competitions. During their 8-week pre-season camp in September–October 2022, these athletes trained and were tested at Inspire Institute of Sport in Bellary, India. ***Results:*** The results indicated that there is no significant difference in peak power output with respect to a Kabaddi player's playing position or training age. But a significant positive correlation (p=0.039) was established between lean body mass and relative peak power output. ***Conclusion:*** The current study suggests that peak power production from the countermovement leap test may be a good way to measure explosive leg power in kabaddi athletes. Kabaddi raiders and defenders have similar vertical jump height, peak power, and relative peak power. Years of kabaddi experience did not affect countermovement jump test variables. According to the study, all kabaddi players have similar physiological demands.

Keywords: Kabaddi, Peak Power, Vertical Jump, Lean Body Mass.

INTRODUCTION

Kabaddi is a very skill-oriented yet aggressive sport that requires highly developed physical qualities such as strength, power and agility to excel at the highest level. Both aerobic and anaerobic capacities play crucial role in achievement of higher grades of performance in a kabaddi player (Pandey & Sardar, 2016). Elite players are required to swiftly alternate between offence and defence, highlighting the critical nature of optimal power output (Aggarwala *et al*., 2019). In the realm of sports science and performance analysis, understanding the physiological and biomechanical attributes that contribute to athletic success is of paramount importance (Suchomel *et al*., 2016). Among these attributes, measuring peak power holds a special place, especially in sports requiring explosive actions and rapid force generation (Suchomel *et al*., 2016; Zemkova, 2022). Higher levels of lower-body power have previously shown strong correlations with execution of skill (Waldron *et al*., 2014), and a reduction in post-match fatigue in team-sports (Johnston *et al*., 2015).

The countermovement jump (CMJ) is therefore a widely adopted technique used by Sport Science practitioners for assessing an athlete's explosive power and has found extensive use across diverse sports disciplines (Bishop *et al*., 2021; Dobbin *et al*., 2017; Philpott *et al*., 2021). Testing of CMJ has been involved in athlete assessment for decades now (Markovic *et al*., 2004; Slinde *et al*., 2008; Rago *et al*., 2018) and its applicability stems from its ability to replicate the rapid eccentric-concentric sequence of movements as seen in dynamic sports like Rugby (Lonergan *et al*., 2018), Volleyball (Sarvestan *et al*., 2018), and Basketball (Pérez- Castilla *et al*., 2021). With recent advances in exercise science and technology, more and more accurate versions of force platforms have been used to determine the lower body explosiveness of athletes (Markovic *et al*., 2004; Moir, 2008).

Nevertheless, the adaptation and interpretation of CMJ outcomes within the specific context of elite male Kabaddi players require thorough investigation. This case-control study assesses peak power using the CMJ in male Kabaddi athletes. By substantiating the relationship between explosive power and Kabaddi performance with empirical evidence, we aspire to build on the theoretical framework of physiological changes of Kabaddi athletes and improve their training and performance enhancement protocol.

METHODS

Participants

Sixteen professional male Kabaddi players (8 raiders and 8 defenders) with an average kabaddi experience of 6.1 ± 3.0 yrs of playing experience (age 22.6 ± 3.2 yrs, body mass 79.1 ± 7.9 kg, body stature 175.2 ± 6.3 cm, and BMI 25.8 ± 1.7) volunteered to take part in this study. Only athletes who were professional level Kabaddi players plying their trade in the Pro Kabaddi League in India were eligible to take part in the study. Players habitually trained six days per week, and none had a history of recent musculoskeletal injuries before participating in this study, as screened by the teams' Sport Physiotherapists. No one was taking any dietary supplements or pharmaceutical drugs that may affect performance during the study and all of them were free from illness during the study period. Verbal explanation of the experimental procedure was provided to everyone; this included the aims of the study, the possible risks associated with participation and the experimental procedures to be utilised and all questions were answered. Individuals then provided written, informed consent before participating in the study. The study was part of the general sports science provision of Haryana Steelers and all the procedures used were reviewed and approved by the local ethics committee (EC/IIS/2023/008) and conformed to the recommendations of the Declaration of Helsinki. The study was carried out during the 8-week pre-season training camp, which spanned from September to October 2022.

Procedures

Protocol: Familiarisation Session

Before taking part in the main experiment, each participant completed one familiarisation session. During the familiarisation session, participants were required to perform as many repetitions as possible until they felt comfortable performing a CMJ. This session ensured that participants were fully familiarised with the experimental condition required for the study. Following the familiarisation process, all participants then completed the experimental session.

Protocol: Testing Procedures

All sessions took place under standard testing conditions. The subjects lived a "normal life" between sessions and were told to refrain from caffeinated beverages and from other training or heavy exertion for the 48 hours before the experiments or during them. Compliance to the protocols' sleeping, food intake and exercise restrictions were assessed verbally. Upon arrival, participants first underwent their body composition analysis, after which all participants undertook a standardised warm-up led by a qualified Strength and Conditioning Coach. Once the standardised warm-up was completed, the players performed a CMJ test.

Performance Tests

Body Composition

The body composition of all athletes was determined using the Bodystat 1500MDD (Bodystat, Isle of Man, UK) device. The athletes were examined in a lying down position on an empty stomach and bladder early in the morning. Electrodes are placed on an athlete's body (two at the feet and two at the hands to complete the circuit). It works by passing a safe battery generated signal through the body and measuring the impedance at two frequencies of 5 kHz and 50 kHz. The outcomes were presented on the screen and recorded by the practitioner. This analysis aimed to assess variables like lean muscle mass and body fat percentage, providing valuable insights into the participants' physical characteristics.

Countermovement Jump Test

The CMJ (a vertical jump test) was performed to assess the explosive power of the leg musculature. The test was performed on a force platform (FDLITE-03-94485, VALD Performance, Brisbane, Queensland, Australia) connected to proprietary data acquisition and analysis software (VALD Performance, ForceDecks 2.0.7594). The equipment was calibrated according to the manufacturer guidelines. The CMJ test in force decks provides good asymmetry analysis and presents information on multiple phases has previously been reported to be both valid and reliable (Markovic *et al*., 2004). Before each session, the individuals' posture was assessed for any compensating mechanisms. All participants were given a verbal cue before being instructed to leap as high as they could on the force plates. There were no exclusions owing to improper performance or compensatory mechanisms of any kind among the sixteen athletes that were examined.

As part of machine calibration, the platforms were 'zeroed' before the test begins. Athletes were asked to assume a 'starting position' on the plates, which is to stand in an upright position with a straight torso, as still as possible, on the platform with weight evenly distributed over both feet. The weight of the athlete was recorded by selecting "measure weight" in the VALD software window. Once this was done, the athletes were asked to perform the test with hands on hips and repeat this test 3 times, with a rest period of 30 s was provided in between each jump as previously described by Komi and Bosco (1978). They were instructed to execute the jumps using the correct technique, keeping their hands

on their hips throughout the jump to minimize lateral and horizontal displacement and prevent any influence arm movements on jump performance (Ishak *et al*., 2022). Jumping height was measured as an estimate of the height change in the athlete's center of mass, taking into consideration the total duration the athlete spends in the air with no ground contact. The results of the three trials that the subjects completed were gathered. The cumulative sum of the raiders and defenders' peak power outputs were relativised to each participant's body weight and recorded following the execution of the three trials. Such tests and scores were discarded if there was any evidence of compensating mechanisms used by the participants to finish the test or if the participants did not adhere to the instructions given.

Statistical analysis

Data are presented as the median values (quartile 1 and quartile 3 values). All data were analysed using the Statistical Package for the Social Sciences (SPSS), version 26, for Windows were used. Group comparisons were conducted employing the Mann-Whitney U rank test, with the effect size quantified as eta-squared. Furthermore, correlation analyses were performed using Spearman's correlation method to investigate relationships within the data. Following convention, the alpha level of significance was set at 5% where values of $P < 0.05$ have been referred to as "significant". Values of "0.000" given by the statistics package are shown here as $P < 0.0005$ (Kinear & Gray, 1995).

RESULTS

Anthropometric Variables

Anthropometric measurements (Table 1) revealed that the players possessed a median body stature of 173.0 cm (interquartile range: 171.8 to 178.5 cm) and a median body mass of 76.9 kg (interquartile range: 73.9 to 80.9 kg). In terms of body composition, the participants exhibited a median dry lean mass of 20.7 kg (interquartile range: 19.8 to 22.4 kg), representing their muscular composition, while the median body fat percentage was 10.8 % (interquartile range: 9.3 % to 14.9 %). In the comparative analysis between raiders and defenders, no significant differences across anthropometric variables; body stature, body mass, dry lean mass, or body fat percentage were present.

CMJ Test Variables

Table 1 The players' explosive lower body strength was reflected in their vertical jump performance, with a median jump height of 31.1 cm (interquartile range: 29.59 to 34.22 cm). Additionally, the assessment of peak power, a key indicator of explosive strength, yielded a median value of 3769.5 watts (interquartile range: 3642.3 to 4312.0 watts) among the Kabaddi players. This metric provides valuable insight into the players' ability to generate rapid force during dynamic movements. Relative power, calculated as a ratio of peak power to body weight, was found to be 50.3 watts/kg (interquartile range: 45.1 to 54.7 watts/kg), offering a normalised measure of their explosive power capabilities. No significant variance was identified in terms of vertical jump performance between the raiders and defenders (U-statistic: 19, z-score: -1.313, p-value: 0.190, $\eta 2$: 0.116). Similarly, the analysis of peak power indicated no substantial divergence between raiders and defenders (U-statistic: 27, z-score: -0.473, p-value: 0.639, $\eta 2$: 0.017). Likewise, the evaluation of relative power demonstrated no significant contrast between raiders and defenders (U-statistic: 28, z-score: -0.368, p-value: 0.711, $\eta 2$: 0.011).

Table 1: Summary of anthropometric data and variables of countermovement jump test in professional players

Variable	Summary Data
Height, in cm	173.0 (171.8 to 178.5)
Weight, in kg	76.9 (73.9 to 80.9)
Vertical Jump, in cm	31.10 (29.6 to 34.2)
Peak Power, in watts	3769.5 (3642.3 to 4312.0)
Relative Power, in watts per kg	50.3 (45.1 to 54.7)
Dry lean, in kg	20.7 (19.8 to 22.4)
Body Fat, as %	10.8 (9.3 to 14.9)

Values as median (quartile1 to quartile 3).

Correlation

Peak power output exhibited a moderate positive correlation with lean body mass ($r = 0.521$, $p = 0.039$*), indicating that elite male Kabaddi players with higher lean body mass tended to display greater peak power output. Conversely, the correlation between peak power output and body fat percentage was non-significant ($r = 0.223$, $p = 0.406$), suggesting that the influence of body fat on power generation is less pronounced. Similarly, the relationship between relative peak power output and lean body mass was minimal ($r = 0.025$, $p = 0.927$), emphasizing the limited connection between these variables. The significant finding of peak power output and lean body mass has been depicted in Figure 1.

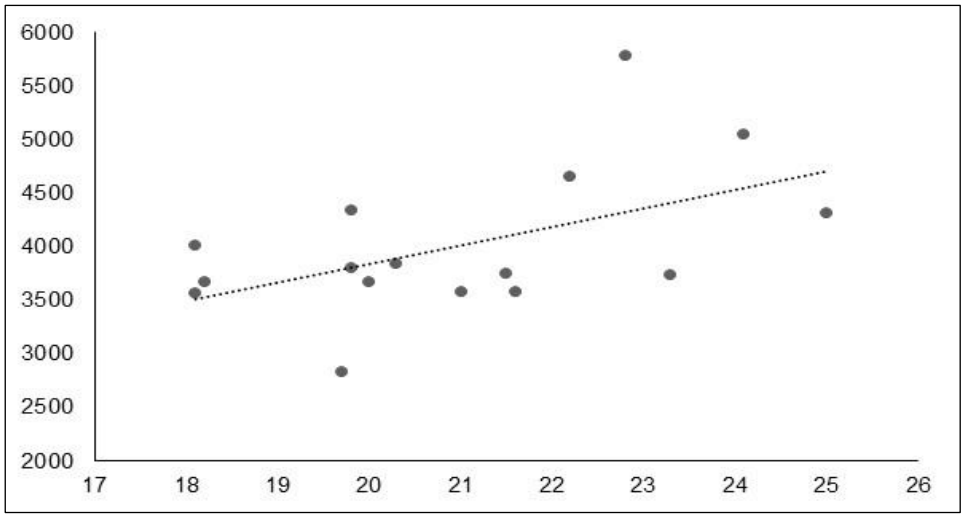

Figure 1: Correlation between Peak power output in Watts with Lean Body Mass (in kg)

DISCUSSION

In this paper, we assessed the athletic prowess of elite male Kabaddi players through the utilisation of the CMJ test. Our study showed that both the playing position and years of playing the sports did not have considerable influence on the parameters of CMJ test. A noteworthy association was established, where a correlation between lean body mass and its potential to impact peak power output.

Driven by the curiosity to explore how distinct roles impact the jumping abilities of elite male Kabaddi players, we investigated the potential influence of playing positions. Within the realm of Kabaddi, two primary roles emerge: raiders and defenders. Given the distinct demands these roles entail, we initially hypothesised that players in different positions would exhibit varying jumping capacities. However, our analysis yielded unexpected results, revealing that the specific playing positions, be it raiders or defenders, displayed no noticeable effect on CMJ test outcomes. This result finds its grounding when we consider the broader context of the Kabaddi game. Kabaddi thrives on versatility, demanding players to master various aspects of the sport, irrespective of their designated roles. Thus, when executing a powerful countermovement jump, the positions players hold within the game seem to have minimal impact on their unique motor development. These findings echo the findings observed by Chatterjee and Bandyopadhyay (2019), which highlighted the need for Kabaddi athletes to possess well-rounded skills. Similarly, Bhutia *et al*., (2020) emphasised the adaptability and proficiency required of Kabaddi players across multiple domains.

Turning our attention to the impact of experience, we sought to understand how the number of years spent playing Kabaddi might influence CMJ performance among elite male athletes. We anticipated that players with more years of experience might exhibit enhanced jumping capabilities due to their prolonged exposure to the sport's physical demands and training regimens. However, our investigation led to intriguing revelations. Surprisingly, when comparing players with more than five years of experience to those with fewer years in the sport, we found no substantial differences in countermovement jump test results. This unexpected finding indicates that the duration of playing Kabaddi may not stand as the sole determinant in the domain of explosive power. This viewpoint is mirrored in the research conducted by Bhutia *et al*., (2020), highlighting the importance of adaptability and a well-rounded approach to skill development in bolstering Kabaddi players' performance. Our study aligns with the notion that Kabaddi's multifaceted nature transcends a linear correlation between years of experience and CMJ performance. A similar interpretation was also suggested by the research of Bhutia *et al*., (2020), underscoring the significance of adaptability and a comprehensive approach to skill development in enhancing Kabaddi players' performance.

To comprehend the intricate relationship between power output and various body composition metrics, a correlation analysis was conducted. The most striking finding was the positive correlation observed between peak power output and lean body mass. This noteworthy correlation suggests that elite male Kabaddi players with higher lean body mass tend to exhibit greater peak power output during CMJ. The connection between muscular composition and peak power generation aligns with the physiological intuition that muscle mass contributes significantly to explosive strength, enabling players with more lean body mass to harness superior power during dynamic movements. Interestingly, the correlation between peak power output and body fat percentage was not statistically significant, indicating that the role of body fat in influencing power generation is less pronounced. This implies that, within the context of Kabaddi performance, body fat might have a relatively limited impact on the player's ability to produce explosive power during countermovement

jumps. This observation underscores the multifaceted nature of power generation, where lean body mass appears to exert a more dominant influence compared to body fat percentage. Additionally, the absence of significance while correlating relative peak power output and lean body mass further emphasises the limited connection between these variables. This implies that while lean body mass contributes to overall peak power output, it has a comparatively minimal role in determining the relative power output when adjusted for body weight. This finding highlights the complexity of the relationship between body composition and power output, where factors beyond lean body mass contribute to the nuances of explosive performance.

Performance testing gains its utmost relevance when it mirrors the actual movements executed by athletes in their specific sporting contexts (Currell & Jeukendrup, 2008). Scientifically, it is well-established that changes in body composition and weight can introduce variations in power development (Ackland *et al*., 2009; Ben Mansour *et al*., 2021). For example, during the off-season, athletes may experience a reduction in jump height due to disproportionate muscle loss (Agu Udemba *et al*., 2018; Sheldarski, 2011). Consequently, insights into an athlete's lean muscle mass obtained through whole-body scans become invaluable information for coaches and trainers when assessing an athlete's potential. This underscores the importance of considering the dynamic interplay between physique, power, and sport-specific performance, which ultimately guides training and conditioning strategies.

CONCLUSION

Our analysis of the relationship between body composition metrics and peak power output in elite male Kabaddi player's sheds light on the critical factors influencing explosive performance. The positive correlation between peak power output and lean body mass underscores the pivotal role of muscle mass in generating superior power during countermovement jumps. This finding aligns with the fundamental understanding that muscular strength is a cornerstone of explosive athleticism. When considering relative peak power output adjusted for body weight, our analysis demonstrated that lean body mass, while contributing significantly to overall peak power, has a comparatively minimal role in determining relative power output. This underscores the complexity of power generation in Kabaddi players, where factors beyond lean body mass, such as neuromuscular coordination and technique, contribute significantly to the nuances of explosive performance. This study emphasizes the multifaceted nature of power generation in elite male Kabaddi players, where a combination of factors, including lean body mass, body fat percentage, and technical proficiency, collectively shape an athlete's explosive performance. Understanding these intricacies is vital for coaches, trainers, and athletes seeking to optimize training regimens and enhance performance in the dynamic and demanding sport of Kabaddi.

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