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ANALYSIS OF THE RELATIONSHIP BETWEEN SELECTED BIOMOTOR ABILITIES AND ANGULAR KINEMATIC PARAMETERS ON BONOUS SKILL PERFORMANCE IN KABADDI PLAYERS

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Author's contribution: A – development of research methodology; B – data collection; C – statistical analysis; D – preparation of the manuscript

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Abstract

Aim The purpose of this study was to examine the analysis of the relationship between selected bio motor and angular kinematical variables with the performance of bonus skill among male kabaddi players (raiders).

Materials and methods. Thirty male raiders aged 18 to 25 years participated in the study. Lower extremity explosive strength was assessed using the standing broad jump test, while selected angular kinematical variables were measured using Kinovea software (version 0.9.5). The execution of the bonus skill was evaluated by expert ratings, with inter-rater reliability assessed and confirmed using Cohen's Kappa coefficient.

Results. Spearman's rank correlation analysis identified a significant association between lower extremity explosive power ($r_s = 0.119$, $p = 0.002$) and the distance between feet($r_s = 0.331$, $p = 0.009$), COG balance ($r_s = 0.291$, $p = 0.006$), angle at the leading leg ankle joint ($r_s = 0.314$, $p = 0.002$) with bonus skill performance. No significant correlations were found for the angle at the trailing leg ankle joint ($r_s = 0.010$, $p = 0.223$), angle at the leading leg knee joint ($r_s = 0.083$, $p = 0.66$), angle at the trailing leg knee joint ($r_s = 0.227$, $p = 0.328$).

Conclusions. The findings suggest that both lower extremity explosive power and the distance between feet, COG balance, angle at the leading leg ankle joint are important contributors to successful bonus skill performance in kabaddi players.

Keywords: kabaddi, raider, bonus skill, Biomotor variable, angular kinematics.

Introduction

Kabaddi, originating from the Indian subcontinent and believed to have a history spanning over 4000 years [1], is a dynamic contact sport involving two teams, each consisting of five to seven players. The game blends the elements of wrestling, judo, rugby, and gymnastics, making it unique and highly engaging. Key movements in kabaddi include catching, holding, locking, and jumping, which require agility and strength [2]. Biomechanics is the science that

explores how both internal and external forces act on the human body, and how these forces shape our movement and biomotor abilities[3]. Biomechanics plays a major role in improving performance by helping identify and correct technique errors. Motor skills can be analyzed using either qualitative or quantitative methods, with high-speed video making it possible to study fast movements in detail [4]. Kabaddi is a combative team sport widely played across India and has gained considerable prominence within the broader arena of Asian sports. The game's growing success is reflected in its elevated status and increasing recognition at both national and international levels [5]. Kabaddi demands a high level of physical fitness, as players must execute actions such as offensive pushes, quick falls, rapid turns, sudden changes in direction, holding, bending, bouncing, and both leg and hand touches all while sustaining holds and breath control. Whether playing the role of offensive or defense, kabaddi players need to possess endurance, agility, technical skill, perfected neuromuscular coordination, mental toughness, and strong presence of mind in order to succeed [6]. Kinanthropometry refers to the scientific measurement of body size and proportions, including parameters such as weight, stature, limb circumferences, skinfold thicknesses, and skeletal breadths and lengths. In contemporary sports, the selection of athletes for optimal performance often relies on assessments of body composition and overall physique [7]. Because of their many real-world uses, anthropometric and biomechanical data are highly valuable. In order to produce statistical guidelines for the design of articles and place of work, the development of apparel and equipment, the construction of furniture, and the creation of biomechanical models, it is necessary to comprehend the range in human physical characteristics. Accurate physical measurements of the human body are therefore essential to inform and improve designs that accommodate a variety of user demographics, as factors like ethnicity, sex, and age play a significant impact in determining these features [8]. Anthropometry is the scientific discipline focused on measuring various dimensions of the human body. Traditionally, it has utilized instruments such as stadiometers, weighing scales, and measuring tapes to identify and assess the size, length, and girth of different body parts, serving both physical and anthropological research purposes [9].This study found that in U18 male football players, greater lean mass and muscle are linked to better vertical jump, while higher fluid and visceral fat slow sprint times, highlighting the importance of optimal body composition for performance[10,11]. Postural balance is essential for carrying out daily activities and tasks. It refers to the capacity to keep or restore the body's center of mass within its base of support, thereby maintaining stability when challenged by external forces [12]. Kinovea is a video analysis, which is a free software application for the analysis, comparison and evaluation of sports and training, especially suitable for physical education teachers and coaches. Some advantages of this software are: observation, measurement, comparison of videos, etc[13]. The focus of this research is to assess Kinovea software's dependability in assessing athletes' drop jump performance. Kinovea 0.9.5 and Cortex 6.0.0.1645, a complete package for motion capture supervision, calibration, tracking, and post-processing, will be used for motion analysis in order to achieve this. The comparison aims to ascertain whether Kinovea can function as a reliable, user-friendly substitute for biomechanical analysis in sports practice and research [14]. With the goal to identify the technical and bio motor variables responsible for kabaddi players success in competitive play, this study investigates how important bio motor skills and joint movement angles impact bonus skill performance in kabaddi players.

Materials and Methods: Thirty male raiders selected from various affiliated college Bharathiar University, Coimbatore, Tamil Nadu India. Thirty male raiders aged 18 to 25 years participated in the study. All participants possessed prior knowledge of kabaddi and had relevant training experience in the sport. A total of eight variables comprising five bio motor abilities and three linear kinematic measures were selected for this study (as presented in Table 1). This research forms part of a PhD thesis approved by the Departmental of Physical Education, Bharathiar University (DPE, BU)[**15**]. Every kabaddi player was given full details regarding the research protocol and the main steps of the study. Regarding the biomechanics involved, no unique incentive strategies were presented. Under the direct

supervision and direction of the researchers from (DPE,BU), every participant carried out the protocol under the same conditions.

Table 1. Characteristics of participation (mean ± SD)

Group of Subjects	*No. of subject*	*Age (In years)*	*Height (In Centimeter)*	*Weight (In kilograms)*
Raiders	30	20±1.9	171±4.5	60±6.0

The ***World Medical Association (WMA) 2024*** has developed the Declaration of Helsinki as a statement of ethical principles for medical research involving human subjects, including research on identifiable human profile and data [16]. Each participation to analysis Age was measured by year, Height was measured by measuring tape and Weight was measured by electronic weight machine.

To assess bonus skill performance, raiders were directed to execute bonus raids in a simulated match atmosphere, following comprehensive warm-ups for both raiders and defenders. Each player completed five raids, with the best performance chosen for detailed analysis. All movements were captured using a Sony A73 camera recording at 240 frames per second. The camera was connected to a PC, enabling video capture via the Kinovea application. Recorded footage was subsequently edited and digital markers were placed on the kabaddi player to accurately track and measure the angular kinematic and bonus skill execution during leg movements.

Figure 1 & 2 Analysis of kabaddi playing performance

Table 2 Description of selected tools and their measuring units

S.N.	Variable	Tool	Measuring Unit
1.	Explosive power	Standing broad jump test	Centimetre
2.	Distance between feet during the execution phase of skill	Kinovea Software	Centimetre
3.	COG balance		Centimetre
4.	Angle at leading leg ankle joint		Degree
5.	Angle at trailing leg ankle joint		Degree
6.	Angle at leading leg knee joint		Degree
7.	Angle at trailing leg knee joint		Degree
8.	Bonus Skill Performance	Rating Scale	Point

Following data collection, kabaddi experts were not only introduced to the core aims of the study but also engaged as active collaborators in evaluating kabaddi players performances. Each expert, equipped with a structured rating scale [18](Table 3), viewed and scored the recorded performances bringing their national level experience and coaching (NSNIS) expertise to the process. To ensure fairness and consistency, expert agreement was checked using Cohen's Kappa statistic, which revealed strong consensus among the judges [17]. The final performance score for each kabaddi players reflected the thoughtful averaging of all expert ratings, blending their perspectives into one meaningful result.

Table 3. Explanation of Rating Scale [18]

S.NO	Comments	Score
1.	Very good	5
2.	Good	4
3.	Average	3
4.	Satisfactory	2
5.	Poor	1

Statistical Technique: Descriptive statistics, i.e., the median, inter-quartile range, was calculated. According to the nature of the data, the non-parametric test 'Spearman Rank Correlation' was employed to find out the relationship between skill performance and bio motor abilities, biomechanics variables with the help of SPSS-software version 23. The level of significance was set at 0.05 [23].

Table 4 presents the median and interquartile range (IQR) values for both skill performance scores and selected biomotor variables. The performance scores had a median of 4 with an interquartile range of 1, while lower extremity explosive power recorded a median of 210.70 and an interquartile range of 27.42. Additionally, the analysis revealed that the correlation between explosive strength and bonus skill performance was positive significant (rs = 0.11, p = 0.53), indicating meaningful relationship at the 0.01 significance level.

Table 4. The relationship of the selected bio motor variable with the performance of bonus skill

S.No	Variables	Median	IQR	'r'value	p-value (sig)
1.	Bonus skill	4	1	-	-
2.	Explosive power	210.70	27.42	0.119	0.02**

*Note: IQR= Inter Quartile Range; ** Denotes significant relationship at 0.01 level of significance*

Table 4 summarizes the median and interquartile range (IQR) values for skill performance scores and selected angular kinematic variables. The median (IQR) values for each variable are as follows: performance score 4 (1), distance between feet 102 (19.18), COG balance 40.42 (16.52), angle at the leading leg ankle joint 79.95 (10.92), angle at the trailing leg ankle joint 73.95 (14.00), angle at the leading leg knee joint 133.05 (4.97), and angle at the trailing leg knee joint 125.92 (1.72).

Correlation analysis indicated that several angular kinematic variables were positive correlation significantly associated with performance: distance between feet (rs = 0.331, p = 0.07), COG balance (rs = 0.291, p = 0.06), and angle at the leading leg ankle joint (rs = 0.314, p = 0.002). In contrast, the correlations for the angle at the trailing leg ankle joint (rs = 0.010, p = 0.223), angle at the leading leg knee joint (rs = 0.083, p = 0.66), and angle at the trailing leg knee joint (rs = 0.227, p = 0.228) were not statistically significant, indicating no meaningful relationship at the 0.01 significance level.

Table 5 The relationship of selected angular kinematical variables with the performance of bonus skill

S.No	Variables	Median	IQR	'r'value	p-value (sig)
1.	Bonus skill	4	1	-	-
2.	Distance Between Feet	102	19.18	0.331	0.07**
3.	COG Balance	40.42	16.52	0.291	0.06**
4.	Angle at leading leg ankle joint	79.95	10.92	0.314	0.002**
5.	Angle at trailing leg ankle joint	73.95	14.00	0.010	0.223
6.	Angle at leading leg knee joint	133.05	4.97	0.083	0.66
7.	Angle at trailing leg knee joint	125.95	1.72	0.227	0.228

*Note: IQR= Inter Quartile Range; ** Denotes significant relationship at 0.01 level of significance*

Discussion

The results of this study reveal that specific angular kinematics variables namely, distance between feet, COG balance, and the angle at the leading leg ankle joint show a significant and positive correlation with skill performance in kabaddi players, while other angular measures do not exhibit meaningful associations at the 0.01 level. These findings closely align with previous literature, which underscores the central roles of dynamic balance and lower limb joint alignment in sports performance [19,*22*]. The clear relationship between leading ankle angle, foot positioning, and balance highlights these factors as important contributors to effective skill execution. This evidence supports targeted training strategies focused on optimizing angular kinematic variables to enhance kabaddi skill acquisition and performance [21].

The results showed that there was no significant difference in the trailing leg ankle joint angle for bonus skill between college, state, junior national, and senior national level kabaddi raiders. Interestingly, junior national level raiders had the highest angle at both the trailing leg ankle and knee joints during bonus skill execution. This matches the findings of Alam and Peter, who also observed joint angle differences such as in the ankle when comparing skill levels or groups, like men and women, in Olympic lifting. This suggests that while some joint movements may vary with experience or group, not all differences are significant during kabaddi bonus skill actions [23].

Conclusion

This study clearly shows that kabaddi skill performance depends on more than just playing ability, but is shaped by a blend of strategic biomechanics and particular joint coordination. Specifically, factors like ideal distance between feet, dynamic centre of gravity control, and leading leg ankle angle develop as important determinants of bonus skill execution. These insights show that successful kabaddi play relies on functional movement patterns as much as physical conditioning. Integrating biomechanical awareness and targeted skill training can greatly enhance player performance, strengthening that knowledge in kabaddi is truly where science meets sport.

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