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Analysis of anthropometrical biomechanical physiological psychological and physical fitness variables among playing ability of backcourt players and wing players in handball

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Abstract

This study aimed to comprehensively analyze and predict the anthropometrical, physical, physiological, biomechanical, and psychological demands of inter-university team handball players. Our objective was to identify the most suitable playing position for each player based on their performance. We analyzed 100 backcourt players and 100 wing players during inter-university tournaments and selected various variables, including anthropometric measurements such as body weight, height, total leg length, and total arm length, biomechanical factors such as ball velocity, ball release height, ball release angle, and height take-off from the ground, physical fitness variables like speed, agility, flexibility, shoulder strength, and leg explosive strength, physiological aspects such as body fat percentage, heart rate, and vital capacity, and psychological variables such as cognitive state anxiety, somatic state anxiety, and self-confidence. To analyze the data, we employed multiple regressions with stepwise elimination. Our results showed that backcourt players had high demands for ball velocity, height, height take-off, speed, agility, shoulder strength, body fat percentage, and cognitive state anxiety. Similarly, wing players required height, total leg length, total arm length, speed, flexibility, heart rate, vital capacity, somatic state anxiety, and self-confidence. In conclusion, our study provides valuable insights into the demands of inter-university team handball players. By identifying the most suitable playing position for each player, coaches can optimize their team's performance and help players reach their full potential.

Keywords: Handball, biomechanics, motion analysis, heart rate, playing ability, physiology and psychology

Introduction

Handball, a fast-paced and skillful team sport, requires players to demonstrate agility, strength, and strategic coordination. Understanding the multifaceted nature of performance in handball, particularly at the university level, involves an in-depth analysis of various physical, psychological, and biomechanical factors that contribute to success on the court. This study explores the anthropometric, physical, physiological, and psychological determinants that influence the playing ability of university-level handball players.

The need to predict an athlete's performance has long been a focal point in sports science, allowing coaches and educators to identify potential talents and optimize training programs. This study's primary goal is to investigate the relationship between selected performance variables and playing abilities of back court and wing players in university handball, ultimately providing insights into how these variables can predict athletic potential.

The findings of this study are expected to offer valuable data to coaches, athletes, and sports scientists, supporting their efforts to enhance performance through targeted training interventions based on individual characteristics. By utilizing anthropometric measures, such as height and hand span, alongside physical fitness attributes like speed, endurance, and leg strength, as well as psychological traits, the research aims to create a comprehensive profile of successful handball players

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Methodology

Study Design: This study employs a cross-sectional design to analyze the relationship between selected anthropometric, biomechanical, physical fitness, physiological, psychological, and performance variables and their influence on the playing ability of university-level handball players. Specifically, it focuses on the playing abilities of back court and wing players. **Participants:** A total of 200 male university-level handball players (100 back court players and 100 wing players) who participated in the South Zone Inter University and All India Inter University competitions at Calicut University in 2022 were selected for this study. The participants were aged between 18 and 28 years with 5-10 years of training experience in handball. **Variables and Measurements:** Dependent variable Playing Ability. Independent Variable Biomechanical Variables (Kinovea 0.8.15 software) - ball velocity, ball release height, ball release angle, take-off height. Anthropometric Variables – height, weight, arm length and leg length (Measuring tape). Physical Fitness Variables – speed (35m Sprint Speed Test), agility (Illinois Agility Test), flexibility (Sit & Reach Test), shoulder strength (Overhead Medicine Ball Throw), leg explosive strength (Sargent Jump Test). Physiological Variables - vital capacity (spirometer), heart rate (b/m), body mass index (BMI). Psychological Variables Competitive State Anxiety Inventory-2 (CSAI-2) - cognitive state anxiety, somatic state anxiety, self-confidence.

Statistical Analysis

This study aims to predict handball playing ability from selected anthropometric, biomechanical, physical, physiological, psychological, and performance variables. Below is a comprehensive statistical approach for each objective. **Descriptive Statistics:** Summarize the data for all variables mean, standard deviation, minimum, maximum, and confidence intervals. **Normality Testing:** Apply to assess whether the data follow a normal distribution. This is crucial for determining the appropriate parametric or non-parametric tests in the subsequent analyses. **Correlation Analysis:** Pearson’s correlation analyzes correlation for both back-court and wing players separately, based on their playing positions. **Multiple Regression Analysis:** To predict handball playing ability, a multiple linear regression model should be employed. The dependent variable is the playing ability, and the independent variables are selected anthropometric, physical fitness, physiological, psychological, and performance variables. Include entre method to identify the most significant predictors.

Discussion

The findings of this study highlight the multi-faceted nature of handball performance, where success depends on a combination of biomechanical, anthropometric, physical, physiological, and psychological factors.

Table 1: Descriptive Statistics of Variables

	Profile	Variables	Back Court Players			Wing Player		
			n	Mean	SD	n	Mean	SD
1	Dependent Variable	Playing Ability	100	73.7	12.274	100	76.48	10.981
Independent Variables								
1	Biomechanical	Ball velocity	100	18.49	1.05	100	18.163	1.146
2		Ball Releasing Height	100	2.257	0.147	100	2.22	0.171
3		Ball Releasing Angle	100	31.91	3.747	100	35.34	4.662
4		Tack off Height	100	0.724	0.308	100	0.682	0.316
5	Anthropometrical	Height	100	174.22	4.396	100	173.66	6.128
6		Weight	100	69.79	9.084	100	71.87	9.149
7		Arm Length	100	71.1	2.459	100	69.24	3.629
8		Leg Length	100	94.53	6.827	100	92.58	4.699
9	Physical Fitness	Speed	100	6.014	0.091	100	5.836	0.791
10		Agility	100	16.285	1.174	100	16.872	1.231
11		Flexibility	100	22.36	3.176	100	23.28	3.99
12		Shoulder Strength	100	8.265	1.057	100	8.191	0.93
13	Physiological	Leg Strength	100	58.79	8.251	100	56.52	9.088
14		Lung Capacity	100	3.621	0.335	100	3.599	0.321
15		Heart rate	100	74.24	9.664	100	72.48	7.827
16		Body Mass Index	100	23.1	2.986	100	23.53	3.261
17	Psychological	Cognitive state Anxiety	100	18.36	5.907	100	17.97	4.91
18		Somatic state Anxiety	100	17.66	4.744	100	19.19	3.978
19		Self-confidence	100	27.91	5.259	100	29.12	4.404

Table 2: Multiple Regression Values Playing Ability and Selected Independent Variables

Model	R	R Square	Adjusted R Square	Std. Error
Back Court Player	0.955a	0.959	0.942	2.39138
Wing Player	0.915a	0.919	0.902	3.96412

Table 3: ANOVA for Back court Players and Wing Players

Model		Sum of Squares	df	Mean Square	F	Sig.
Back Court Player	Regression	11332.87	19	596.467	13.321	0.000b
	Residual	3582.13	80	44.77		
	Total	14915	99			
Wing Player	Regression	9380.998	19	493.737	15.442	0.000b
	Residual	2557.962	80	31.975		
	Total	11938.96	99			

Table 4: Regression Analysis of Prediction Equation of Back Court Players and Wing Player on Playing Ability

Model	Variables	Back court Player			Wing Player					
		B	SE	t	Sig.	B	SE	t	Sig.	
	(Constant)		-42.637				44.842			
1	Height	0.081	0.196	2.499	0.034	-0.214	0.454	-2.471	0.007	
2	Weight	0.128	2.812	0.05	0.196	-1.214	1.454	-1.471	0.639	
3	Leg Length	0.092	1.961	2.499	0.143	-1.158	1.116	-1.365	0.176	
4	Arm Length	-0.114	1.136	-0.271	0.87	0.077	0.169	1.457	0.006	
5	Ball Velocity	0.18	0.43	2.091	0.00	2.631	0.689	1.732	0.005	
6	Ball Release Height	-0.178	0.707	-2.139	0.00	-3.844	2.055	-1.958	0.341	
7	Ball Releasing Angle	-0.295	0.992	-2.886	0.744	0.119	0.046	2.562	0.019	
8	Tack off Height	0.002	0.12	2.436	0.057	2.377	1.777	1.104	0.273	
9	Speed	-0.078	1.173	-3.103	0.01	-0.647	0.539	-1.91	0.022	
10	Agility	-0.012	0.71	-1.264	0.00	-0.711	0.755	-2.589	0.01	
11	Flexibility	2.615	1.044	2.257	0.194	0.5	0.319	1.57	0.012	
12	Shoulder Strength	1.035	1.179	2.581	0.012	-0.581	0.268	-1.458	0.058	
13	Leg Strength	-1.148	0.413	-1.859	0.567	-0.117	0.103	-1.143	0.257	
14	Heart Rate	-0.128	0.092	-1.128	0.019	-0.128	1.612	-3.576	0.00	
15	Body Fat Percentage	0.076	2.764	1.933	0.157	-1.928	1.612	-2.576	0.566	
16	Lung Capacity	-0.047	0.001	-1.501	0.005	1.044	0.001	2.988	0.024	
17	Cognitive State Anxiety	-0.374	0.151	-2.503	0.014	-0.434	0.212	-2.043	0.057	
18	Somatic state Anxiety	0.124	1.174	1.285	0.202	1.339	1.263	1.292	0.20	
19	Self-confidence	0.173	0.164	1.33	0.002	1.315	0.205	1.535	0.00	

Biomechanical Aspects

The role of ball velocity and release height is particularly vital in maximizing scoring potential, especially for backcourt players. The correlation between takeoff height and performance for wing players underscores the importance of jumping ability in high-pressure shot scenarios. Anthropometric and Physical Fitness: The relationship between anthropometric characteristics like height and arm length suggests that taller players have a natural advantage, particularly in blocking and shooting over defenders. Wing players' reliance on speed and agility aligns with their need for quick breaks and defensive recovery. Physiological and Psychological Factors: Physiological endurance, as measured by heart rate and vital capacity, is crucial for sustaining performance across a full game. Players with higher cardiovascular endurance performed better in extended games. Furthermore, psychological resilience, particularly high self-confidence, was a defining trait of top-performing players, indicating that mental preparedness is just as important as physical conditioning.

Conclusion

The most effective way to assess the predictive playing ability of handball backcourt players is by using physical measurements such as height. - The most effective way to assess the predictive playing ability of handball wing players is by using physical measurements such as height and arm length. - The most effective way to assess the predictive playing ability of handball backcourt players is by using biomechanical measurements such as ball velocity, ball release height, and tack height. - The most effective way to assess the predictive playing ability of handball wing players is by using biomechanical measurements such as ball velocity and ball release angle. - The most effective way to assess the predictive playing ability of handball backcourt players is by using physical fitness measurements such as speed, agility, and shoulder strength. - The most effective way to assess the predictive playing ability of handball wing players is by using physical fitness measurements such as speed, agility, flexibility, and shoulder strength. - The most effective way to assess the predictive playing ability of handball backcourt players is by using physiological measurements such as heart rate and lung capacity. - The most effective way to assess the predictive playing ability of handball wing players is by using physiological measurements such as heart rate and lung

capacity. - The most effective way to assess the predictive playing ability of handball backcourt players is by using psychological measurements such as cognitive state anxiety and self-confidence. - The most effective way to assess the predictive playing ability of handball wing players is by using psychological measurements such as cognitive state anxiety and self-confidence.

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