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The Factorial Structure of Some Physiological Measurements as an Indicator for Selecting Judo Players in the Kingdom of Saudi Arabia

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Abstract: Objectives: The general objective of this study is to use the factorial structure of some physiological measurements as an indicator for selecting judo players. **Methodology**: The study employed a descriptive survey method, with a research sample size of 30 young judo players representing clubs (Youth, Ahad, and Ansar). To achieve the study's objectives, the researcher relied on some functional measurements, including heart rate, vital capacity, blood pressure (systolic and diastolic), cardiac output, stroke volume, VO2max, neuromuscular compatibility, emotional stability, and reaction time. The measurements were taken in September 2021 at the Exercise Physiology Laboratory in the Department of Physical Education and Sports Sciences and on outdoor courts at Taibah University.

Results: The study's results indicated the emergence of three factors in the physiological measurements specific to judo players, which can be used as indicators for selecting judo players, namely heart rate, cardiac output, and systolic blood pressure. **Recommendations:** The study recommended the importance of focusing on the physiological determinants specific to judo players that were extracted from the study's results. These factors can serve as a scientific basis for selecting judo players in the Kingdom of Saudi Arabia and in organizing and directing training programs for judo players.

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1. Introduction

Our contemporary world has witnessed significant developments across various domains of life. This is evident in the evolution of international and global sports competitions, including the Olympic Games. With the remarkable progress seen in the levels of athletic achievement, it has become crucial to discover the characteristics and requirements of performance in various sports activities to attain high and advanced levels (Omaira, 2009).

Numerous scientific research studies in the field of sports have focused on identifying the specific specifications required by various sports activities and the conditions that athletes must meet to align with the type and nature of the sport they practice. Additionally, scientific-based selection has become imperative in achieving championships and athletic excellence (Londers et al., 2000; Sharaf et al., 2011; El Kiki and Masoud, 2015).

Many scientific studies emphasize that the selection process primarily relies on physical, physiological, physical, kinetic, and emotional specifications and requirements that athletes must possess. It is essential to pinpoint the precise specifications necessary for individuals to excel in their respective sports activities (Abdel-Fattah and Hassanein, 1997; Abdel-Khalek, 2005).

The selection process is predictive and is built on the guidance of various physical, physiological, and morphological measures, as well as indicators of physical fitness and physiological efficiency, reflecting the type of body pattern. These factors interact within predictive equations that can be consulted for the selection of emerging athletes in some Olympic combat sports, potentially achieving the principle of human effort economics in the sports field (Abada, 2004; Abdel-Fattah, 2003; Londers et al., 2000).

Physiological measurements are crucial factors in the selection process and reaching international athletic levels. They serve as important indicators of an athlete's condition and their capabilities and functional potential, enabling them to engage in sports activities with high efficiency.

Selection is a predictive process based on guidance from various capacities and attributes, including physiological measurements and indicators of kinetic and skill levels for athletes at championship, international, and Olympic levels. These factors interact in predictive equations that can be consulted in selecting emerging athletes in certain Olympic combat sports, potentially achieving the principle of human effort economics in the sports field (Abdel-Fattah, 2003; Londers et al., 2000).

Problem Statement

Judo is a sport that requires specific attributes in each player that may not be present in others. These attributes enable them to fulfill the required duties during various situations encountered in competitions. Judo has matured and advanced due to the efforts of experts who have studied and addressed its various challenges scientifically, aiming to enhance the level of athletes. To achieve success in judo and secure championships, judo players must possess numerous functional capabilities that enable them to perform their duties distinctly and effectively.

When selecting talented individuals in judo, it is essential to consider two crucial aspects: physiological and morphological. These determinants play a fundamental role in selecting talented individuals. Moreover, training an athlete who lacks an appropriate body and functional build for judo is a waste of time and effort (Hegazy, 2006).

The rules of judo grant the player the right to use all parts of their body in dealing with their opponent. Thus, the player can possess several functional specifications that enable them to engage in defensive and offensive operations. These specifications should distinguish them from other competitors, serving as selection determinants that must be present in outstanding judo players. They contribute to predicting the level that can be achieved and the possibility of a judo player continuing to play the game at a high level of competence. Through factor analysis of selected physiological measurements, some factors can be extracted and used as selection determinants for judo players.

Importance of the Study

The scientific and practical significance of this study lies in identifying the key physiological measurements specific to judo players, which are crucial requirements when selecting young talents in the sport of judo. These measurements can be integrated into training objectives to enhance training effectiveness and achieve success. These considerations motivated the researcher to conduct this study.

Study Objective

The general objective of this study is to identify the factorial structure of some physiological measurements specific to judo players, aiming to establish them as selection indicators.

Research Question

What are the physiological measurements that should be present in a judo player as selection indicators?

Study Fields

Human domain.

Judo players in the youth category representing clubs such as Ahad, Ansar, and Shabab

Temporal Scope

The study's measurements were conducted from September 15, 2021, to September 25, 2021.

Spatial Scope

The measurements were taken in the Exercise Physiology Laboratory at the Department of Physical Education and Sports Sciences and on outdoor sports fields at Taibah University.

Study Terminology

Factorial Structure

Factorial analysis is a statistical method that represents a large number of sports processes and operations in the analysis of correlations between variables. It then interprets these correlations and reduces them to the smallest number of variables called factors" (El-Sayed, 2008).

Physiological Measurements

These measurements express the functions of human body organs and are used to determine the functional competence of judo players (Operational definition).

Sports Selection

It is the process of selecting the best elements who have the potential to engage in a specific activity. It involves discovering motor skills and physiological characteristics that distinguish each individual. They are then directed towards a specific type of sports activity that aligns with their distinctive traits, aiming for success and achieving the desired levels (Hussein, 2002).

2. Study Methodology and Procedures

Study Methodology

The researcher employed a descriptive approach with a survey method, which aligns with the nature of the study.

Study Population

The study's population consists of judo players registered with the Saudi Judo Federation, with a total of 1,278 players across various age categories.

Study Sample

The study sample size was 30 judo players representing clubs like Ahad, Ansar, and Shabab in the youth category.

Study Variables
Independent Variable: Factorial Structure
Dependent Variable: Physiological measurements of judo players

Tools and Equipment Used:

1. Stadiometer (for measuring height).
2. Calibrated medical scale (for measuring weight).
3. Electronic blood pressure measurement device.
4. Medical stethoscope for heart rate measurement.
5. Dry spirometer for measuring vital capacity.

The measurements used in the study

In light of the theoretical study and in accordance with the study's objectives, and referencing the available scientific studies and literature on physiological measurements, the researcher identified the following measurements, considering the following studies: Londers et al. (2000) study, Shuraf et al., (2011) study, and Hassan's (2020) study.

- Suitability of measurements and tests for the players under study.
- Ease of conducting and implementing measurements and tests.

Physiological Measurements Utilized in the Study: Appendix (1)

• Heart Rate Measurement: Medical stethoscope
• Vital Capacity Measurement: Using the dry spirometer.
• Blood Pressure Measurement (Systolic and Diastolic): Using a blood pressure measurement device.
• Stroke Volume Measurement.
Formula: Stroke Volume (SV) = 100 + 0.5 (Pulse Pressure, mmHg) - 0.6 (Diastolic Blood Pressure, mmHg) - (0.6 × Age in years).
• Cardiac Output.
Formula: Cardiac Output = Stroke Volume × Heart Rate.
• Cardiac Index.
Formula: Cardiac Index = Cardiac Output (in liters) ÷ Body Surface Area.
• Measurement of Maximal Oxygen Consumption (VO2max): Cooper Test.
VO2max = (22.351 × kilometers) – 11.288 (Hassanein, 2015; Foss & Keteyian, 1995).
• Measurement of Neuromuscular Compatibility: (Hassanein, 2004).
• Measurement of Emotional Stability: A hand stability measurement device was used for measuring emotional stability (Taha, 2002).
• Measurement of Reaction Time: (Hassanein, 2004).

Normalization of Measurement Distributions

To ensure that the sample is free from non-normal distribution flaws, the researcher calculated the mean, standard deviation, skewness, and kurtosis for the variables under study. The results are presented in Table 1 below:

Table 1: Mean, Standard Deviation, Skewness, and Kurtosis Values for the Study Sample in Physiological Measurements of Judo Players (n = 30)

Physiological Measurement	Unit	Mean	Standard Deviation	Skewness	Kurtosis
Heart Rate	bpm	73.27	4.36	0.51	-0.04
Vital Capacity	mL	4447.07	237.54	-0.60	0.55
Systolic Blood Pressure	mmHg	118.50	5.28	0.09	-0.58
Diastolic Blood Pressure	mmHg	74.87	5.20	0.27	-0.85
Stroke Volume	mL	65.80	5.77	-0.35	-0.52
Cardiac Output	L/min	4.81	0.44	0.54	0.03
Cardiac Index	L/min/m²	2.74	0.37	0.77	1.07
VO2max	L/kg/min	38.78	4.32	-0.12	-0.71
Neuromuscular Compatibility	Degree	15.70	1.64	0.12	-0.36
Emotional Stability	Times	4.20	1.49	1.23	2.45
Reaction Time	cm	12.70	0.59	-0.47	0.15

The table (2) shows that the physiological measurements of the study sample follow a normal distribution, with the skewness coefficient ranging between (1.23 and -0.60); that is, not exceeding (±3). This directly indicates that the sample represents a normally distributed population, indicating the absence of non-normal distribution defects in the sample.

The primary study

The primary study was conducted on the study sample from September 15, 2021, to September 25, 2021, at the Physiology of Physical Activity Laboratory and the outdoor sports facilities of Taibah University.

Statistical Methods

The researcher employed several statistical procedures using SPSS 20 (Statistical Package for the Social Sciences) software to achieve the study's objectives. These methods included:

- Mean (Arithmetic Mean).
- Standard Deviation.
- Skewness.
- Kurtosis.
- Factor Analysis.

Study Question

What are the physiological measurements that should be present in a judo player as selection indicators?

Presentation and Discussion of Results

Factor Analysis of physiological Measurements

Table (3) demonstrates that the exploratory factor analysis, after rotation, of the functional indicator matrix for judo players resulted in the extraction of four factors. Factor (four) was excluded due to having fewer than three variables. The percentage of variance explained by the first factor was 27.980%, the second factor 22.392%, the third factor 17.538%, and the fourth factor 10.878%.

Table (4) reveals that the analysis of physiological measurements for judo players yielded three fundamental factors. Heart rate measurement ranked first with a saturation degree of 0.949, followed by heart thrust in second place with a saturation degree of 0.945, and systolic blood pressure in third place with a saturation degree of 0.834.

Discussion of the results of the factorial analysis of physiological measurements.

After reaching the intercorrelation matrix, factor analysis was conducted with the aim of interpreting these incident correlations between measurements in the light of the minimum possible number of extracted factors. These factors are considered descriptive names given to a group of tests or variables with high correlations, which are assumed to reflect common characteristics.

The Principal Components method, as proposed by Hotelling, was used in the analysis of the factor matrix of the study variables. This method was chosen to distinguish it from other factor analysis methods in that it extracts the maximum variance of the correlation matrix, as explained by (Farg, Safwat, 1985).

The Kaiser-Gutman criterion, suggested by Gutman for determining acceptable factors, was used. This criterion accepts factors whose eigenvalue is greater than one, considering that the expected number of factors is directly related to the number of tests used, according to the following equation:

Where r = Number of factors.

n = Number of tests.

Orthogonal Rotation

Orthogonal rotation is a process of rotating axes that leads to a simpler and more regular shape of the extracted factors. This facilitates the interpretation of factors according to the appropriate reference framework to obtain the closest solutions to the Simple Factorial Structure. Then, the extracted factors are orthogonally rotated using the Varimax Rotation method.

It is evident from the researcher's readily available reference framework that orthogonal rotation is one of the most commonly used rotation methods in research and factorial studies in the field of physical education. Here, Farg and Safwat (1985) indicate that orthogonal rotation is performed while maintaining a 90-degree angle between the axes. Since the sine of a right angle is zero, this means that there is a zero relationship between any two orthogonal factors. This implies that the factors extracted through this rotation method are independent and non-interrelated. Table 3 illustrates the factor matrices after orthogonal rotation using the Varimax Rotation method for the research sample, with variable loadings on the extracted factors totaling three factors.

Table (2): Presents the intercorrelation matrix among the physiological measurements of the investigated sample.

Variable	Heart Rate	Vital Capacity	Systolic Blood Pressure	Diastolic Blood Pressure	Stroke Volume	Cardiac Output	Cardiac Index	Maximum Oxygen Consumption (VO2max)	Emotional Stability	Reaction Time	Muscular-Neural Compatibility
Heart Rate	1.00										
Vital Capacity	0.09	1.00									
Systolic Blood Pressure	-0.15	0.48	1.00								
Diastolic Blood Pressure	0.28	0.14	0.36	1.00							
Stroke Volume	-0.32	-0.01	0.06	-0.85	1.00						
Cardiac Output	0.35	0.04	-0.04	-0.66	0.77	1.00					
Cardiac Index	0.54	0.06	-0.10	-0.40	0.46	0.81	1.00				
Maximum Oxygen Consumption (VO2max)	-0.72	-0.24	-0.12	-0.34	0.39	-0.10	-0.19	1.00			
Emotional Stability	-0.23	0.03	0.09	-0.23	0.38	0.23	-0.05	0.31	1.00		
Reaction Time	-0.20	0.02	0.02	-0.11	0.05	-0.08	0.07	0.22	-0.14	1.00	
Muscular-Neural Compatibility	-0.15	-0.41	-0.36	-0.24	0.19	0.10	-0.07	0.17	0.19	0.07	1.00

Table (3) Factor Matrix and Saturation Values after Rotation for Physiological Measurements of Judo Players: Final results of orthogonal rotation after removing saturations less than (± 0.35).

Factor arrangement	**measurement**	**The factors after rotation**				**Frequencies of occurrence**
		1	**2**	**3**	**4**	
VAR00006	Cardiac payment	0.945	-0.238		0.143	0.95
VAR00005	Stroke volume	0.881	0.402		0.123	0.84
VAR00004	Diastolic blood pressure	-0.813	-0.321	0.280		0.97
VAR00007	Cardiac coefficient	0.790	-0.469		-0.163	0.91
VAR00001	Heart rate	0.108	-0.949			0.75
VAR00008	Maximum oxygen consumption (VO2max).	0.115	0.837	-0.190		0.87
VAR00003	Systolic blood pressure		0.132	0.834	0.112	0.73
VAR00002	Vital capacity			0.810		0.67
VAR00011	Reaction time	0.105	0.200	-0.675	0.136	0.53
VAR00010	Emotional stability		0.293		-0.820	0.77
VAR00009	Neuromuscular coordination	0.262	0.412		0.651	0.67
Intrinsic value		3.078	2.463	1.929	1.197	8.68
Explained variance ratio (Factor importance ratio)		27.980	22.392	17.538	10.878	
Accumulated variance ratio (Cumulative variance ratio)		27.980	50.371	67.909	78.787	

Table (4) presents the final factors extracted through factor analysis using orthogonal rotation of the Physiological measurements for judo players.

The factor ranking	**Indicator name**	**The factor loadings**
The first	Heart rate	0.949
The second	Heart thrust	0.945
The third	Systolic blood pressure	0.834

Interpreting factors and determining physiological measurements

The researcher relied on the interpretation of factors derived through orthogonal rotation and accepted three factors. Table 3 illustrates these factors in the order of their appearance in the factor matrix. Table 4, which pertains to the final saturations of the research sample, reveals that the first factor, heart rate, achieved a saturation rate of 0.949 out of the total selected research variables. The second factor, cardiac output, achieved a saturation rate of 0.945, and the third factor, systolic blood pressure, achieved a saturation rate of 0.834 out of the total variables. From this study, it is evident that the measurements with the highest saturations on the factors will serve as indicators for the selection process from a functional perspective of the study sample. In other words, the functional measurements used as selection indicators contain the most significant implications, comprising a number of extracted factors. This implies that each factor is represented by a single test, with the one having the highest saturation, as shown in Table 4.

Based on this, the selected units for each functional measurement are derived from this study and are considered pure units, as their saturations on the other factors are not essential.

From the foregoing interpretation of the three factors and based on the functional measurements of judo players and the extraction of each variable from each factor, which is the one with the highest saturation among the variables, the acceptable factors that this study revealed are three factors, as shown in Table 3. These factors include heart rate, cardiac output, and systolic blood pressure. These results are attributed to the type and nature of the function specific to the study sample, in line with various scientific studies in general sports and judo in particular. Key studies that emphasize the importance of the measurements obtained, such as Londers et al. (2000), Hussein (2001), Ismail (2010), El Kiki and Masoud (2015) in various sports, and Shoraf et al. (2011), Hamouda (2018) in judo.

This aligns with the findings of Al-Beik et al. (2002) and Christopher (1995), who agree that physiological measurements have a direct impact on sports performance, as there is a clear relationship between the structural aspect, represented by body composition and structure, and the functional aspect, represented by performance.

Through the presentation and discussion of the study, it becomes evident to the researcher the importance of functional measurements for judo players as one of the essential determinants that can be used in selection processes. Additionally, they serve as a significant indicator of motor and functional capabilities, especially the measurements extracted from the study and the three factors (heart rate, cardiac output, and systolic blood pressure) as important selection determinants. These determinants can distinguish emerging talents during selection processes, in addition to standardizing training loads.

Conclusions

Through the factorial analysis of the data in this study, within the scope of its objectives, the procedures followed, and the results yielded by the statistical data processing, it was possible to infer the acceptance of three fundamental factors in the Physiological measurements of judo players:

- Heart rate.
- Cardiac output.
- Systolic blood pressure.

Secondly: Recommendations

In light of the conclusions reached in the study, the researcher recommends the following:

The necessity of paying attention to the specific physiological determinants when selecting judo players, which were extracted from the study's results, namely heart rate, cardiac output, and systolic blood pressure. These determinants can serve as a scientific basis for:

- Selecting judo players in the Kingdom of Saudi Arabia.
- Assessing the training situation and physical condition of the players.
- Organizing and directing specialized training programs for judo players.

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Attachments

Attachment (1)

Physiological Measurements

Emotional Stability Measurement

The hand stability measuring device is used to measure emotional stability.

Test Procedure Steps

1- The player holds the plastic handle (sensor) from its end, directing the metal tooth towards the first hole (the widest one).

2- The player inserts the tooth into the hole upon the lab technician's call (start), and attempts to stabilize it in the center of the hole, avoiding touching the sides, for a duration of 10 seconds.

3- After the 10-second period and upon the lab technician's call (stop), the player removes the metal tooth from the hole.

4- The player repeats the previous steps for each of the five holes in accordance with their width order, then the counter reading is taken to record the total touches made during the measurement. The fewer touches recorded, the more emotionally stable the player is considered.

Reaction Time Measurement

The ruler test is used to measure reaction time.

Tools

A ruler marked so that a line is drawn in black between the numbers 12 and 13 cm; a suitable-height table.

Test Procedure Steps

1- The lab technician sits on the chair, placing the arm to be tested in a comfortable position on the table, with the thumb facing the index finger, and the hand protruding from the table by (3 - 4) inches.

2- The lab technician holds the ruler at the top and positions it vertically on the table so that it passes through the thumb and index finger of the lab technician, noting that the lower edge of the ruler faces the lab technician's thumb and index finger.

3- The lab technician releases the ruler to drop vertically, attempting to grasp it with the thumb and index finger at the area coated with black paint, if possible.

4- If the lab technician succeeds in grasping the ruler with the thumb and index finger precisely at the black-painted line, their response is considered correct.

5- If the lab technician grasps the ruler before the black-painted area, their response is faster than the normal average, and the distance between the black area and the lab technician's grasp of the ruler indicates the extent of the individual's response speed exceeding the required normal level.

6- If the lab technician grasps the ruler after the black-painted area, their response is slower than the average, and the distance between the black area and the lab technician's grasp of the ruler expresses the extent of their response slowness below the required normal level.

Neuromuscular Compatibility Measurement

The tennis ball throw test against the wall is performed to assess neuromuscular compatibility.

Tools

(Tennis ball and wall). A line is drawn on the ground at a distance of five meters from the wall.

Test Procedure Steps

1- The subject stands in front of the wall and behind the line drawn on the ground, where the test is conducted according to the following sequence:

2- The tennis ball is thrown five times consecutively with the right hand, with the subject receiving the ball after it rebounds from the wall with the same hand.

3- The tennis ball is thrown five times consecutively with the left hand, with the subject receiving the ball after it rebounds from the wall with the same hand.

4- The tennis ball is thrown five times consecutively with the right hand, with the subject receiving the ball after it rebounds from the wall with the left hand.

5- The tennis ball is thrown five times consecutively with the left hand, with the subject receiving the ball after it rebounds from the wall with the right hand.

6- For each correct attempt, a score is calculated for the subject; thus, the final score is out of 20 points.

Measurement of the maximum oxygen consumption VO2max
Cooper Test
Execution Method

The individual runs (with the option of alternating running and walking if necessary) for a duration of twelve minutes, and the maximum oxygen consumption can be calculated using the following equation:

$$VO_{2max} = (22.351 \times kilometers) – 11.288$$

$$VO_{2max} = (35.97 \times miles) – 11.29$$

Age Level				**Health Condition**
Less than 30 years	**39-30 years**	**40-49 years**	**50 years and above**	
Less than 1 mile	Less than 0.95 mile	Less than 0.85 mile	Less than 0.80 mile	Sick
1.24-1 miles	1.14-0.95 miles	0.85-1.04 miles	0.80-0.99 miles	Weak
1.25-1.49 miles	1.39-1.15 miles	1.05-1.29 miles	1.0-1.24 miles	Medium
1.50-1.74 miles	1.40-1.64 miles	1.30-1.54 miles	1.25-1.49 miles	Good
1.7 miles and above	1.65 miles and above	1.55 miles and above	1.50 miles and above	Excellent

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