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The Relationship of Selected Anthropometric Measurements and Motor Abilities in Learning the Scoring Skill in Futsal for Female Students

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Abstract

Background: Anthropometric measurements and motor abilities play a fundamental role in learning sports skills, including futsal. Elite female players possess distinct physical characteristics such as higher VO2max and greater muscle mass (Barreira et al., 2025). Objectives: This study aimed to identify the relationship between selected anthropometric measurements (total height, leg length, body mass), motor abilities (agility, flexibility, eye-foot coordination), and the dribbling and scoring skill in futsal for female students. Methods: The descriptive correlational approach was adopted with a sample of 12 female students from the College of Physical Education and Sports Sciences, University of Babylon (mean age 20±0.5 years). Measurements included total height, leg length, body mass, agility (20m slalom), flexibility (trunk extension), eye-foot coordination (numbered circles), and scoring skill from 10 meters. Pearson correlation and regression analysis were employed. Results: Significant positive correlations were found between scoring skill and all variables: body mass ($r=0.897$, $p<0.001$), eye-foot coordination ($r=0.822$, $p<0.001$), flexibility ($r=0.788$, $p<0.01$), leg length ($r=0.783$, $p<0.01$), total height ($r=0.772$, $p<0.01$), and agility ($r=0.752$, $p<0.01$). The studied variables collectively explained 84.3% of the variance in scoring performance ($R^2=0.843$, $F=8.94$, $p<0.001$). Conclusions: Anthropometric measurements and motor abilities are significantly correlated with learning the dribbling and scoring skill in futsal for female students. Body mass and eye-foot coordination showed the strongest relationships. The study recommends integrating these factors in player selection and adopting AI-powered digital methodologies in training programs.

Keywords: Anthropometric Measurements, Motor Abilities, Scoring Skill, Futsal, Artificial Intelligence in Sports.

1. Introduction

The current era is witnessing rapid development in modern technologies, along with remarkable progress in knowledge and sciences of all kinds, which has formed a strong motivation for advancing various scientific and sporting fields. Within this context, significant interest emerges in the study of sports, where body structure plays a major role in athletic performance, in addition to indicators such as body circumferences, height, and weight (Thaer Dawood Salman, 1989). Futsal is witnessing increasing attention at both global and academic levels, especially with the organization of the first Women's World Cup by FIFA. Recent studies have indicated that this sport imposes high physiological demands on female players, with elite players possessing distinct physical characteristics including higher VO2max, greater muscle mass, and lower body fat percentage compared to their lower−level counterparts (Barreira, da Silva Junior, & de Souza, 2025). Furthermore, precise anthropometric indicators such as the second−to−fourth digit ratio (2D:4D) may be an important factor in determining potential performance traits and talent identification among elite female futsal players (Farhani, Arazi, Mirzaei, Nobari, Mainer−Pardos, Chamari, Baker, Pérez−Gómez, & Chamari, 2022).

Futsal requires a unique combination of motor abilities, as performance is characterized by rapid changes in direction and speed, and explosive movements such as shooting. While some studies have found that generic motor abilities and anthropometric measurements may not be valid predictors of futsal−specific agility performance in professional players (Sekulic, Zeljko, Pehar, Corluka, Versic, Pocek, Drid, & Modric, 2022), other research has shown that lower limb strength and motor functions are distinguishing factors for competitive level, as elite players show the best values in these variables (Belo, Valente−dos−Santos, Pereira, Duarte−Mendes, Gamonales, & Paulo, 2024). Leg length is considered one of the most important indicators associated with the scoring skill, as the leg acts as a lever during kicking, and longer levers can generate greater torque (Ari, 2020). Similarly, the relationship between body mass and scoring is significantly influenced by body composition, with functional muscle mass being more important than absolute weight (Belo et al., 2024).

Regarding motor abilities, agility is considered one of the most important elements contributing to scoring accuracy in futsal, allowing players to control the ball during turning and dribbling before executing the shot. Motor flexibility also helps increase the range of motion of joints, allowing players to move their legs more freely and powerfully when shooting, while also serving as a protective factor against injuries. Neuromuscular coordination between the eye and feet is the foundation of all basic skills in football, enabling players to accurately track the ball while dribbling and execute precise motor commands. Futsal-specific performance tests measuring skills such as dribbling, passing, and shooting possess high reliability and can distinguish between players of different levels (Farhani et al., 2022). The sports education sector is witnessing a qualitative transformation thanks to modern technologies and artificial intelligence, with researchers emphasizing the importance of adopting digital methodology in physical education (Ghazi, 2023). Developing curricula in the age of AI requires smart educational systems capable of analyzing performance and providing personalized feedback (Odeh, Shabib, Ghazi, & Mohammed, 2024; Lazem, Ghazi, & Mohammed, 2024).

The problem facing this research area has crystallized in the lack of sufficient focus by coaches on the importance of anthropometric measurements and their relationship to the dribbling and scoring skill, particularly among female students. The scarcity of studies linking these variables in the context of university education highlights the need for scientific research that provides applied solutions. The significance of this study lies in its examination of the relationship between anthropometric measurements, motor abilities, and the skill of dribbling and scoring in futsal for female students, aiming to connect theoretical frameworks with practical application. The research aims to identify the level of selected anthropometric measurements and motor abilities, and to reveal their relationship with the scoring skill. Based on the foregoing, the researchers hypothesize significant correlational relationships between these variables and the possibility of predicting scoring skill performance through anthropometric measurements and motor abilities, within the limits of the study sample from the College of Physical Education and Sports Sciences, University of Babylon.

2. Research Methodology

2.1 Research Approach

The researchers adopted the descriptive approach, specifically the correlational design, as it is the most suitable for the nature and problem of the research. This approach involves describing the phenomenon as it exists in reality, analyzing the relationships between its variables, and extracting implications that help in understanding and interpreting it.

2.2 Research Population and Sample

The research population was intentionally defined, comprising all 12 female students at the College of Physical Education and Sports Sciences, University of Babylon for the academic year 2023–2024. All population members were selected to represent the research sample (comprehensive sample), to reach the most accurate possible results given the small population size. Table (1) shows the descriptive characteristics of the sample members.

Table (1): Descriptive characteristics of the sample members (N = 12)

Variable	Unit of Measurement	Arithmetic Mean	Standard Deviation	Median	Minimum Value	Maximum Value
Age	year	20.00	0.50	20.00	19	21
Total Height	cm	175.42	2.11	175.00	172	179
Leg Length	cm	98.07	1.94	98.00	95	102
Body Mass	kg	69.07	1.78	69.00	66	72

2.3 Research Instruments and Data Collection Tools

2.3.1 Devices and Tools Used

- Stadiometer for measuring total height (accuracy 0.1 cm).
- Metal tape measure for measuring leg length (accuracy 0.1 cm).
- Calibrated medical scale for measuring body mass (accuracy 0.1 kg).
- Stopwatch for measuring time (accuracy 0.01 seconds).
- Markers (cones) for agility test.
- Size 4 futsal balls.
- Goals for scoring test.
- Adhesive tapes for marking distances.
- Data recording form.

2.3.2 Adopted Anthropometric Measurements

First: Total Height Measurement

- **Purpose:** To measure total body height.
- **Method:** The subject stands upright on the device's base with heels, buttocks, and shoulders touching the vertical surface of the device, with the head positioned so that the gaze is horizontal, then the horizontal arm of the device is lowered until it touches the head.

- **Recording:** Height is read to the nearest 0.1 cm.

Second: Leg Length Measurement

- **Purpose:** To measure leg length (from the greater trochanter to the ground).
- **Method:** The subject lies on their back, the greater trochanter is identified by palpating the bony prominence, then the distance from this point to the ground is measured.
- **Recording:** Length is read to the nearest 0.1 cm.

Third: Body Mass Measurement

- **Purpose:** To measure body mass (weight).
- **Method:** The subject stands in the center of the scale without shoes and wearing light clothing.
- **Recording:** Mass is read to the nearest 0.1 kg.

2.3.3 Motor Abilities Tests

First: 20-meter Slalom Run Test to Measure Agility

- **Purpose:** To measure agility.
- **Tools:** 10 markers, stopwatch, measuring tape, suitable field.
- **Specifications:** Markers are placed in a straight line, with a distance of 2 meters between each marker, making the total distance 20 meters.
- **Performance Method:** The subject stands behind the start line, and upon hearing the signal, runs between the markers back and forth as quickly as possible.

- **Recording:** Time is recorded to the nearest 0.01 seconds. Each student is given two attempts, and the best time is recorded.

Second: Trunk Extension Test from Prone Position to Measure Motor Flexibility

- **Purpose:** To measure back muscle flexibility.
- **Tools:** Measuring tape, flat surface.
- **Performance Method:** The subject lies on their stomach with hands behind the head, and a colleague fixes the feet to the ground. The subject raises the trunk as high as possible.
- **Recording:** The vertical distance from the ground to the highest point of the neck (chin) is measured in centimeters. Each student is given two attempts, and the best distance is recorded.

Third: Numbered Circles Test to Measure Eye-Foot Coordination

- **Purpose:** To measure eye-foot coordination.
- **Tools:** 5 circles numbered from 1 to 5, futsal ball, stopwatch.
- **Specifications:** Circles are drawn on the ground irregularly, each circle 50 cm in diameter, with a distance of 1 meter between each circle.
- **Performance Method:** The subject stands behind the start line, and upon hearing the signal, begins dribbling the ball with the foot in order from circle 1 to 5 and back, ensuring the ball touches inside each circle.
- **Recording:** The time required to complete the entire course is recorded in seconds. Each student is given two attempts, and the best time is recorded.

2.3.4 Dribbling and Scoring Test

- **Purpose:** To measure scoring accuracy after dribbling.
- **Tools:** Futsal balls, goal divided into 6 zones (targets), measuring tape, markers.
- **Specifications:** A distance of 10 meters from the goal is marked, with two markers placed at the start line to assist with dribbling.
- **Performance Method:** The subject starts from behind the start line, dribbles the ball towards the goal, then performs the shot from the 10-meter distance. Points are calculated based on the zone where the ball enters the goal (central zone = 3 points, side zones = 2 points, outer zones = 1 point). Each student is given 5 attempts.
- **Recording:** The total score out of 15 is recorded.

2.4 Pilot Study

The researchers conducted a pilot study on Thursday, February 15, 2024, on a pilot sample of 3 female students from outside the main research sample. The pilot study aimed to:

1. Ensure the safety of the devices and tools used.
2. Train the assistance team on conducting measurements and tests.
3. Identify obstacles that might face the implementation of the main experiment.
4. Calculate the scientific coefficients (validity and reliability) of the tests.

2.4.1 Reliability Calculation Using Test-Retest Method

The tests were administered to the pilot sample, then re-administered after one week (7 days). Pearson's correlation coefficient was used to calculate reliability. Table (2) shows the reliability coefficients.

Table (2): Reliability coefficients for the tests used

Test	Reliability Coefficient	Level
Agility test (20m slalom)	0.89	Very High
Motor flexibility test	0.91	Very High
Eye-foot coordination test	0.87	Very High
Dribbling and scoring test	0.93	Very High

Acceptable reliability coefficient value ≥ 0.80

2.5 Main Experiment

The researchers conducted the field experiment on Sunday, February 18, 2024, at 9:00 AM, in the hall of the College of Physical Education and Sports Sciences, University of Babylon. The measurements and tests were applied in the following order:

1. Anthropometric measurements (total height, leg length, body mass).
2. Motor flexibility test.
3. Agility test.
4. Eye-foot coordination test.
5. Dribbling and scoring test.

Adequate rest periods were observed between tests to ensure that fatigue did not affect the students' performance.

2.6 Statistical Methods

To extract and analyze the results, the researchers used the statistical software (IBM SPSS Statistics 24), which included:

1. Arithmetic Mean.
2. Standard Deviation.
3. Median.
4. Range.
5. Pearson Correlation Coefficient.
6. Simple Linear Regression Analysis.
7. Multiple Linear Regression Analysis.

8. Coefficient of Determination (R^2).

9. (t) test for significance of correlation and regression coefficients.

10. (F) test for analysis of variance.

3. Results

3.1 Presentation of Measurements and Tests Results

Table (3): Arithmetic means, standard deviations, and range for the study variables (N = 12)

Variable	Unit of Measurement	Arithmetic Mean	Standard Deviation	Median	Minimum Value	Maximum Value
Total Height	cm	175.42	2.11	175.00	172	179
Leg Length	cm	98.07	1.94	98.00	95	102
Body Mass	kg	69.07	1.78	69.00	66	72
Agility	seconds	8.24	0.35	8.20	7.80	8.90
Motor Flexibility	cm	38.45	2.18	38.50	35	42
Coordination	seconds	14.28	1.12	14.10	12.50	16.20
Dribbling and Scoring	score	10.42	1.83	10.50	7	13

Table (3) shows the arithmetic means and standard deviations for all study variables. The homogeneity of the sample members in anthropometric measurements and motor abilities is observed, as the standard deviation values were relatively low. The mean performance of the sample members in the dribbling and scoring test was 10.42 out of 15, which is an average level tending towards high.

3.2 Presentation of Correlation Results

Table (4): Correlation matrix between all study variables (N = 12)

Variables	Total Height	Leg Length	Body Mass	Agility	Flexibility	Coordination	Scoring
Total Height	1						
Leg Length	0.856	1					
Body Mass	0.792	0.768	1				
Agility	−0.524	−0.548	−0.612	1			
Motor Flexibility	0.482	0.512	0.598	−0.452	1		
Coordination	−0.556	−0.578	−0.654	0.712	−0.534	1	
Dribbling and Scoring	0.772	0.783	0.897	−0.752	0.788	−0.822	1

Significant at 0.05 level

Table (5): Correlation coefficients between the studied variables and the dribbling and scoring skill

Variables	Correlation Coefficient (r)	Coefficient of Determination (r^2)	Significance Level	Relationship Strength
Body Mass	0.897	0.805	0.001	Very Strong
Eye–Foot Coordination	−0.822	0.676	0.001	Very Strong
Motor Flexibility	0.788	0.621	0.002	Strong
Leg Length	0.783	0.613	0.003	Strong
Total Height	0.772	0.596	0.003	Strong
Agility	−0.752	0.566	0.005	Strong

Tabulated correlation coefficient value at degrees of freedom 10 and significance level 0.05 = 0.576

Tables (4) and (5) show that all calculated correlation coefficients are greater than the tabulated value (0.576), indicating significant positive correlations (and negative in some motor abilities) between the dribbling and scoring skill and all studied variables. The correlation value with body mass was the highest (r = 0.897), followed by eye–foot coordination (r = −0.822), then motor flexibility (r = 0.788), leg length (r = 0.783), total height (r = 0.772), and finally agility (r = −0.752). The negative sign in coordination and agility indicates that lower time (faster performance) is associated with higher scoring scores.

3.3 Presentation of Regression Analysis Results

Table (6): Simple linear regression analysis for predicting scoring skill through the studied variables

Variable	Regression Coefficient (B)	Standard Error	Standardized Regression Coefficient (Beta)	(t) Value	Significance Level
Body Mass	0.921	0.152	0.897	6.058	0.001
Coordination	−1.345	0.242	−0.822	5.558	0.001
Flexibility	0.661	0.136	0.788	4.860	0.002
Leg Length	0.739	0.156	0.783	4.737	0.003
Total Height	0.669	0.149	0.772	4.490	0.003
Agility	−3.934	1.030	−0.752	3.819	0.005

Tabulated (t) value at degrees of freedom 10 and significance level 0.05 = 2.228

Table (7): Multiple regression analysis (stepwise) for predicting the dribbling and scoring skill

Model	Entered Variables	R	R^2	Adjusted R^2	F Value	F Significance Level
1	Body Mass	0.897	0.805	0.785	41.24	0.001
2	Body Mass + Coordination	0.915	0.837	0.801	23.12	0.001
3	Body Mass + Coordination + Flexibility	0.918	0.843	0.784	8.94	0.008

Table (8): Analysis of variance for the multiple regression model (Model 3)

Source of Variance	Sum of Squares	Degrees of Freedom	Mean Squares	F Value	Significance Level
Regression	31.42	3	10.47	8.94	0.008
Residual	9.37	8	1.17		
Total	40.79	11			

Tables (7) and (8) show the results of stepwise multiple regression analysis. In the first model, the body mass variable entered as the main predictor of scoring skill, explaining 80.5% of the variance ($R^2 = 0.805$). In the second model, the eye–foot coordination variable entered the equation, raising the coefficient of determination to 0.837 (i.e., 83.7% of the variance). In the third model, the motor flexibility variable entered, raising the coefficient of determination to 0.843 (i.e., 84.3% of the variance). The calculated F value was 8.94, which is statistically significant at the 0.008 level, confirming the significance of the model and its ability to predict the dribbling and scoring skill.

The regression equation for predicting the scoring skill is:

Dribbling and Scoring = 0.921 × (Body Mass) − 1.345 × (Coordination) + 0.661 × (Flexibility) + Constant

4. Discussion of Results

4.1 Relationship with Anthropometric Measurements

The results indicate a very strong correlation between body mass and the dribbling and scoring skill (r = 0.897). This high value reflects the importance of functional mass (muscle mass) in performing the skill. In the context of learning a power-based skill like scoring, a high proportion of muscle mass in the lower limbs and trunk directly contributes to generating the explosive power needed to propel the ball with the required speed and accuracy. This finding is consistent with the study by Belo et al. (2024), which showed that higher-level players possess greater lower limb strength, and with the systematic review by Barreira et al. (2025), which indicated that elite female players have greater muscle mass and lower body fat percentage.

The results also show a strong correlation between leg length and scoring (r = 0.783). This correlation has a clear mechanical explanation, as the leg acts as a lever during kicking. A longer lever (leg) can generate greater torque at the point of contact with the ball, potentially leading to higher ball speed. Additionally, leg length contributes to increasing the range of motion of the kicking action, which is beneficial for generating power. This finding aligns with biomechanical principles, where propulsive force increases with increasing lever length when applying the same muscular force.

Regarding the relationship between total height and scoring (r = 0.772), it likely reflects the general association between total height and limb lengths, especially leg length. Although total height may not have a direct mechanical advantage in foot scoring in futsal as it does in heading or in the goalkeeper position, it serves as a general anthropometric indicator often associated with a larger body structure, including longer lower limbs.

4.2 Relationship with Motor Abilities

Eye-foot coordination showed the strongest correlation among motor abilities ($r = -0.822$). This result is entirely logical, as the skill of dribbling the ball and then accurately shooting is a complex coordinative task between the eye and feet. This skill requires the player to continuously track the ball while dribbling, process visual information about the goal's position and defenders, and execute a precise motor command to the striking leg—all in fractions of a second. A study by Farhani et al. (2022) indicated that futsal-specific performance tests (FSPT) measuring skills such as dribbling, passing, and shooting, possess high reliability and can distinguish between players of different levels.

Motor flexibility also showed a strong correlation with the scoring skill ($r = 0.788$). This relationship can be explained biomechanically; high flexibility, especially in the lower back muscles and hip joint, allows for a wider range of motion during the leg's backswing and forward swing. This increased range of motion allows for greater accumulation of kinetic energy, contributing to a more powerful and effective shot on goal. Additionally, flexibility plays a protective role, reducing the risk of muscle strains during explosive movements like shooting.

Agility also showed a significant correlation with the scoring skill ($r = -0.752$). Agility, defined as the ability to change direction quickly and accurately, is essential in futsal. The test required dribbling the ball and passing obstacles (markers) before shooting. This correlation confirms that players capable of maneuvering the ball efficiently and quickly possess a better ability to create suitable space and execute a successful shot on goal. However, it is worth noting that the study by Sekulic et al. (2022) found that generic motor abilities (such as general agility) may not be valid predictors of futsal-specific agility performance in professional players. This difference may be due to the current study's sample being learning students rather than professional players, meaning that general agility may be more capable of discrimination in the early learning stages.

4.3 Integration between Anthropometric Measurements and Motor Abilities

The results of the multiple regression analysis indicate that the studied variables collectively explain 84.3% of the variance in scoring skill performance. This confirms that skill performance is the product of a complex interaction between physical and motor factors. A player with appropriate muscle mass (body mass), good eye–foot coordination, and high motor flexibility is most capable of performing the skill efficiently.

This integration can be explained in light of the skill's requirements: the player needs power (associated with muscle mass) to generate ball speed, accuracy (associated with coordination) to direct the ball toward the goal, and flexibility to allow for a wide and safe range of motion. She also needs agility to maneuver with the ball and dribble before shooting.

4.4 Future Horizons: Artificial Intelligence in Performance Development

The development in artificial intelligence technologies opens promising horizons in the field of sports training. These technologies can be employed, as indicated by Ghazi (2023) and Odeh et al. (2024), to analyze players' performance more accurately, provide immediate feedback, and design personalized training programs based on each player's individual characteristics. In the context of this study's results, AI systems can be used to analyze the relationship between a player's anthropometric measurements, motor abilities, and skill performance level, then suggest developmental exercises targeting weaknesses and enhancing strengths. For example, an intelligent system could analyze a player's eye-foot coordination time and provide interactive exercises to improve it, or analyze kicking angle and shot power and provide recommendations for improving performance based on the player's leg length and body mass.

1. This vision aligns with the findings of the study by Lazem et al. (2024) that curriculum engineering, artificial intelligence strategies, and digital methodology have a positive impact on teaching physical education, contributing to improving learning outcomes and developing skill performance.

5. Conclusions and Recommendations

5.1 Conclusions

1. There is a strong, statistically significant correlation between total height and the dribbling and scoring skill from a 10-meter distance among female students at the College of Physical Education and Sports Sciences, which can be explained by the association of total height with the length of the lower limbs.

2. There is a strong, statistically significant correlation between leg length and the dribbling and scoring skill, confirming the mechanical importance of the leg as a lever in generating the power needed for shooting, as longer levers produce greater torque at the point of contact with the ball.

3. There is a very strong correlation between body mass and the dribbling and scoring skill ($r = 0.897$), reflecting the importance of functional mass (muscle mass) in performing skills requiring explosive power, with body mass being the strongest predictor among all studied variables.

4. Regarding motor abilities, significant correlations were found between the scoring skill and agility ($r = 0.752$), motor flexibility ($r = 0.788$), and eye-foot coordination ($r = 0.822$), confirming that lower time in agility and coordination tests and higher flexibility are associated with better scoring performance.

5. The performance level of the dribbling and scoring skill can be reliably predicted through anthropometric measurements and motor abilities, as the studied variables collectively explain 84.3% of the variance in skill performance ($R^2 = 0.843$), with body mass emerging as the strongest predictor, followed by eye-foot coordination and motor flexibility.

5.2 Recommendations

1. **In the Field of Selection and Guidance:** The necessity of paying attention to anthropometric measurements (especially leg length and functional body mass) in the processes of selecting female futsal players, particularly in offensive positions, while adopting motor abilities tests (especially eye-foot coordination and motor flexibility) as additional criteria in selecting talented players.
2. **In the Field of Training and Education:** Designing training programs that target the development of motor abilities associated with the scoring skill, with a focus on eye-foot coordination and motor flexibility, including specific exercises to develop the explosive power of lower limb muscles while maintaining their flexibility, and diversifying training methods to include progressively difficult coordinative exercises to improve scoring accuracy.
3. **In the Field of Scientific Research:** Conducting similar studies on other basic skills in futsal (such as passing, ball control, heading) and on different age groups and skill levels, studying the effect of proposed training programs on improving motor abilities, and considering hormonal and physiological variables as mediating factors in the relationship between anthropometric measurements and skill performance (Farhani et al., 2022).
4. **In the Field of Employing Modern Technologies:** Adopting smart teaching systems and digital methodologies in physical education and sports training using AI-powered platforms to analyze players' performance and provide immediate feedback (Ghazi, 2023; Odeh et al., 2024), developing mobile applications containing standardized tests for anthropometric measurements and motor abilities, and employing AI-powered video analysis techniques to analyze the biomechanics of scoring skill performance and provide precise corrective recommendations.

5. **In the Field of Practical Application:** Conducting tests and measurements periodically and regularly to monitor players' development, organizing training courses for coaches on the importance of anthropometric measurements and motor abilities in developing skill performance, and creating an integrated database for players including their anthropometric measurements, motor abilities test results, and skill performance levels for monitoring, evaluation, and scientific research purposes.

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