

## Some Biomechanical Determinants and Their Relationship to High Jumps Scoring Accuracy in Handball Players

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### ABSTRACT

*This study aimed to identify some of biomechanical determinants affecting accuracy of scoring from a high jump according to biomechanical variables in handball, as well as to verify value of correlation coefficient of these variables related to accuracy of scoring from a high jump in handball. Neglecting role of many biomechanical determinants and sometimes not referring to them, even though these determinants may have an effect, even if indirect, on direct variables affecting projectile. Research problem lies in knowing some of indirect variables and their effect on direct variables and knowing priority in affecting scoring from a high jump, and this is a service to training process and thus achieving goals of scientific research. The researcher used descriptive method. Sample consisted of six players from Samarra University handball team, with a total of 72 observations. Sample was selected purposively based on their playing positions to achieve study's objectives, as jump shot is a specialized skill. SPSS statistical package was used to analyze data, employing means, standard deviation, coefficient of variation, and Pearson's correlation coefficient. Results showed significant correlations between studied variables and scoring accuracy. The researcher recommends designing training programs based on kinematic analysis to develop jump shot skill, and emphasizing these variables in training process.*

Keywords: Biomechanics; Biomechanical determinants; Handball; Jump scoring.

### ABSTRAK

Penelitian ini bertujuan untuk mengidentifikasi beberapa determinan biomekanik yang mempengaruhi akurasi penilaian dari lompatan tinggi sesuai dengan variabel biomekanik dalam bola tangan, serta untuk memverifikasi nilai koefisien korelasi variabel ini terkait dengan akurasi penilaian dari lompatan tinggi dalam bola tangan. Mengabaikan peran banyak determinan biomekanik dan terkadang tidak merujuknya, meskipun determinan ini mungkin berpengaruh, bahkan jika tidak langsung, pada variabel langsung yang mempengaruhi proyektil. Masalah penelitian terletak pada mengetahui beberapa variabel tidak langsung dan pengaruhnya terhadap variabel langsung dan mengetahui

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prioritas dalam mempengaruhi penilaian dari lompatan tinggi, dan ini adalah layanan untuk proses pelatihan dan dengan demikian mencapai tujuan penelitian ilmiah. Peneliti menggunakan metode deskriptif. Sampel terdiri dari enam pemain dari tim bola tangan Universitas Samarra, dengan total 72 pengamatan. Sampel dipilih secara sengaja berdasarkan posisi bermain mereka untuk mencapai tujuan studi, karena jump shot adalah keterampilan khusus. Paket statistik SPSS digunakan untuk menganalisis data, menggunakan rata-rata, standar deviasi, koefisien variasi, dan koefisien korelasi Pearson. Hasil menunjukkan korelasi yang signifikan antara variabel yang diteliti dan akurasi penilaian. Peneliti merekomendasikan merancang program pelatihan berdasarkan analisis kinematik untuk mengembangkan keterampilan jump shot, dan menekankan variabel-variabel ini dalam proses pelatihan.

Kata Kunci: Biomekanika; Penentu biomekanika; Bola tangan; Mencetak gol lompat.

## **INTRODUCTION**

Sports field in our time is a mirror that reflects level of thinking of peoples, their level of sophistication and their ambition for progress and prosperity. It is result of scientific efforts and numerous studies that have contributed to creating high achievement of various sports activities. Handball is one of those games that researchers and specialists have sought to delve into its details because it is characterized by strength, rapid motor responses, and quick decision-making. This is due to presence of opponent very close, especially in scoring skill, which is one of most important skills through which team can achieve victory in matches. In particular, scoring from a high jump which is widely employed in games requires either a considerable deal of strength and maximal speed, or good mechanical skill. The goal's relative modest size and the goalkeeper's ability to cover a significant portion of it with his hands and knees make performing challenging. Since scoring choices are governed by a number of factors, the player who is scoring must decide which region to fire at swiftly and accurately.

It demonstrates the player's influence over performance factors and direction. In order to achieve an advanced level of accuracy and speed of scoring from a high jump, it is necessary to work on applying correct biomechanical principles, which can be revealed through analysis to obtain best position for motor performance and to identify most accurate biomechanical variables and relationships affecting improvement of skill level and scoring accuracy. Importance of current study lies in knowing extent to which biomechanical variables affect accuracy and speed of scoring from a high jump with a handball.

Neglecting role of many biomechanical determinants and sometimes not referring to them, even though these determinants may have an effect, even if indirect, on direct variables affecting projectile. research problem lies in knowing some of indirect variables and their effect on direct variables and knowing priority in affecting aiming from a high jump. This is a service to training process and thus achieving goals of scientific research.

Research Objectives to identifying some of biomechanical determinants of accurate scoring from a high jump in handball. Identifying some biomechanical determinants and their relationship to scoring accuracy from high jumps in handball.

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Research hypothesis there is a correlation between biomechanical determinants and scoring accuracy from high jumps in handball.

## METHODS

Methodology is approach to thinking and working that the researcher adopts to organize, analyze, and present his ideas, and then arrive at reasonable conclusions and facts about phenomenon or subject of study. (Vandalin 1977) Choice of scientific method or approach that a the researcher uses and applies to study a particular phenomenon is related to nature of problem being studied. (Vandalin, 317, 1977), and the researcher used descriptive method in style of studying correlational relationships as it is appropriate method for solving problem, achieving goals and testing hypotheses.

Research population includes players of Samarra University handball team, and research sample included a number of players, totaling (6) (players specializing in high jump shooting), and they were selected purposively. Table (1) shows sample percentage.

**Table 1.** Shows percentage of research sample

Research community	Goalkeepers	Corner players	Pivot players	Back line	Participating sample	Back line sample percentage
18	3	4	2	9	6	66.66%

### Homogeneity of sample

To assure homogeneity of the sample in several characteristics that may impact the outcomes of the main experiment, the researcher homogenized the sample members in the following variables: height, mass, age, training age, leg length, arm length, and foot length, as shown in Table (2).

**Table 2.** Shows specifications and homogeneity of research sample

No.	Mass	Height	Age	Training age	Leg length	Leg height	arm length
1	85 kg.	182 cm.	22 year	4 year	46 cm.	96 cm.	83 cm.
2	87 kg.	197 cm.	20 year	2 year	49 cm.	98 cm.	84 cm.
3	88 kg.	188 cm.	21 year	2 year	48 cm.	96 cm.	81 cm.
4	86 kg.	190 cm.	19 year	1 year	47 cm.	96 cm.	81 cm.
5	85 kg.	186 cm.	22 year	4 year	46 cm.	95 cm.	80 cm.
6	90 kg.	198 cm.	21 year	3 year	48 cm.	99 cm.	86 cm.
Statistical indicators	86.83	190.16	20.83	2.66	47.33	96.66	82.50
	1.94	6.27	6.40	5.99	1.21	1.50	2.25
	0.83	0.21	0.19	0.69	0.07	0.84	0.62

Results showed homogeneity of sample by decrease of skewness coefficient from ( $\pm 1$ ), which indicates that distribution of sample is quasi-normal, as (Hamoudi, 2009) indicates that this indicator is good, as closer these values are to zero or zero, more it indicates that distribution is normal or close to it, and thus sample is homogeneous according to results of skewness coefficient (Hamoudi, 168, 2009).

### Equipment and tools used

1. (CASIO) type video camera with a frequency of (120) images/second, quantity (2).
2. HP computer.

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3. Software and applications used on computer ( Excel, SPSS, Kinovea)
4. (12) legal handballs.
5. A standard handball court.
6. Two tripods.
7. Adhesive tape.
8. Indicator signs and attempt numbering boards
9. A drawing scale with a length of (1m).
10. Medical scale
11. Measuring tape

Field research procedures

Identifying biomechanical variables: After reviewing previous scientific studies (Khalil, 2004), (Al-Sulaimi, 2015), (Shatnawi, 2021), (Havolli, 2021) and researcher's experience, some variables related to skill of scoring from a high jump in handball were identified, including:

1. Knee angle: This is angle between connecting line between ankle joint point and knee joint point and line distance between hip joint point and knee joint point is measured from behind and by step.



**Figure 1.** Illustrates how to calculate knee angle

2. Hip joint angle with fulcrum: It is angle between trunk line thigh is measured from front and in degrees.



**Figure 2.** Illustrates how to extract hip joint angle with pivot leg

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3. Elbow angle: This is angle between drawn line from shoulder joint point to elbow joint point line drawn from wrist joint point to wrist joint point elbow is measured from front and in degrees.



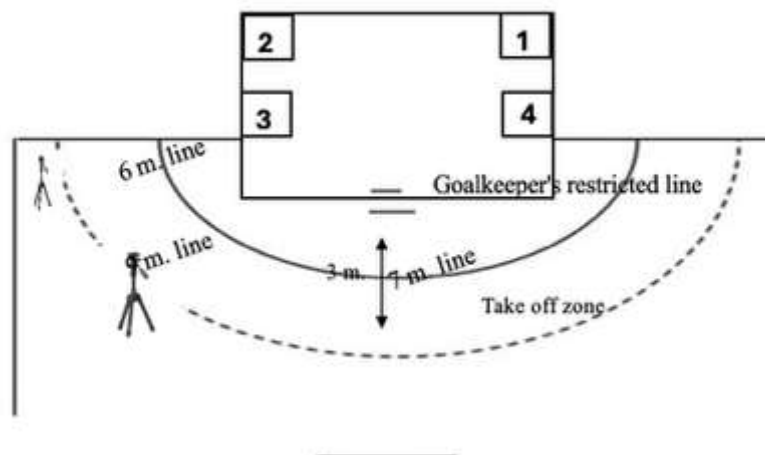
**Figure 3.** Illustrates how to extract elbow angle

## Scoring accuracy test

The researcher sought to adopt a test for accuracy of scoring skills from a high jump, a scientifically standardized test suitable for research sample.

Test Name: Accuracy Test for High Jump Handball Scoring Skill (Quoted from Muhammad, 2004, p. 95). purpose of test: Accuracy of aiming from a high jump. Tools: (12) Handball (4) squares, each with a side of (40 cm), are fixed in corners of goal. How to play: player stands behind starting line holding ball. player takes (2-3) steps and then performs a jump shot to square (1), then (2), then (3), then (4). performance is repeated three times, meaning (12) balls are shot, three to each of four squares. Rules: Do not take more than three steps.

1. A point is scored when ball enters designated scoring area.
2. A shot outside box is counted as (zero).
3. A shot in which player moves more than three steps will not be counted.



**Figure 4.** Illustrates test

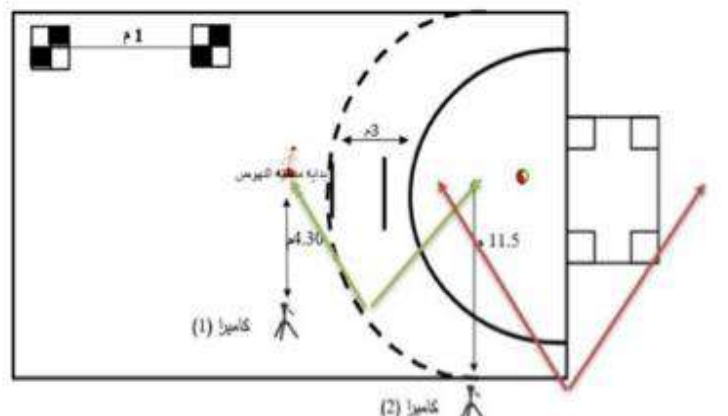
## Exploratory Experiment

Al-Mandalawi et al. (1990) state that exploratory experiment is "practical training for the researcher to identify negatives and positives he encounters during work in order to avoid them" (Al-Mandalawi et al., 1990, p. 107). the researcher conducted experiment on Thursday, February 12, 2026, at 10:00 AM on field of College of Physical Education and Sports Sciences, Samarra University. This experiment was conducted on (3) students from college who specialize in handball, and its objective was:

1. Identifying problems that the researcher may encounter during main experiment.
2. Ensuring suitability of devices and tools used.
3. Finding appropriate position for video cameras (its horizontal distance and vertical height).
4. Determining time required to conduct tests.
5. Determining sufficient number of support staff.
6. Setting indicators for three steps and defining performance requirements.
7. Fixing scoring positions with tape.

## Main experiment and video recording

Six members of the Samarra University team participated in the major experiment on Tuesday, February 19, 2026, at 11:00 am in the Samarra Club's closed hall, accompanied by a support staff. Two cameras were used to record the players' efforts at a rate of 120 pictures per second. Measuring from the ground to the camera lens's focus point on the player's right side, the first camera was 4.30 meters horizontally from the player's field of movement and 1.38 meters vertically. It was restricted to recording the player's movements from the start of the standing area until the actual firing started. The second camera was positioned 11.5 meters horizontally to the player's right, and its function was to measure speed of ball from moment ball left player's hand during scoring until it crossed goal line. Figure No. (5) shows position of camera and beginning of player's performance of scoring skill from a high jump. A drawing scale of 1 meter was used.



**Figure 5.** Shows location of cameras

## Kinematic analysis of players' attempts

Footage was transferred from video cameras using (Flash memory) type ((TOSHIBA)) to a portable device (computer), and motion analysis program (kinovea) was

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used to extract biomechanical variables. After analyzing films, information was collected and stored through Excel program.

## Statistical Methods

The researcher used statistical software package SPSS to process obtained data mean, standard deviation, Percentage Law, Torsion coefficient, Pearson correlation coefficient.

## RESEARCH RESULTS

Scientific research methodology requires presenting and analyzing results that the researcher reached in his study in order to complete explanation about most of similarities and differences that research reaches theoretically. This chapter came to remove ambiguity from results of this study so that they do not remain just numbers of variables extracted from analysis of videos of players' attempts at skill of scoring from a high jump. It contains an analysis of results recorded in tables that serve our research. Below is a presentation of results with analysis.

Presentation and analysis of results of means and standard deviations of biomechanical variables for skill of scoring from a high jump in handball:

**Table 3.** Shows results of means, standard deviations, skewness coefficient, and coefficient Differences in biomechanical variables of high-flying scoring skill in handball

No.	Variables	Measurement unit	Mean	St.d	Torsion coefficient	Coefficient of variation
1	Hip angle with pivot leg	Degree	187	5.47	0.66-	2.9%
3	Elbow angle	Degree	156.8	18.5	1.1-	11.8%
3	Knee angle	Degree	184.2	5.42	0.52-	2.9%

Significant because Sig  $\leq$  (0.05)

From table (3) can note values circles calculation and deviations standardization for variables biomechanics under search and it appears values that circles calculation she was different that's nature all variable matter that it distances us on analysis this is amazing values being pop-up from road measurement different different variable biomechanical as they varied values deviation standard and crossing on gauge distraction per variable and she crossed values twist on values distribution natural for individuals sample per variable so she was variables distributed naturally because of confinement values (3 + 3-) torsion it is mentioned (forgetfulness et, al. 2021) that distribution natural located between (3+, 3-)(Omission et al. 146, 2021) and for purposes comparison distraction between variables it happened use coefficient difference as a crossing on road for comparison dispersion variables with some of them some they varied levels difference in a way big in variables biomechanics different so it reached smallest value it is (2.9%)(angle) knee while it reached higher value difference variable corner attachment so it reached (11.8 %) and with that differences she was large between variables different unless that all of them he was less from (30%) and transfer about (Shawkat 2013) it indicates to that value coefficient difference if she was less (30%) indicates on that individuals sample they were closely in results distraction standardization (Shawkat 46, 2013).

Relationship between extracted variables and scoring accuracy

**Table 4.** Shows results of simple correlation coefficient value biomechanical variables of jump scoring skill in handball and their relationship to scoring accuracy

No.	Variables	Correlation coefficient value	Sig. level	Sig. type
1	Hip angle with pivot leg	0.90	0.00	Sig.
3	Elbow angle	0.96	0.01	Sig.
3	Knee angle	0.78	0.00	Sig.

## DISCUSSION

Hip angle and scoring accuracy have a correlation value of 0.90 with a significance level of 0.00, as seen in the table. A significant positive correlation between two variables is indicated by this value. An increase in hip angle causes the body's center of gravity to rise, which raises the ball's launch point. The study ascribes this to the fact that the body gets more straight as the hip angle rises and approaches 180 degrees, which raises the body's center of gravity and, ultimately, the ball's launch point. One of the key elements in reaching the best projectile accuracy is this. This is what Al-Nayel and Khaled (2009) indicated, stating that launch point height is one of direct factors affecting projectile (Al-Nayel and Khaled, 2009, p. 204). This means that it has an impact on achieving accuracy, especially in this type of shooting, which requires a suitable extension of body parts to achieve a good height and distance from opponent. A suitable hip extension provides a better view of target area, as this variable depends on many other variables, including launch point height.

What Al-Fadhli and Al-Bayati (2010) pointed out is that increasing hip angle means keeping body's center of gravity inside body, which means not needing a large force to transfer body's center of gravity to horizontal component and benefiting from effort exerted to obtain maximum possible height for ball's launch point. This means good performance at moment of rising with high power and good kinetic momentum (Al-Fadhli and Al-Bayati, 2010, p. 165). This was also confirmed by study of Serrien (2015), In order to move momentum and get the highest starting point for the ball, it's important to pay attention to performance-related kinetic sequence and angles and what role they play (Serrien, 2015, p. 10). When the vertical speed goes up and the horizontal speed goes down, Mohamed (2007) found that increasing the hip angle helps reach the highest possible height by moving the body's center of gravity up.

Table (4) shows that there is a correlation between elbow angle and scoring accuracy, as correlation value reached (0.96) and significance level was (0.01). This indicates a significant positive correlation between two variables. the researcher attributes this to fact that increasing elbow angle will increase radius and thus obtain a greater peripheral speed due to direct relationship between radius and peripheral speed. Consequently, this will result in a high ball launch speed and excellent accuracy. This is what Yaseen (2021) indicated, that increasing arm extension helps players prepare to throw ball at a high speed, as player has a wide range of throwing motion (Yaseen, 2021, p. 137).

Regarding knee angle, Table (4) shows a correlation of (0.78) with a significance level of (0.00), indicating a relationship between two variables. the researcher attributes this to fact that knee angle affects height of body's center of gravity through flexion and extension of knee joint, thus influencing height of ball's launch point. Converting

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horizontal velocity to vertical velocity without losing velocity gained during approach run requires a suitable force. This force is generated through flexion of knee joint, resulting in appropriate propulsion. Naturally, angle will be small due to this flexion. Shatnawi (2021) indicates that propulsion process depends on significant flexion and extension of knee joint. This phase must be completed in shortest possible time to minimize lost velocity and utilize it to increase height of body's center of gravity (Shatnawi, 2021, p. 2859). Al-Bayati (2008) also noted that a higher center of gravity is indicative of correct application of flexion and extension process, through proper flexion and full extension of knee and hip joint angles, will ultimately affect accuracy achieved.

## **CONCLUSIONS AND RECOMMENDATIONS**

Based on results that arrived by the researcher study maybe conclusion what next there is a significant correlation between hip angle of standing man and scoring accuracy. There is a significant correlation between elbow angle and aiming accuracy. There is a significant correlation between knee angle and scoring accuracy.

Based on results, the researcher recommends following need to adopt results extracted from research in training process to develop skill of scoring from high jumps, according to priority of variables. Necessity of providing feedback from coaches and specialists in teaching high jump scoring skill, based on results of kinematic analysis and correcting errors related to biomechanical aspects affecting performance, in order to develop high jump scoring skill. Designing training curricula based on mechanical principles to improve scoring performance from high jumps and achieve better results. Considering kinetic correlation between kinematic variables when training a skill Scoring from a high jump and focusing on developing cognitive aspect of players related to technical aspects of skill of scoring from a high jump and its relationship to kinematic variables, such as angle relationships. Knee high a point starting ball and variable speed Approaching quickly starting ball. Conducting studies on other types of scoring at goal for players of Iraqi national handball team.

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