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An Analytical Study of the Relationship between Kinematic Variables of the Base and Push Phases of the Distant Aiming Facing the Jump and their Relationship to the Accuracy of Scoring in Handball

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Abstract
There is a deficiency in the performance of the players in terms of physical and skill, and by not choosing the correct distances in jumping and choosing the appropriate distance for the jump step and the movement of the body during flight, in addition to weakness in the shooting, where the shooting passes through two critical stages, namely the invocation and the push, so the researchers decided to analyze this skill and reveal the its kinematic variables. The research aims to Recognize the values of some kinematic variables for the two phases of leaning and pushing for the far-off scoring from the handball jump and to calculate the accuracy values of the far-off scoring from handball jumping and the relationship between the values of some kinematic variables for the leaning and pushing phases of the far-off scoring from jumping and the accuracy of the handball. The following conclusions and Recommendations were reached at the end of the research:

1. Follow the increase in the speed of the approximate step in the instantaneous speed of the ball when performing the shot by jumping facing from the front.
2. The player's flight angle is affected by the angle of advancement when performing the shot by jumping facing from the front.
3. The player's flight time until he left the ball is related to the maximum height of the player's hip joint at the moment of flight performance of the shot by jumping facing the front.
4. The angle of flight is reduced in a way that helps to maintain the horizontal speed. Perform the shooting by jumping in front of the front.
5. The horizontal distance that the player obtains from the variables that are affected by the speed of the approximate steps.

Keywords: Kinematic, Biomechanical, Handball, Iraq

Introduction
Modern technical means have helped researchers and those in charge of the training process in the field of sports education to change and overcome the old and traditional training methods based on them and take them out of the space of speculation and coincidence to adopt modern scientific methods that serve the skill achievement by studying biom-echanical variables and applying them in the training field. This enables us to improve sports techniques and take the player to the best performance. The main objective of biomechanical is to research the application of laws to living bodies to achieve performance efficiently. Also, by knowing the laws of movement, results can be estimated, and the process of detecting performance errors (Mitwali, 2008, 14) [7] and biomechanics is included in the use of advanced technology that continuously keeps pace with the tremendous progress the world is witnessing in various fields of science and knowledge.

Fundamental and derived sciences of various applied and theoretical fields contributed to developing sports achievements, whether they are individual or team games. Team games have become a vast field that attracts these events' players, researchers, and followers. One of these team games is handball. Handball depends on mastering the basic skills as a fundamental basis for progressing the level. It also requires the exemplary motor behavior in the adopted positions and the physical, motor, mental and psychological abilities that must be characterized by handball players, which enables them to perform the outstanding movement during the games in an integrated way to achieve the main goal in scoring the most significant number of goals in the goal of the opponent and then winning the result of the game. Handball has details, and multiple situations that may be difficult for the player and the coach to observe with the naked eye since developing them and delivering them to the required level needs to use the scientific method in analyzing movements performed by the player. The

science of physical biomechanics is one of the most important sciences that studies the characteristics of the movement. It detects it by particular scientific devices to obtain valuable information in describing the movement of the human body or any part of it. Hence, it expresses the implications of its values to the laws used by other sciences that contribute to problems related to the methods of teaching the technical performance of motor skills and its development and stabilization (Helmy, 1977, 10) [10]. Moreover, knowing the course of movement and the extent of the relationship between descriptive variables to improve the level of skill performance and achieve its goal (Al-Hashimi, 1991, 43) as well as the use of the latest computer programs significantly contributes to the analysis of sports movements accurately, which created a major scientific renaissance that helped researchers.

Hence, the importance of research through the study and analysis of the chemical variables of the stages of base and push for distant aiming while jumping in handball and its relationship to the accuracy of handball scoring, which will be measured using several computer programs in the analysis of videos on the aiming accuracy in handball.

The handball game has witnessed tremendous and remarkable development, whether in physical performance, skill, or plans. The penetration process to reach the opposing team's goal, especially from the center and the wing, became difficult for the players, so they had to resort to alternative solutions to score goals. One of them is distant aiming while jumping. This is one of the most effective aims to reach the opposing team's goal while avoiding friction with the opponent. Additionally, the mastery of this type of aiming enables the striker to overcome any obstacles taken by defenders since the higher the aiming player is, the more freedom there would be for aiming and scoring goals (Hammuda and Salim, 2008, 114). Through many studies the researchers looked at in this field, whether in print or online, about aiming while jumping in handball, it was noted that the level of players in distant scoring while jumping is not at the required level. There is a lack of performance of players physically and skillfully. This lack of performance is due to not choosing the proper distance in jumping or not choosing the right distance for the jump.

Moreover, the body movement while jumping in addition to weakness in aiming. Aiming passes two key stages, base and push. Thus, the researchers thought about analyzing this skill and detecting its mechanical variables for the base and push stages and their relationship to the scoring accuracy to reach its weaknesses and strengths.

1. Identify the values of some of the mechanical variables for the base and push stages of distant aiming from jumping in handball.
2. Learn about the accuracy values of distant scoring from jumping in handball.
3. Identify the relationship between the values of some Kenimatic variables of the base and push stages of distant aiming from jumping and the accuracy of scoring in handball.

A statistically significant relationship between the values of Kinematic variables of the base and push phases of distant aiming of jumping and the accuracy of scoring in handball.

1. Human field: Advanced players of the al-Futuwa Sports Club in handball.
2. Temporal Field: 27/5/2021.
3. Spatial field: Arena of the group games branch/ Faculty of Physical Education and Sports Sciences.

a) Kinetic analysis is defined as studying the parts of the movement and knowing the impact of causal variables to improve the performance of the movement and achieve its objective (Al-Hashimi, 1991, 43).
b) Kinematic is one of the subfields of biomechanics, which studies the overt movement regardless of the force causing it. It also studies time, displacement, angles, speed, and path (Al-Sumaidi, 1987.47). It is also known as one of the subfields of the biomechanics, which studies the external form of the movement of the athlete (overtly) without addressing the force causing the movement, and it is called the science of the geometric description of the movement (Al-Samarai, 1988, 53) [5] (Alsheikh, 1975, 26).
c) Aiming is a skillful compound performance characterized by strength, speed, and accuracy in throwing the ball towards the goal (Stein, 1974, 21).
d) Accuracy reduces deviation or difference to the maximum possible from optimal performance with all mechanical and aesthetic movement calculations (Tikriti and Muhammad Ali, 1986, 68).
e) Accuracy of the Aiming is the ability of the player to control his/her movements toward the goal (Al-Sukari, 1979, 449).

Methodology

Research Methodology

The researchers used the descriptive approach due to its suitability to the nature of the research.

Research Sample

The research sample was deliberately selected. It is represented by the Al-Futuwa Sports Club team players in Ninawa Province, who ranked fifth place in the Premier League for 2020-2021. The number of the players is five players. Table 1 shows the features of the research sample.

Table 1: Shows the research sample Features (N=5)

Statistical Processors / Measurements	Arithmetic medium	Standard deviation	Variation coefficient %
Age (Year)	32.8	1.924	5.864
Mass (Kg)	81	7.314	9.030
Height (Cm)	179.6	3.782	2.106
Train Age	17.4	2.510	14.425
Arm Length (Cm)	78.8	3.701	4.697
Stem Length (Cm)	56	2.550	4.553
Leg Length (Cm)	103	4.637	4.502
Accuracy Test Score	10.8	1.303	12.072

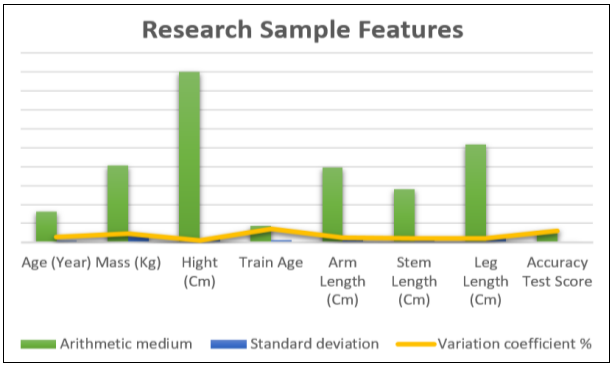

Fig 1: Shows a graph of the research sample features

Table 1 shows that the value of the variation factor ranges between (2.106-14.425) which indicates the homogeneity of the sample. The closer the variation coefficient to 1%, the higher the homogeneity. However, if it exceeds 30%, the sample is heterogeneous (Al-Tikriti and Al-Obaidi, 1996, 161) [2].

Data Collection Methodology

For data collection, the researchers used the following methods:

Measurement

- Measuring the body mass of the players with a medical scale.
- Measuring the heights of players using the restometer device to get the nearest height in cm and another measuring tape to measure some parts of the body.

Aiming Accuracy Test

Test Name

Test of the accuracy of distant aiming facing jumping (Movement).

Test Tools

The researchers used 12 handballs, one handball goal, and an assistant who handed in balls to the tester.

Performance Specifications

The tester stands behind the 9-meter line and runs when the start signal is given to receive the ball from the assistant and then aims from three steps forward, jumping to shoot the ball and then going back three steps and so on. The goal in handball is divided into three parts, from the crossbar to the ground, with 1-meter width for each area. The tester aims at the three areas of the goal consecutively four times, with 12 aims starting with the first area and ending with the third one, as shown in Fig 2.

Scoring:

- The tester is given a point if the ball enters the required area and zero point otherwise.
- The test's total score is 12 points (Al-Khyat & Al-Hayali, 2001, 509) [4].

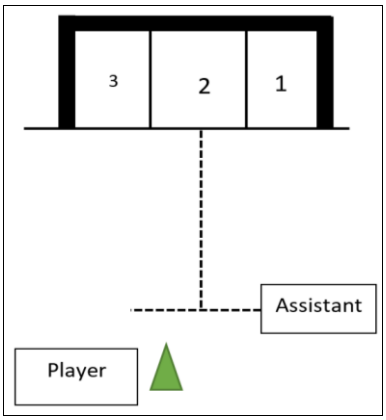

Fig 2: Shows how the test is performed

Research Tools and Devices

- The researchers used one high-speed video camera (CASIO) number. They used a Chinese-made Nikon video camera at high speed for video recording. The camera was placed 3.70 m from the player's right side, and the lens's focus (1.45 m) was above the ground. The speed of the video camera is (300 images/second).
- Two camera tripods.
- A medical scale to measure the body mass of the players
- A restameter to measure the height of the players
- A measuring tape to measure other body parts
- Twelve handballs.
- Sketching scale (1 meter)
- Data entry forms

Final Research Experiment

The final experiment was conducted on the sample of 5 players of Al-Futuwa Sports Club in Ninawa Province who used their right arm to shoot on Thursday, May 27, 2021, at 12:00 p.m. The experiment was conducted in the Arena of the Team Games/ Faculty of Physical Education and Sports Sciences branch.

Research Variables

Biomechanical variables were selected by looking at scientific sources, references, and similar research. The variables to be addressed by the researchers are as follows:

Kinematic Variables of the Last Step

- Step length
- Step time
- Step Speed

Kinematic Variables to Collision Initiation Stage (Base)

- Collision angle (Base)
- Left hip Angle
- Left Knee angle
- Left ankle angle
- The height of body mass gravity center at collision[1]
- Right Knee angle
- Left hip angle
- Left knee angle
- Left ankle angle
- Height of body mass gravity center at the end of the absorption stage
- Horizontal displacement of body mass gravity center
- Vertical displacement of body mass gravity center
- Stage time
- Horizontal speed of the stage
- Vertical speed of the stage

Kinematic variables for the push and jump stage:

- The leaning angle of the stem
- Left shoulder angle
- Lifting angle
- Height of body mass gravity center at the end of the pushing stage
- Horizontal displacement of body mass gravity center
- Vertical displacement of body mass gravity center
- Stage time**.**
- Horizontal speed of body mass gravity center
- Vertical speed of body mass gravity center
- The highest altitude of body mass gravity center for the jumping stage
- The height of the ball

[1] Body mass gravity center (BMGC) was determined through the hip to measure the biomechanical variables

- Horizontal displacement of body mass gravity center
- Vertical displacement of body mass gravity center
- Stage time
- Horizontal speed of the stage
- Vertical speed of the stage
- The real-time distance of the ball's kick-off
- The real-time the ball
- The real-time speed of the ball's kick-off
- Angle speed (shoulder) of the aiming arm
- Circumferential speed

Calculating the Research Variable

1. The method of measuring the length of the last step: the measurement is done by calculating the displacement from the moment the free foot (right) leaves the ground to the moment the heel of the base foot (left) touches the ground.
2. The method of measuring the left knee angle in collision mode: is the angle between the left hip joint and the left ankle joint of the base foot.
3. The method of measuring the angle of the right knee in absorption mode: the angle between the right hip joint and the right ankle joint of the free foot.
4. The method of measuring the angle of the left ankle in collision mode: this is the angle between the left knee joint and the endpoint of the metatarsal of the base foot.
5. The method of measuring the angle of body collision: the angle between the point of the body mass gravity center the moment the base foot collides with the ground and between the horizontal line on the ground.
6. The method of measuring the angle of the stem at the moment of pushing the body: Is the angle between the point between the center of the shoulders with the horizontal line of the stem point.
7. Measuring the left hip angle in collision mode is the angle between the left shoulder and the left knee.
8. The method of measuring the angle of the jumping corner of the body at the moment of pushing: the angle between the body mass gravity center points the moment the base foot leaves the ground and the horizontal line on the ground.
9. At the moment of pushing the body, the left shoulder angle is the angle between the left elbow and the left hip.
10. The body mass gravity center's height in collision mode is measured from the body- mass gravity center point vertically to the ground.
11. The method of measuring the height of the ball at the highest flight point of the body: the measurement is done from the center of the ball vertically to the ground.
12. The method of measuring the horizontal displacement of the flight stage: is the horizontal line connecting the body mass gravity center at the moment of jumping and the body mass gravity center at the highest flight point.
13. The measurement of the vertical displacement of the flight stage is the vertical line connecting the body mass gravity center at the moment of jumping and the body mass gravity center at the highest flight point (Al-Badrani, 2010, 68) [1].

Data Extraction Methodology

After the high-speed Nikon video cameras recorded the players' attempts, the two cameras were linked to the Pentium 7 Computer, and the data was transferred to the hard drive. Then, the data was copied on a CD to be transferred to the data analysis software**.**

Analysis Software

Analysis, in general, is a way to divide the whole movement into parts and study these parts in-depth to reveal their minutes (Al-Sumaidaiy, 1987, 91). The following software and applications have been used based on their functions:

- AutoCAD, an engineering software used for kinetic analysis
- Image Ready for photo and video cutting
- ACD See 10 Photo Manager photo software for images
- Excel

Statistical Means

The researcher used the following statistical methods**:**

- Arithmetic medium
- Standard deviation
- Difference factor
- Simple linking factor (Pearson)
- The statistical package (SPSS)

(Al-Tikriti & Al-Obaidi, 1999, 155, 160, 272) [3]

Results and Discussions

Results of Biokenimatic Variables for the Base and Push Stages of Distant Aiming Facing Jumping of the Accuracy Test

Results of Biokenimatic Variables for the Base Stage of Distant Aiming Facing Jumping of the Accuracy Test

Table 2: Shows the Computational Medium, Standard Deviation, Correlation Factor, and Error Ratio Of Biokenimatic Variables for the Distant Aiming Phase Facing Jumping With the Accuracy Test

Statistics / Player	Measurement unit	Base Stage		Accuracy Results		(r) Value	Error Ratio
		Arithmetic Medium	Standard Deviation	Arithmetic Medium	Standard Deviation		
Step length	meter	.865	.023	11	1.225	-.486	.203
Step time	second	.0617	.011			-.913*	.015
Step speed	m/s	14.70	2.801			.806*	.050
Collision corner	degree	115	1.581			.645	.120
Left hip angle	degree	127.9	11.260			-.607	.139
Left knee angle	degree	162.4	12.361			-.594	.145
Left ankle angle	degree	115.2	6.290			.957**	.005
Body Mass Gravity Center at Collision	meter	.806	.042			-.976**	.002
Right hip angle	degree	168.6	3.974			-.719	.086
Right knee angle	degree	160.4	9.051			.823*	.043
Right ankle angle	degree	141.4	12.895			.776	.062

Body Mass Gravity Center at the End	meter	.999	.167			-.801	.052
Body Mass Gravity Center Horizontal Displacement	meter	.295	.027			.394	.256
Body Mass Gravity Center Vertical Displacement	meter	.0411	.0187			-.939**	.009
Stage time	second	.102	.004			.763	.067
Stage horizontal speed	m/s	2.881	.172			.122	.423
Stage vertical speed	m/s	.409	.204			-.932*	.011

- The following can be observed from Table 2:

1. There is a (-0.913) negative correlation between step time and the accuracy at a probability level of (015.0). The researchers attribute this to the short last step to focus the body parts near the center of gravity of the body mass, and therefore, it will shorten the period, which is the task of this stage for good and suitable preparation for the second stage, which is the pushing stage and then flight. James Hay indicates that one of the essential factors in determining the high speed is the strength of the excellent reaction of the ground to the feet, and the compatibility between bending and stretching of the knees (Hay, 1987: 422).
2. There is a (0.806) positive correlation between step speed and accuracy at a probability level of (05.0). The researchers attribute this to obtaining a good transition from the approximate run to the base stage, then the pushing stage while maintaining speed continuity as much as possible. Additionally, the short period at this stage leads to increased speed, which prepares the player to reach the appropriate height and thus get accuracy in shooting. It works to lift the body up and towards the goal, because the rapid movement of the body enables us to get the maximum height that effectively achieves the goal of movement of rapid scoring of the ball (Hay, 1987: 452).
3. There is a (0.957) positive correlation between the angle of the left ankle and the accuracy reached at a probability level of (005.0). The researchers attribute this to the importance of the stage, in which the reliance on the left base foot leads to the effective rise of the player, which facilitates the accuracy of the correction better as one of the most critical factors determining the high speed is the strength of the excellent ground reaction on the feet and the compatibility between the fold and the stretch of the knees.
4. There is a (-0.976) positive correlation between the height of the body mass gravity center during the collision and the accuracy at a probability level of (002.0). The researchers attribute this relationship to the same reason mentioned above in point (3). Moreover, the higher the player is, the more accurate the shot is. Chaney *et al*. indicate a cross fit between the collision angle and the body mass gravity center (Chaney *et al*., 2000: 43).
5. There is a (0.823) negative correlation between the angle of the right knee joint and accuracy at a probability level (043.0). The researchers attribute this relationship to the more prominent angle of the right knee. The lower the height of the body mass gravity center is due to the distance of the body parts from the center of gravity of its mass. Thus, the form of the knee will not raise the player's body to the top well, which weakens the accuracy of aiming towards the goal because it does not reach the highest possible point and vice versa**.**
6. There is a (-0.939) negative correlation between the vertical displacement of the body mass gravity center at a probability level of (009.0). The researchers attribute this relationship to the same reason mentioned in paragraph (5). Additionally, the vertical displacement is the one that works at the height of the center of gravity of the body mass to the highest point. It is vital for the player to accurately control the shot's accuracy towards the target and vice versa. Players must take a proper flight angle to ensure flight and hip height (increased vertical displacement) that keeps flying and thus get good accuracy in aiming to the goal (Aref & Ismail, 1989, 137) [17].
7. There is a (-0.932) negative correlation between total vertical speed and accuracy at (011.0). The researchers attribute this relationship to the fact that the speed depends mainly on two main elements, displacement and time. The more the speed is, the less is the accuracy, and the less proportionally the height of the body to a situation where the player aims towards the goal while obtaining good accuracy for scoring.

Results of Biokenimatic Variables for the Pushing Stage of Distant Aiming Facing Jumping of the Accuracy Test

Table 3: Shows the computational medium, standard deviation, correlation factor, and error ratio of biokenimatic variables for the propulsion and flight phase of distant aiming facing jumping with the accuracy test

Statistics / Player	Measurement unit	Base Stage		Accuracy Results		(r) Value	Error Ratio
		Arithmetic Medium	Standard Deviation	Arithmetic Medium	Standard Deviation		
Stem angle	meter	84.2	13.827	11	1.225	.177	.388
Right shoulder angle	second	68.9	12.085			.828*	.042
Rising angle	m/s	88.3	3.346			-.122	.423
Height of body mass gravity center at the end of the pushing stage	degree	1.168	.049			-.772	.063
of body mass gravity center horizontal displacement during the pushing stage	degree	.4413	.121			.860*	.031
of body mass gravity center vertical displacement during the pushing stage	degree	8.459	12.263			.228	.356

Push stage time	degree	.132	.0115	11	1.225	-.089	.444
of body mass gravity center horizontal speed during the pushing stage	meter	3.439	1.154			.767	.065
of body mass gravity center vertical speed during the pushing stage	degree	56.619	81.624			.229	.356
of body mass gravity center highest point	degree	111.39	72.158			-.334	.292
Ball height	degree	2.460	0.195			-.399	.253
of body mass gravity center horizontal displacement while flying	meter	0.439	0.152			-.464	.216
of body mass gravity center vertical displacement while flying	meter	0.446	0.224			.288	.319
Stage time	meter	0.256	0.019			.849*	.034
The horizontal speed of the flying stage	second	1.777	0.686			-.537	.176
The vertical speed of the flying stage	m/s	1.689	0.786			.138	.413
Instant distance of the ball kick-off	m/s	0.130	0.014			.947**	.007
Instant time	second	0.042	0.006			.386	.260
Instant speed of the. Ball kick-off	m/s	3.177	0.611			.308	.307
The angular speed of the shooting arm	Degree/s	481.349	90.308			-.157	.401
The circumferential speed of shooting arm	m/s	4.362	2.095			.801	.051
Wrist angle after shooting	degree	89.4	81.610			-.373	.268
Right elbow angle after shooting	degree	147	17.011			-.870*	.028
Right shoulder angle after shooting	degree	150.2	14.346			-.861*	.031

- The following can be observed from Table 2:

1. There is a (0.828) positive correlation between the angle of the right shoulder joint and the accuracy at a probability level of (04.0). The researchers attribute this relationship to the basis of the movement of the shooting arm starting from the shoulder joint, which is directed to the correct movement towards the goal, and thus this movement gets good aiming accuracy.
2. There is a (0.828) positive correlation between the horizontal displacement of the body mass gravity center in the push stage and accuracy at a probability level of (04.0). They say that this relationship results from the continuity of the horizontal approaching run to move vertically after the end of the pushing stage. Hence, the body continues moving horizontally towards the goal despite rising to the top, which makes the body close to the goal, which increases the accuracy of scoring and gives a better scoring chance.
3. There is a (0.849) positive correlation between the time of the flight stage and accuracy at a probability level of (03.0). The researchers attribute this relationship to the time of the flight stage and its importance in the shot's accuracy. The greater the flight time given the player, the greater the chance of good scoring and getting better accuracy and vice versa. Northrip noted that flight time is determined by the height of the body mass gravity center, where the higher the body in the air, the higher the flight time. Additionally, the increase in flight time increases the body time in the air, which in turn leads to increased accuracy in aiming (Northrip, 1979: 252) [20].
4. There is a (0.947) positive correlation between the real-time distance of the ball and the accuracy at a probability level of (007.0). The researchers attribute this relationship to the extension of the shooting arm while the palm is moving to get a reasonable distance with the height of the body mass gravity center at the maximum height of the moment the ball starts from the palm aimed towards the goal to get the best accuracy by shooting. Moreover, the arm's horizontal speed increases the ball's speed. This occurs through the proper bonding between the body parts and the feet motor transport to the stem and then to the arm to get a good ground reaction of the feet, and compatibility in the bend and stretch of the knees (base and push) leads to an increase in accuracy and thus good scoring (Hay, 1987: 452).
5. There are consecutive (870-0.) (-0.861) negative correlations between both the angle of the right elbow joint and the angle of the right shoulder joint the moment the ball left the palm with accuracy at a probability level of (02.0) (0.31). The researchers attribute this relationship to the arm's aiming towards the target in that the movement starts from the shoulder joint and moves to the joint of the wrist ending with the palm towards the goal. Also, the more the mechanical motor bonding of the aiming arm is good, the more the accuracy of the aiming toward the goal is.

Conclusions and Recommendations

Conclusions

1. Appropriate timing of the length of the last step is crucial in the accuracy of distant aiming from jumping**.**
2. The height of the body mass gravity center in the base stage depends on both the ankle angle and the knee angle of the foot during the forward reliance process and this eventually leads to scoring with reasonable accuracy.
3. The higher the body's vertical displacement of the body mass gravity center and the vertical speed of the body in the base stage are, the higher the body will be while jumping, which achieves good scoring accuracy.
4. The bigger the angle of the shoulder of the shooting arm, the better scoring accuracy there will be.
5. The more the horizontal displacement of the body mass gravity center in the pushing stage and the increase in stage time, the more time the player has to get the highest point achieved by vertical jumping to the top, which helps in scoring.
6. The scoring accuracy is repeated both from the angle of the elbow and the shoulder angle of the shooting arm at the moment of the aiming.
7. There is a correlation between accuracy and the instant distance of the ball at the moment of scoring.

Recommendations

1. Ensure a slight flight angle by advancing at a low angle.

2. Emphasizing that there is no significant bending of the knee joint at the moment of pushing.
3. Emphasizing that there is enough and appropriate speed and angle of advancement.
4. Emphasizing the development of the performance of the last step to serve the aiming process.
5. The need for club and team coaches to pay attention to biomechanical variables to develop their players' aiming accuracy**.**

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