# ANALYZING THE RELATIONSHIP BETWEEN SOME BIO-KINEMATIC VARIABLES AND THE LEVEL OF TECHNICAL PERFORMANCE OF THE SKILL OF THE DOUBLE-BALLED BACK AEROBIC FLIP PRECEDED BY THE ARAB JUMP ON THE GROUND MOVEMENT MAT

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**ABSTRACT**

The importance of research in the use of modern technologies and computers in kinetic analysis in diagnosing performance on sound scientific and technical bases until accurate data is obtained that may help organize and direct training processes by revealing weaknesses and strengths and giving the necessary treatment.

The aim of the research is to: Identify the relationship between some of the bio-kinetic variables with each other and the level of technical performance of the skill of the double-balled back aerobic flip preceded by the Arab jump on the floor movement carpet. The most important conclusions were: The existence of a significant relationship between some bio-kinematic variables and the level of technical performance of the skill of the posterior pelvic airlift preceded by the Arab jump on the ground movements.

The researchers recommended: Emphasizing the importance of the initial horizontal rise speed for its positive impact on the moments of leaning and pushing in order to reduce the decrease in the values of kinetic energy in addition to reducing the time of the stage of getting up and emphasizing the good kinetic rhythm.

## I.    INTRODUCING THE RESEARCH

**1.1 Introduction and the research importance**:

Sports games have become one of the most important indicators of the advancement of countries. Gymnastics is one of the Olympic sports games that has a good portion of medals. Those who trace the game of the game can notice great development that took place in kinetic performance. This development did not come by chance, but rather due to the development that encompassed all the domains of life. Researchers and specialists paid attention to this game, where they made advantage of the theoretical sciences, including biomechanics to achieve sports achievements in the various international competitions; this context resulted in more difficulty and complications in the competitive level in those competitions to the extent that the performed movements can only be distinguished by analyzing them or analyzing the connection of their phases with each other. The kinetic skills in the sport of gymnastics are characterized by plurality, difficulty, diversity as well as variation based on the used gymnastics devices for both males and females. Those skills are governed by many biomechanical variables that determine the quality of the technical performance; the technical performance of any movement is restricted by a number of biomechanical characteristics and variables that determine the quality of performance, where performing the kinetic tasks according to these variables results in the best possible achievement with an integration of performance aesthetic and consistent domains.

The ground movements mat is one of gymnastics apparatuses that differs from the other equipment in terms of training and evaluation, where there are three kinetic groups determined by the international law and each motor group includes several movements. Evaluating performance on the ground movements mat is done through certain movements performed by the athlete and each movement has a certain number. The player should, at least, perform four requirements, including the non-acrobatic movements, forward acrobatic movements, balled and open backward acrobatic movements with half, one or two leaps on the lengthened .The double balled back aerobic flip with a difficulty degree of (0.30) is considered as one of the important movements of the third group, which is performed on the ground movements mat and the study sample individuals can perform them well. In the light of that, the study importance lies in using modern technology and computer in analyzing the kinetic performance,

where performance is analyzed based on scientific foundations in order to obtain accurate data that guide and organize the training process and uncover weaknesses and strengths. Developing the required skills helps players to perform tasks with more degree of difficulty.

**1.2 The study problem:**

Based on the researchers' observations about the Gymnastics championships that are held at the level of the country in the youth category and the training that athletes received, they noticed that there is a problem in the low level of performance for the skill of double balled back aerobic flip preceded by the Arab jump which is considered as one of the specified requirements on the mat of ground movements, where this skill is considered as a key for performing more difficult skills. This case motivated the researchers to investigate the causes related to the low level in performing the targeted skill by performing a kinetic analysis for the weaknesses and strengths of performance in order to obtain accurate data that help in designing new methods of training and facilitate the coach's mission with regard to improving the level of technical performance of the skill.

**1.3 The study objectives:**

The study aimed at identifying the relationship between the values of some bio kinematic variables and the level of technical performance for the skill of double balled back aerobic flip preceded by the Arab jump on the ground movements mat.

**1.4 The study hypothesis:**

There is a significant correlation relationship between the values of some bio kinematic variables and the level of technical performance for the skill of double balled back aerobic flip preceded by the Arab jump on the ground movements mat.

**1.5 The study domains:**

1.5.1 The human domain: the athletes of the gymnastics national team ( youth) whose ages ranged between (14-16) years old for the training season (2019-2020).

1.5.2 The spatial domain: Iraq- Baghdad- the training center of Gymnastics ( the collection of sporting halls), Martyr, Sameer Khammas hall.

1.5.3 The temporal domain: 1/9/2020 – 1/3/2021.

## II. THE STUDY METHODOLOGY AND ITS FIELD PROCEDURES:

**2.1 The study methodology:**

The nature of the study problem determines the methodology that should be used to solve the study problem; therefore, the researchers used the descriptive approach with its survey image due to its compatibility to the study nature and objectives. (Van Dalin) suggested that the survey study is one of the patterns of descriptive researches. The survey studies could have a narrow or wide range, and the survey data may be gathered from each member in the study population or the carefully-selected sample. The study domain and depth will be mainly based on the nature of the problem (9:38).

**2.2 The study population and sample:**

The study population was represented by the young athletes of the gymnastics national team whose ages ranged between (14-16) years old with a total of (4) athletes, who were selected intentionally since they perform the targeted skill well, and thus they were chosen as the study sample.

The study sample consisted of (3) athletes, where one athlete was excluded due to injury, and thus the selected sample percentage was (75%). The researchers suggested that each athlete should be given three attempts to perform double-balled back aerobic flip preceded by the Arab jump; therefore, there will be (9) attempts.

2.2.1 The consistency of the study sample:

In order to avoid the factors affecting the study results in terms of the difference in (height, mass, age, training age, the level of technical performance) among the sample individuals. The researchers used the skewness coefficient for the results of the field survey to measure height, mass, age and the level of technical performance. Table (1) shows the value of the skewness coefficient for the variables which ranged between (-1.689 – 1.458).

Table (1) The consistency of the study sample (height, mass, age, training age, the level of technical performance)

| Number | Variables | Measurement units | Mean | SD | Skewness coefficient |
|---|---|---|---|---|---|
| 1 | Height | cm | 166.80 | 4.00 | 0.00 |
| 2 | Mass | Kg | 62.400 | 9.379 | 1.689- |
| 3 | Age | Year | 15.333 | 0.577 | 1.732 |
| 4 | Training age | Year | 9.000 | 2.645 | 1.458 |
| 5 | The level of technical performance | Degree | 7.666 | 0.415 | 0.936 |

## 2.3 The methods of data collection and the used instruments:

2.3.1 The methods of data collection:

- Arabic and foreign references.
- The internet.

2.3.2 The used instruments:

- 2 Video cameras (Sony) with 134 photos /second.
- A pentium-4 computer.
- Medical scale.
- A Laptop (Dell).
- Metal measurement tape.
- Two platforms with three stands.
- A mat for ground movements .

## 2.4 The pilot study:

The researchers conducted the pilot study in the closed indoor hall of Challenge center for training gymnastics which is situated in Al-Karkh in Baghdad. The study was conducted on Monday (18/5/2020) at (4:00) pm in order to verify the validity and safety of devices, inform the team members about their tasks, test the quality of lighting in the hall, determine the suitable angles for video-taping, determine the suitable height of the camera lens and the horizontal distance of the camera, test the camera status and the identify the suitable distance to see the performance and to identify the obstacles that could take place in the main experiment to avoid them.

While implementing the pilot study, we noticed the following:

The hall's lighting is not appropriate.

The camera's distance from the range of performance is not sufficient to see the whole body of the athlete and thus the researchers changed the place of implementing the main experiment to be in the main central hall – the collection of the sporting halls – Martyr, Sameer Khamas hall.

**2.5 Evaluating the technical performance for the skill of double balled back aerobic flip preceded by the Arab jump:**

Technical performance was evaluated out of (10) by (5) arbitrators ** licensed by the international federation of gymnastics. Based on the last amendments of the international law of gymnastics, the final score of the athlete is (20), representing the sum taken from the two committees (D and E) * (*), where the Committee (D) evaluates the difficulties and the specific requirements and gives a score ranging from (0-10), while committee (E) evaluates the technical performance within the score range (0-10). In the current study, the researchers preferred to give a final score of (10), since there is no certain kinetic sequence performed by the athlete and thus arbitration will be limited to committee (E) for evaluating the technical performance. The final score was calculated by omitting the highest and lowest value and dividing the residual by (3).

**2.6 The analysis method by computer:**

Computer analysis was performed by the following steps:

The videotaped material was converted to (pdf) files using (Snazzi) software and then they were stored on (CDs) to facilitate the analysis steps. Then, movement was divided using a (VCD) cutter into pictures to find out the restricted variables and store them in the icon of (my documents) in the computer. The targeted files were then inserted to (kinovea) software that is installed on the laptop, which is a software for analyzing sports movements.

**2.7 The main experiment:**

The main experiment was conducted on Monday (25/5/2020) at (4:00) pm in the central hall for gymnastics, the collection of sporting halls (martyr Sameer Khamas hall) in Baghdad with the existence of the assistant staff and using the measurements that enable us to see the athlete's movement range based on the height of the camera lens. Phosphorus signs were placed on the body joints of all the sample individuals with a total of (3) athletes. The researchers also agreed with the specialists to come and evaluate the technical performance for the skill of double balled back aerobic flip preceded by the Arab jump.

2.7.1 The videotaping of the study sample:

The study sample was videotaped using (Sony) camera with a frequency of 134 photos /second. The camera was placed on a three-stand platform with (1.40) m high and a distance of (9.50) m from the right side of the investigator for camera 1,while camera 2 was placed in the same distance and height on the left side of the investigator. The cameras were placed in a manner that allows for videotaping the experiment accurately and the researchers adopted the measurement of the leg for each athlete to represent the drawing scale.

**2.8 The study variables:**

The stage of pivoting on the ground (the final stage of the Arab jump): the speed of approach, the angle of landing after approaching, knee joint angle, hip joint angle, take off angle.

The stage of take off, which is divided as follows: Take off angle, trunk slope angle, the maximum height of hip point when taking off, the angular speed of the knee joint.

The pivoting stage, which is divided as follows: pivoting angle, the maximum height of hip joint point.

The landing stage: the angle of landing.

** The technical performance was evaluated by the following international arbitrators:

AbdulRazzaq Katem Ali- international arbitrator

Yasser Najah Hussein- international arbitrator

Amer Sakran Hamza- international arbitrator

Ra'ed Jassim- international arbitrator

Ismail Ibrahim- international arbitrator

* (E,D) they refer to the words (Difficulty) and (Execution)

### III. 3. DISPLAYING, ANALYZING AND DISCUSSING THE RESULTS:

**3.1 Displaying the results of kinematic analysis for the study's kinematic variables of the body and the technical performance for the skill of double balled back aerobic flip preceded by the Arab jump.**

Table (2) The means and standard deviations for some bio kinematic variables and the technical performance of the skill of double balled back aerobic flip preceded by the Arab jump

| Number | Kinematic variables | Measurement units | Stage | Mean | SD |
|---|---|---|---|---|---|
| 1 | Running approaching speed | m/s | Pivoting | 3.077 | .6320 |
| 2 | Landing angle after approaching | Degree | | 79.000 | 1.870 |
| 3 | Knee joint angle at pivoting | Degree | | 159.67 | 4.974 |
| 4 | Hip joint angle at pivoting | Degree | | 135.22 | 5.044 |
| 5 | Take off angle | Degree | Take off | 88.444 | 2.743 |
| 6 | Trunk slope angle while taking off | Degree | | 92.333 | 1.224 |
| 7 | The maximum height of hip joint point while taking off | Meter | | 1.170 | .0190 |
| 8 | The angular speed of the hip joint | m/s | | 3.968 | .3440 |
| 9 | Pivoting | Degree | pivoting | 43.777 | 1.563 |
| 10 | The maximum height of hip joint point while pivoting | Meter | | 2.0189 | .1020 |
| 11 | Landing angle after pivoting moment | Degree | Landing | 76.222 | 2.108 |
| 12 | Technical performance | Degree | | 7.666 | .4150 |

**Data will be explained based on stages as follows:**

1. The stage of pivoting down on the ground:

The mean and standard deviation for the variable of approaching speed was (3.077), (0.632) respectively, while the mean and standard deviation for the variable of landing angle after approaching was (79.000), (1.870) respectively. The mean and standard deviation for the variable of knee joint angle was (159.67), (4.974) respectively, while the mean and standard deviation for the variable of hip joint angle after approaching was (135.22), (5.044) respectively.

2. The stage of take off:

The mean and standard deviation for the variable of take off angle was (88.444), (2.743) respectively, while the mean and standard deviation for the variable of trunk slope angle was (92.333), (1.224) respectively. The mean and standard deviation for the variable of maximum height of hip point was (1.170), (0.019) respectively, while the mean and standard deviation for the variable of the angular speed of the hip joint was (3.968), (0.344) respectively.

3. The pivoting stage:

The mean and standard deviation for the variable of pivotingangle was (43.777), (1.563) respectively, while the mean and standard deviation for the variable of the maximum height of hip joint point at pivotingwas (2.0189), (0.1024) respectively.

4. The landing stage:

The mean and standard deviation for the variable of landing angle was (76.222), (2.108) respectively, while the mean and standard deviation for the variable of technical performance was (7.666), (0.415) respectively.

Table (3) The correlation relationship between the kinematic variables for the stages of skill and technical performance

| kinematic variables | | Approaching speed (lying) | Landing after approaching | Knee joint angle | Hip joint angle | Take off angle | Trunk slope | The maximum height of hip joint (take off) | Angular speed | Pivoting angle | The maximum height of hip joint (flying) | Landing after flying | Technical performance |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Pivoting stage | Approaching speed (lying) | | -0.026 | -0.290 | 0.479 | 0.589 | -0.189 | 0.195 | -0.050 | 0.016 | -0.016 | 0.546 | -0.189 |
| | Landing after approaching | | | 0.132 | 0.146 | 0.163 | 0.138 | -0.619 | 0.085 | 0.084 | -0.602 | -0.016 | -0.016 |
| | Knee joint angle | | | | 0.726* | -0.266 | -0.609 | 0.222- | -0.171 | 0.119 | -0.397 | -0.490 | 0.511 |
| | Hip joint angle | | | | | 0.310 | -0.752* | 0.306 | 0.450 | -0.258 | 0.670* | 0.511 | 0.511 |
| Take off stage | Take off angle | | | | | | -0.752* | -0.215 | -0.352 | 0.157 | -0.645 | -0.347 | -0.347 |
| | Trunk slope | | | | | | | -0.219 | 0.500 | -0.086 | 0.016 | 0.810* | 0.810* |
| | The maximum height of hip (take off) | | | | | | | | 0.543 | -0.264 | 0.398 | 0.621 | 0.621 |

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Angular speed | | | | | | | | | ▦ | -0.651 | 0.592 | 0.304 | 0.304 |
| Pivoting stage | Pivoting angle | | | | | | | | | | ▦ | 0.244 | 0.352 | 0.352 |
| | The maximum height of hip (flying) | | | | | | | | | | | ▦ | 0.030 | -0.333 |
| Landing stage | Landing after flying | | | | | | | | | | | | ▦ | 0.266 |
| | Technical performance | | | | | | | | | | | | | ▦ |

*R tabulated value under a degree of freedom (7) at statistical significance of (0.05)= 0.666

### 3.2 Displaying the results of correlation matrix between the kinematic variables with each other and with the technical performance:

The nature of the relationship between the variables of kinematic variables with each other and with the technical performance using the matrix of correlation coefficient that shows the correlations. By investigating the matrix as illustrated in table (3), the researchers noticed that there are (6) statistically significant correlation relationships, of those (4) relationships are positive while (2) are negative and all of them were more than the tabulated value (0.666), with a degree of freedom of (7) at (0.05) as follows:

The variable of knee joint angle in the stage of pivoting on the ground gained a positive correlation with the variable of hip joint angle with about (*0.726) .Also, the variable of hip angle during the stage of pivoting on the ground had a negative correlation with the variable of trunk slope angle during the take off stage, which was (-0.752)as well as a positive correlation with the variable of the maximum height of the hip joint during the pivoting stage which was about (*0.670). Furthermore, the variable of trunk slope angle during the take off stage had a positive correlation with landing angle and the values of technical performance, where the correlation values were (*0.810) for both of them.

### 3.3 Discussing the results of correlation matrix between the kinematic variables with each other and with technical performance:

Based on correlation results in table (3) between the kinematic variables and technical performance, the relationships will be discussed as follows:

As for the positive relationship between the variable of knee joint angle and the variable of hip joint angle for the same stage which had a value of (0.726), the researchers attributed this correlation to the increase in the value of

knee angle which provides more possibility to produce more vertical impulse power due to the approximation of rotation axes of the two joints with the power function line which, in turn, contributes to obtaining the vertical velocity. This is done by accelerating the track of body weight center to reach the maximum height for the hip joint point while taking off. Researchers suggested that the load on joints and muscles results in a flexion of the knee joint, where it takes the form of resistance that that outweigh the strength of thigh muscles, and thus increases the effectiveness of the leg or the foot movement in the impulse rate; this case positively affects the values of take off angle, where the leg takes the position of preparation flexion which leads to a strong movement of inflexion and pushing for the foot during the take off stage, in that the angel will be in the appropriate value that matches with the targeted kinetic task (7:55).

As for the inverse relationship between the variable of hip joint angle and trunk slope angle, the researchers attributed this relationship to the fact that the trunk slope reduces the moment of inertia around the cross-sectional axis which, in turn, increases the speed of rotation in the double balled back aerobic flip. As soon as the athlete's body leaves ground and stops rotating around the cross-sectional axis, it gains more slope and rotation by shortening the body's radiuses to increase the angular velocity of the hip joint. This case contributes to the speed of the whole body rotation and requires flexing the knees and pulling them towards the chest; indeed, this balling brings the body parts closer to the rotation axis. This interpretation agrees with the scientific fact which states that when moment of inertia declines, the angular velocity increases and vice versa (9:83).

As for the positive relationship between the variable of hip joint angle and the variable of the maximum height of hip joint point, which means that both variables move in the positive direction. The researchers attributed this to the fact that when the hip joint angle increases, the height of the hip joint point increases which, in turn, contributes to obtaining a suitable pivoting route for the body movement and taking a larger pivoting arch. In order to have a large pivoting route of the body, the athlete should produce more pushing force, and thus a higher pivoting speed in accordance with Newton second law, which states that "the acceleration of an object is dependent upon two variables – the net force acting upon the object and the mass of the object".

$$\therefore \text{Force} = \frac{\text{Mass} \times \text{speed}}{\text{Time}} \quad (5:132)$$

By knowing the time of performance or the time in any time of this performance and the mass or the moving part, we can conclude the affecting power and the acceleration of the body or any point on it (6:412). (Mohammad Yousef Al-Shaikh) suggested that the body pivoting bow reduces the rate of falling of the athlete's body under the effect of gravity and prepares a suitable landing angle (8:287). The same finding was confirmed by (Eiman Shaker Mahmoud) who stated that " the horizontal velocity is a main source to obtain the required pushing force to change the direction of the body weight center in the horizontal or vertical direction" (4:194).

As for the inverse relationship between the variable of take off angle and the variable of trunk slope angle with a correlation value of (-0.725), the researchers attributed it to the disposition of the athlete in the preparatory stage to flex all the joints of his body as a preparation for the pivoting stage which, in turn, results in increased extending in the joint of the knee due to the process of take off which takes place by the maximum flexion and the maximum extension. The researchers suggested that the inverse relationship between the take off angle and the trunk slope angle is attributed to the fact that when the pivoting angle increases, the trunk slope angle decreases; this means that the sloping push is directed upward more than forward. Therefore, it is necessary to have a full extension for all the body's joints as soon as the athlete takes off in order to raise the body weight center upward and achieve more pushing force (8:278). This context was also confirmed by (Ahmad Ameen Ashour) who suggested that "the take off angle is one of the indicators which reveals that the athlete has taken the right position in relation to the route of the body weight center at the pushing moment " (2:36).

The researchers attributed the positive relationship between the variable of the trunk slope and both the landing angle after pivoting and the technical performance which is (0.810), (0.810) respectively to the fact that the three variables go in the same direction, and that the increase in any one of them means an increase in the value of the other variable. The researchers suggested that the landing distance achieved by the sample individuals was compatible with the requirements of the technical performance of the targeted skill based on the heights that the

athletes achieved; the achieved heights have the potential of providing the sufficient time for the rotation and landing in the right way since the increase in this distance has a negative effect on height which, in turn, affects negatively on landing angle by a decline in this angle. The athlete's effort is more perfect when he masters the right and safe landing that the athlete achieves using his body (3:51).

## IV. CONCLUSIONS AND RECOMMENDATIONS:

### 4.1 Conclusions:

Based on the results of research and the statistical analysis of data, we concluded the following:

1. There is a significant positive relationship between the knee joint angle in the stage of pivoting and the variable of hip joint angle.
2. There is an inverse correlation relationship between the hip angle in the pivoting stage and the variable of trunk slope angle with the vertical line.
3. There is a significant positive relationship between the hip joint angle in the stage of takeoff and the variable of the maximum height of hip joint.
4. There is an inverse correlation relationship between the variable take off angle in the takeoff stage and the variable of trunk slope angle.
5. There is a significant positive relationship between the trunk slope angle with the vertical line in the stage of take off and the angle of landing after flying.
6. There is a significant positive relationship between the trunk slope angle in the stage of take off and the variable of the technical performance values.
7. There was an involvement for trunk, arms and anchoring feet. This involvement took place in a simultaneous rhythm, where the amount of movement was transferred from the legs to the trunk, then from the trunk to the arms. This movement process takes place in a certain dynamic structure, where the legs are the basic source of movement.

### 4.2 Recommendations:

1. Emphasizing the importance of primary horizontal take off speed due to its positive effect on the moments of standing and pushing in order to reduce the values of kinetic energy and the time of taking off stage as well as emphasizing the good kinetic rhythm concerning the length of steps and their role in raising the indicators of motor transfer.

2. Emphasizing the importance of developing the pushing force of the legs during the stage of take off via the dynamic relationship between front and back pivoting and the levels of acceleration track for the body weight center to reach the best pivoting track after the pushing moment.

3. The necessity of developing the values of kinetic energy among young athletes by increasing the values of speed and their effects on the values of kinetic energy during the take off stage by leg pushing to perform movements with more difficulty.

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