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The relationship of certain values of angular difference and angular velocity to rotational steps in triple jump with numerical implementation

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Abstract: *The kinematic analysis is used to accurately determine the performance level of the players' movements and athletic abilities, which allows the values of the kinematic variables to be extracted and compared with the typical kinematic variables to know the strengths and weaknesses of the players' performance and contribute to change the performance for the better, as our research aimed to investigate the relationship between the values of the time variable The angular velocity of the pivot phases in triple jump and the level of digital performance.*
We used a descriptive research based on the method of motion analysis using kinematography, and the research sample consisted of Four (04) national champions in triple jump, who were deliberately selected. After analyzing and discussing the results, we came to the following conclusions, There is a significant correlation between the angle difference in hop push and performance (R=-0.982) . And a existence of significant correlation between angular velocity and performance only in step (R =0.979) and jump (R=0.981) because angular velocity is the result of angular difference divided by time, so the greater the angular difference with stability or lack of time, the greater the angular velocity.
Keywords: *Angular difference, angular velocity, rotational phases, triple jump, Digital Achievement Level.*

Introduction

The activities of the arena and athletics games are diverse in the performance in athletics, as they have great muscular ability, including the triple jump event, which is one of the jumping games, as it is the focus of attention of spectators, experts, practitioners and specialists in this field, and it depends The success of the athlete in the triple jump depends on the mastery of the technical performance of him, which depends on the proper planning in training. (Hay, 1992)

The trio (Suleiman Saad, Nafeh Al-Dulaimi and Fadel Muhammadon) this basis biomechanics appeared in the modern era as one of the sciences that shows and explains to us the errors and problems faced by the athlete in the performance, whether in the approximate run in terms of the speed of the run or its slowness, as well as the length of the step or its brevity, (Guebli, 2018) shows the problem lats that the sweater faces in the jump phase, such as hop-scotch, step and jump, and show errors in them in terms of the angle of flight for performance, height of flight, flight speed and other body positions. Therefore, biomechanics is the science that provides the proper foundation for the coach and the athlete when it comes to performance issues. It revolves around them and their relationship with the mathematical performance of the various movements.In this regard, both to the fact that achieving objectivity in the study of human movement is very difficult due to the complexity and overlap of factors that affect performance, and the difference in movement patterns and their enumeration(King & Yeadon, 2015) , so the movement analysis allows the individual athlete to control the performance The technician has it well and truly away from the eye of the naked eye, using scientific and technical means for the purpose of analyzing the movement of the athlete for each action , A mathematical mechanism (King & Yeadon, 2015).

Through what has been presented and mentioned previously, we have identified the lack of studies in this area at the at the level of Algeria, , as the researchers identified his field of research in the study of pivot stages (hopscotch, Step and jump) in jumping The trio through the motor performance and its relationship to the digital level for the purpose of identifying what contributes to the development of high athletic performance, as well as the detection of errors and negatives, the technical and motor performance, which helps in the development process for coaches and athletes so that specialists can use it to accompany in this field.

Among the similar studies that deal with our subject:

Study by Samuel James Allen titled "Optimisation of performance in the triple jump using computer simulation". The purpose of this study was to develop a realistic computer simulation model of the triple jump in order to achieve optimal technique. A 13-segment, subject-specific computer simulation model of the triple jump with oscillating masses was developed. Torque generators were placed at each hip and shoulder knee, ankle, and ball joint. Kinematic and kinematic data of the triple jump were collected using a force plate and a Vicon motion analysis system. Features were measured with an iso-accelerometer dynamometer, torque-angle and torque-angle-velocity relationships were calculated, and the improved technique showed corresponding symmetrical shoulder flexion performed by elite athletes. Effects of increased force and neglect of angles Then, the swing constraints were examined. Turns out with increasing strength, performance improves, angular momentum constraints are essential for reproducing realistic renderings.

Study from BING YU titled "Conversion of Horizontal to Vertical Velocity in Triple Jump," The purpose of this study is to determine the effects of selected factors on the conversion of horizontal to vertical velocity in the triple jump. Ten top athletes were studied. for each athlete, 3D kinematic data were collected for at least four complete trials in the same competition. The loss in horizontal velocity and the gain in vertical velocity were calculated during each phase. The loss of horizontal velocity is a linear function of the increase in vertical velocity. The slope of this linear function, A1, is called the conversion coefficient from horizontal to vertical velocity. The loss of horizontal velocity increases with the increase in vertical velocity. The sensitivity of the loss of horizontal velocity to the increase in vertical velocity increased as A1 increased.

Stady of Lise Rioux-Lachaud titled Biomechanical approach to the triple jump. Using an evaluation system combining videographic tools with effort measurement tools, it becomes possible to mechanically analyze the behavior of an athlete during the execution of his movements. In this study, the sports discipline chosen is the triple jump. The support phases being decisive, we highlight for each of them, kinematic and kinetic variables relating to the overall behavior of the body. Studied together, these variables make it possible to understand the performance measured at the center of mass during the aerial phases. We also consider the influence of the different segments on the behavior of the body in the support phase as well as in the aerial phase, which makes it possible to detect any problems encountered by the athlete throughout his jump. Finally, we analyze other types of variables in order to better understand the jumping technique specific to each athlete.

Problematic

Due to the fact that these phases require a high level of physical and technical preparation, and with the aim of learning more about what happens to the athlete in these phases and identify the mechanical variables to pay attention to in order to improve and develop them,(S. Allen et al., 2016) through the use of modern scientific techniques, based on biomechanical-kinetic analysis, because it is important for both the coach and the athlete to save time and effort, and because it is a way to highlight common errors in performance and how to avoid them in order to achieve the ideal performance, i.e.i.e., the application of laws and fundamentals that help determine the best sport form for the motor performance of skills,(Ameti et al., 2022)as well as the mechanical reasons for success and failure in the execution of the movement, based on the fact that the biomechanical variables (angular difference and angular velocity) are a product of physical and skill preparation characterized by a special technique in which speed and power play an important role to achieve a better performance of this event, (Liu et al., 2015) and the competition that the sport is experiencing today to achieve record numbers A new world, but the numerical level of Algerian champions is still low compared to the international and Arab level, so he thought, that a researcher in this study should find the reasons for the low level of performance of Algerian masters through an analysis, to know the values of some variables of angular difference and angular velocity in relation to each of the disciplines (jump, step, jump) (Hay, 1992) and their relationship with performance in order to obtain accurate information about performance, identify weaknesses and strengths and increase the level of performance of Algerian masters in this activity based on a number of points, the most important of which are the level of performance, digital level, angular difference and angular velocity (P. Thotawaththa & Chandana, 2022). Therefore, the following question was raised:

- What is the relationship between the values of the variables angular difference, angular velocity and digital level of performance in triple jump?

The angular difference

It is the difference between the moment of touching down the supporting foot and the moment of leaving the climbing phase for the hop, the step and the jump. The corresponding figure shows this (Li et al., 2005).

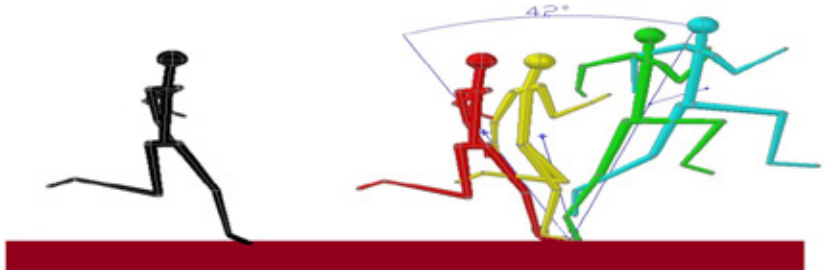

Figure 1. *Explane the phases for the hop, the step and the jump.*

Angular velocity

The angular velocity of the body for the phase (impact - absorption - push-off) of the hop, the step and the jump, by means of the angular difference divided by the time, between the moment when the ascending foot touches the ascending board (the impact phase) from one side and the moment of release (the end of the push-off phase).Velocity angle = angular difference/time (degrees/second).(Hay, 1992)

Triple jump: it is one of the jumping disciplines in athletics.

The pivot phases, the three phases of the triple jump, are as follows(Moura et al., 2022a)

Take-off: In this first phase, you lift off with the jumping leg to reach the greatest horizontal distance possible, and then land on the same jumping leg.(P. C. Thotawaththa & Chandana, 2022)

Step: In this phase, the leg with which the jump was performed is pushed onto the opposite leg and lands on it.

Jump: This is the final swing, the execution of which is similar to the long jump, with the push being executed with maximum forward force.

Digital Achievement Level: It is the result or the distance achieved by the athlete in the triple jump.

Methodes and protocole of research

Research methodology: based on the study, the descriptive approach was used as it is suitable for the type of study.

Research sample: some national champions in triple jump were selected.

Table 1. E*xplane result of sample in triple jump.*

The triple jump.	The research sample.				
	Jumper 1	Jumper 2	Jumper 3	Jumper 4	Jumper 5
Completion distance (m).	16.16	16.15	16.09	16.04	15.89

Research domains:

1 - Human domain: some of the (older) national champions.

2 - Spatial domain: the athletics complex on 05 July in Algiers.

3 - temporal domain:

* Filming phase January 05, 2022

* Video analysis phase from February to March 2022

Research tools:

The following methods were used: Measurement, test, personal interview and technical-scientific observation.

Measurement: The length was measured in centimeters with a tape measure and the mass in kilograms with an electronic scale

Test: The triple jump test was performed in accordance with the legal requirements, giving each player (3) attempts to determine the best of them, and with the help of the work team.

Programs used in research

Analysis is generally a means of breaking down the overall movement into parts and examining these parts in depth to reveal their subtleties (Al-Sumaidaie, 1987,91). After performing the video recording, the researcher converted the video films into CDs. Then, the student used the following programs, each according to its task:

A. Ifilm Idit v1.3: This program can be used to cut parts of the film into small pieces as desired.
B. Format Factory: this is one of the programs used to convert the quality of the movie from DAT to MPEG.
C. .Program Image Ready CS: This program can be used to cut the motion into single consecutive frames.
D. ACD See Manager : With this program, each of the cut images can be displayed, so that the researcher can determine the beginning and the end of the important parts to be analyzed.
E. Auto CAD 2007: it is a global program used in technical applications and corrections. The researcher benefited from this program in the extraction of the mother data for all distances, dimensions and heights, as well as in the extraction of the center of gravity of the body mass by Fisher's method for each image alone.

For extraction, I performed the following steps:

- Identify and select the image to measure its variables :
- Determine the anatomical points on the image and connect the points to obtain the stick figure of the imag.

Dimensional measurement will be measured by specifying the beginning and the end of the displacement, and by the instruction to be selected from the program, we get the measurement of the specified displacement, then the measured displacement is multiplied by the real displacement amount of the drawing scale (the value of the drawing scale (1) meter), we get the real displacement

F. Max Traq: It is one of the programs used in motion analysis to extract angles, distances and offsets and convert them from raw data to real data after converting and multiplying by a real scale.
G. Microsoft Office Excel 2007: it is one of the office programs, and the researcher benefited from this program in mathematically processing the raw data, extracting the center of gravity of the body mass for each image, and drawing the motor trajectories.
H. Microsoft Office Word 2007: it is one of the office programs, and the researcher benefited from this program to obtain the imaginary kinetic series of the jumpers.
I. Paint program: it is one of the programs of the operating system (Windows7) that the researcher used in modifying some of the drawings presented in the study.

The main experience

The main experiment was conducted on January 05, 2022 at ten of the clock in the extension of July 05, 1962 in Algiers, on jumpers and in the presence of the team of assistants.

(06) Trials were filmed for each player, according to international law, for the effectiveness of the triple jump. The best trial was selected according to the performance for the analysis of the movement with a drawing scale of 1 cm in length at each camera location, as shown in Figure No. (17), to convert the dimensions of the image to reality or the distance of the cameras from the field of action as follows:

Camera No. (01): It is 12 m away from the area of the approximate run, at a height of (0.60), to cover the camera beam for the last three steps of the approximate run, as well as the area of ascent, flight and landing of the inflatable.

Camera #(02): The same distance and height to cover the area of the ascent, flight and descent of the step stage as well as the ascent, flight and descent of the jump stage

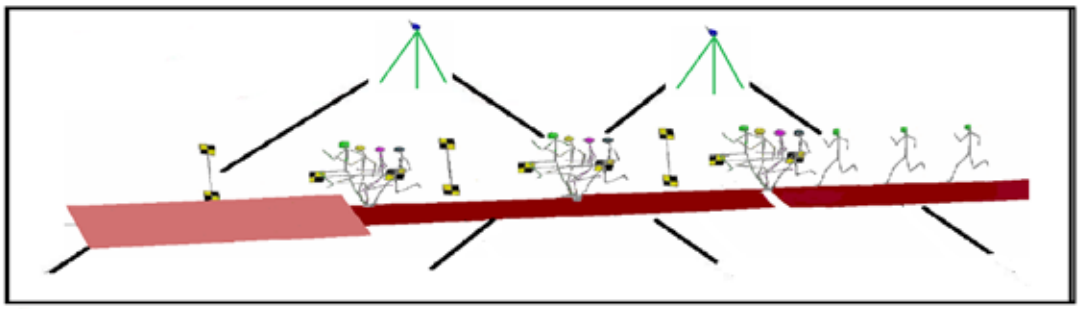

Figure 2. *Explane Stages of the triple jump*

Control of variables

- The homogeneity of the sample in terms of height and weight.
- The best triple jump trial was selected from (06) actual trials of the jumpers.
- Direct monitoring of the completion of the photographs with the help of the working team (specialists in photography).
- Dimensions were determined using a measuring board in the photograph for a distance of 1 m and using guide marks to accurately determine angles and dimensions.

Results

Presentation and discussion of the values of the variables angular difference and angular velocity of the progress stages of the research sample. It shows the arithmetic mean, standard deviations, correlation coefficients with performance and likelihood ratio in the values of the variables of angular difference and angular velocity of the progress stages of the research sample.

Table 2. *Explane the results of correlation coefficient*

Angular velocityfor phases getting up					
Phases	**Variants**	**Mean**	**Standard Deviation**	**Value (r) Calculated**	**Probability**
Hopscotch	Angular difference(degrees).	58.075	5.262	*-0.982	0.030
	Time (Sec).	0.175	0.019	-0.582	0.418
	Angular velocity(degrees/sec).	329.68	26.543	-0.101	0.899
Step	Angular difference(degrees).	51.790	2.272	0.626	0.374
	Time (Sec).	0.180	0.022	0.356	0.644
	Angular velocity(degrees/sec).	289.08	35.063	*0.979	0.025
Jump	Angular difference(degrees).	51	2.582	-0.637	0.363
	Time (Sec).	0.190	0.026	0.185	0.815
	Angular velocity(degrees/sec).	272.98	40.437	*0.981	0.032

(*) Significant at an error rate of ³ 0.05 and in front of a degree of freedom (2) the tabular value of (R) is (0.950).

From the table, it can be seen that there is a significant correlation in the variables (angular velocity) for the steps, the stride and the jump, except for the successful hopping, as the calculated (r) value reaches (0.979) and (0.981), respectively, which is greater than the tabulated (r) value at the significance level (0.05) and amounts to (0.950). As for the variables of angle difference, there was a significant difference with success only in the hop cake phase, because the estimated (r) of (-0.982) was calculated, which is greater than the table value (0.950), then, that there was no significant correlation with the achievement of the step and jump because the values of (ranged t) were calculated between (0.626, 0.637) - which is lower than the table value of (r) at the significance level (0.05), which is (0.950).

Discussion

Through the above table, it is clear that there is a significant correlation between angular difference only in hopping and conversion, and there is a significant correlation between angular velocity and conversion only in walking and jumping(Moura et al., 2022b).

Stability or lack of time increases the angular velocity, moreover, the reason for angular velocity is also related to the front and rear support angles, which form the angular difference according to the following equation: Angular velocity = angular difference / time(Fong et al., 2014), and since time was constant in all phases of the rise of the triple jump, which led to the emergence of such a relationship, since time is inversely proportional to angular velocity, so the longer the time, the lower the angular velocity and vice versa.(Fong et al., 2014)

The researcher attributes this to the absorption of shock on impact with the ground with a loss of horizontal velocity. So flying refers to a "flight angle of the important mechanical factors", (YU, 1999) the trajectory of the weight of the jumper, and this angle is determined by relating the horizontal velocity achieved to the trajectory of the horizontal velocity. And that the loss of horizontal velocity between the approaching run and the increase of the jumped steps is the smallest that can be compared with the rest of the steps, because the jumper wants to maintain the maximum angular distance to continue the technical performance of the sky jump, therefore, the vertical height of the body is as low as possible to maintain the horizontal speed, because the horizontal speed is inversely proportional to the vertical height of the centre of gravity of the body mass, and the angles of the knee, hip, boot and ankle are less bent than in the rest of the steps, and the jumper sets unlike the long jump, in the triple jump the jumper places his leg on the board, often rising with the front foot.(Rioux-Lachaud, 2000)

As in the step, the jumper reduces the angle of flight to maintain horizontal velocity as much as possible, and the appropriate height of the body's centre of gravity to achieve a reasonable horizontal distance.In addition, this step is one of the most difficult steps for the jumper because the ascending leg is the same leg that was lifted in the step pursuit step, which is indicated by allen "The reason for the short distance of the step compared to the other steps is due to the fact that it is performed under difficult and complex conditions, since the ascending foot has performed an ascent and landing after a rather long flight process during the step pursuit process (S. J. Allen, 2010)" In addition, the angles of the knee and ankle of the ascending leg are strongly bent, and the landing of the foot on the ground is done with the heel or the whole foot, which requires more time, so the loss of angular velocity is greater, and in the takeoff, the jumper increases the angle of flight more than in the steps of the pursuit step and the stride to reach a reasonable height, to compensate for the loss of angular velocity in the previous steps, and the time in this step is greater than the rest of the steps, also because of the bending that occurs in the corners of the body, especially the knees and ankles, and the precipitation of the torso forward, resulting in a significant time that leads to a lack of increase in horizontal speed and angular velocity.(S. Allen et al., 2016; Hay, 1992; Hussain et al., 2022; Rioux-Lachaud, 2000; YU, 1999)

Conclusion

The presence of a significant correlation between the angular deviation at the sky command and the realization, and the presence of a significant correlation between the angular velocity and the realization at the step and at the jump. Angular velocity.(Allen et al., 2016; Hussain et al., 2022; Liu et al., 2015(

Although there is a statistically significant correlation in terms of cinematic analysis, it needs to be deepened in kinematic aspects, as the biomechanical analysis of triple jump sports has many connections and plays an important role in the development of this sport.

Our research was concerned with the analysis of the technical phases of the triple jump, so it was necessary to study other physiological, physical and psychological aspects in order to obtain a good numerical performance and to expand the sample so that the results can be generalized

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