

Evaluation of the Kinematic Variables of the Egyptian National Team Triple Jump Women's

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- Introduction:

The triple jump competition is one of the complex kinetic performances, which is characterized by complexity and difficulty, especially for women, it requires high physical efficiency in terms of strength, speed, flexibility, agility and compatibility, so that the contestant can meet the requirements of each phase, where the appearance of the same kinematic factors that affect the movement of the body as a projectile is repeated during the three elevations. (4), (6)

Women's triple jump in Egypt is one of the competitions that suffers from delayed international achievements, which requires analyzing the technical performance of Egyptian players to determine the reasons for the poor digital levels. Egyptian female athletes also achieved late positions in the first Arab Athletics Championship under 23 years, which calls for studying the kinematic variables of their performance to identify strengths and weaknesses.

And through the presence of (the two researchers) among the members of the Egyptian delegation participating in the first Arab Athletics Championship under 23 years, which was held in Tunisia during the period from 18 to 25 May 2023.

The researchers sought to evaluate the performance of the Egyptian national team players in a detailed scientific manner by photographing and analyzing the performance of the players participating in the various competitions in which they represent Egypt.

This research aims to analyze the kinematic variables of the performance of the Egyptian players participating in the triple jump competition to identify the strengths and weaknesses in the technical performance of the Egyptian players, and to compare the Egyptian performance with the Arab and international levels to identify technical gaps to provide practical recommendations for the development of training programs in a way that contributes to improving the technical performance to support the sports development of triple jump competitions in Egypt through accurate scientific results.

Search Procedures

The study was conducted during the first Arab U-23 Athletics Championships, which was held in Tunisia from 18 to 25 May 2023, using a Sony video camera with a frequency of 240 frame/sec to film all attempts, choose the best attempt for each athlete in terms of the achieved digital level, and subject them to biomechanical analysis procedures, using Dartfish TeamPro4 kinetic analysis software to analyze the basic variables for each attempt..

Research sample:

The sample included all the players participating in the triple jump competition, and their number is five players from the following countries (two Egyptian players, a Tunisian player, an Algerian player, a Moroccan player), and the best attempt was selected for each player to conduct a kinematic analysis.

Table (1) Shows the numerical levels achieved for the research sample in the tournament

M	Player Name	Country	Verified Number	Rank	Personal Record
1	Wissal Harkas	Algeria	13.14 m	The first	m13.02
2	Aya El Aglaoui	Morocco	12.51 m	Second	m12.57
3	Ghada Hamdani	Tunisia	12.50 m	Third	m12.78
4	Reem Abdelrazeq	Egypt	12.36 m	Fourth	m11.80
5	Salma Abdelhamid	Egypt	12.14 m	Fifth	12.23 m

Kinematic variables under study:

By reviewing previous studies, the most important kinematic variables were selected, through which the phases of skill performance can be evaluated. (1 ، 2 ، 5 ، 11)

Table (2) the kinematic variables studied

M	Kinematic variables	Unit of measurement
1.	CM in TD and TO The horizontal speed of	m/s
2.	CM in TD and TO speed of vertical The	m/s
3.	CM in TD and TO The speed of	m/s
4.	TOandsupport at the moment of vertical CM The height of	m
5.	support rear the moment of vertical and take off leg at The knee angle of the	deg
6.	Free legthe of knee angleThe	deg
7.	Free legthe of Thigh angleThe	deg
8.	distanceThe take off	m
9.	of take off AngleThe	deg
10.	Angle of flightThe	deg
11.	Support time	sec
12.	Relative distances	m
13.	Percentage distance	%

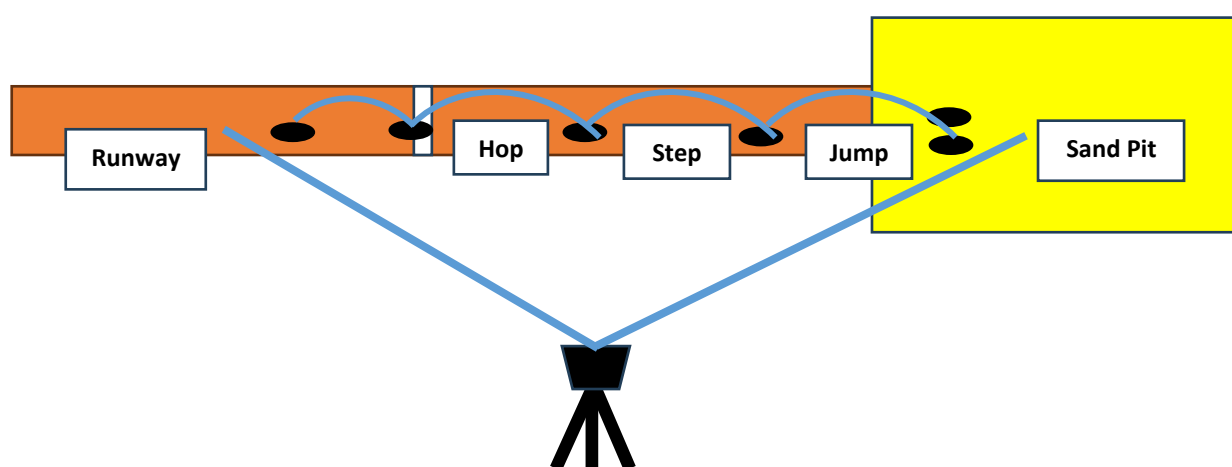
**Figure (1) shows where the camera is put during capture**

Table (3) : the variables of the last step in approach

Variable	Unit of measurement	1	2	3	4	5	Average	Standard deviation
Verified Number	m	13.14	12.51	12.50	12.36	12.14	12.53	0.37
Length of the last step	m	2.03	1.93	1.95	1.59	1.71	1.84	0.18
Last step time	Sec	0.250	0.233	0.233	0.191	0.208	0.22	0.02
Average speed of the last step	m/s	8.12	8.28	8.37	8.32	8.22	8.26	0.10

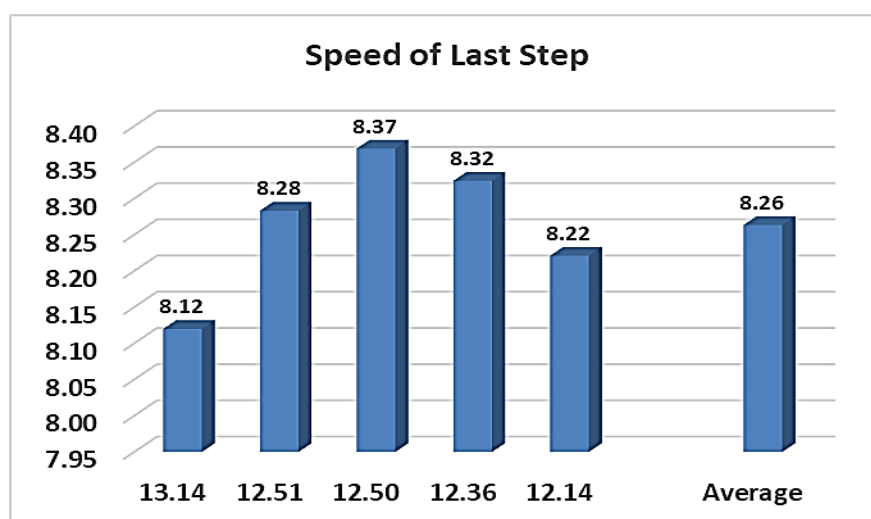
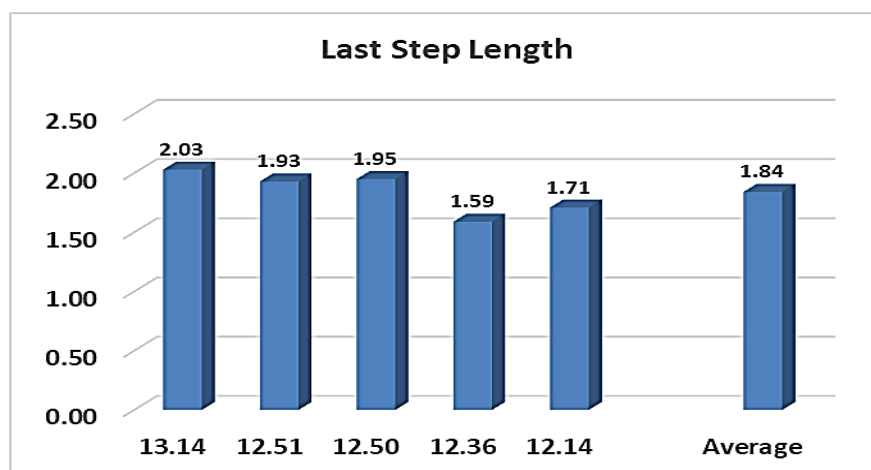


Table (4) : the kinematic variables of the hop phase

Variable		Unit of measurement	1	2	3	4	5	Average	Standard deviation
Verified Number		m	13.14	12.51	12.50	12.36	12.14	12.53	0.37
The horizontal CM speed of	TD	m/s	8.38	8.13	8.36	8.11	7.50	8.10	0.36
	TO	m/s	7.63	8.25	8.00	7.75	7.63	7.85	0.27
vertical The CM speed of	TD	m/s	1.25	1.50	2.38	2.38	0.00	1.50	0.98
	TO	m/s	3.75	2.63	2.50	2.88	2.63	2.88	0.51
The speed of CM	Front Pivot	m/s	8.47	8.26	8.70	8.45	7.50	8.28	0.46
	Rear pivot	m/s	8.50	8.66	8.38	8.27	8.06	8.37	0.23
Height of the CM	Support Vertical	m	0.98	0.93	0.85	0.86	0.82	0.89	0.07
	TO	m	1.05	1.06	0.92	0.95	0.93	0.98	0.07
Knee angle of the take off leg	Support Vertical	you	134.0	134.5	125.4	135.5	127.9	131.46	4.51
	TO	you	171.5	177.7	175.2	175.7	175.8	175.18	2.27
The knee angle of the Free leg		you	83.8	67.8	78.9	61.7	82.9	75.02	9.80
The Thigh angle of the Free leg		you	108.7	99.4	111.1	110.7	113.4	108.66	5.44
The take off distance		m	0.41	0.34	0.37	0.34	0.37	0.37	0.03
The Angle of take off		you	69.20	69.40	67.30	70.00	69.20	69.02	1.02
The Angle of flight		you	13.50	17.50	18.10	22.60	15.40	17.42	3.42
Support time		sec	0.125	0.125	0.133	0.116	0.116	0.12	0.01
Relative distances		m	5.13	5.23	4.80	4.82	5.19	5.03	0.21
Percentage distance		%	39.0%	41.8%	38.4%	39.0%	42.8%	0.40	0.02

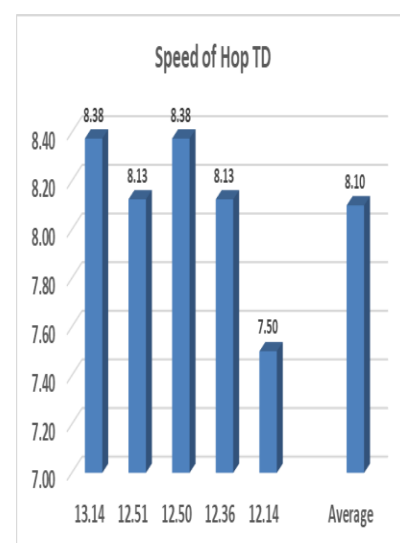
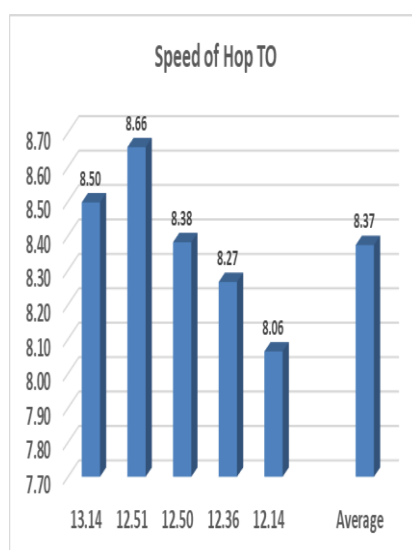
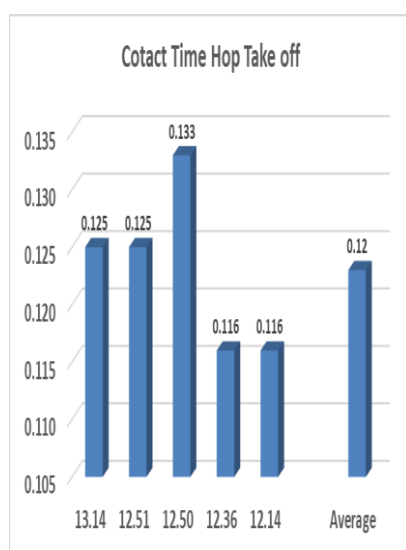


Table (5) : the kinematic variables of the step phase

Variable		Unit of measurement	1	2	3	4	5	Arithmetic mean	Standard deviation
Verified Number		m	13.14	12.51	12.50	12.36	12.14	12.53	0.37
The horizontal CM speed of	TD	m/s	7.38	6.75	6.38	6.13	5.63	6.45	0.66
	TO	m/s	6.50	6.25	6.00	5.88	5.75	6.08	0.30
speed vertical The CM of	TD	m/s	1.00	1.13	2.50	2.38	2.00	1.80	0.70
	TO	m/s	1.25	1.38	1.50	1.63	2.13	1.58	0.34
CM The speed of	Front Pivot	m/s	7.44	6.84	6.85	6.57	5.97	6.73	0.53
	Rear pivot	m/s	6.62	6.40	6.18	6.10	6.13	6.29	0.22
Height of the CM	Vertical Support	m	0.91	0.87	0.81	0.81	0.73	0.83	0.07
	TO	m	0.97	0.91	0.90	0.85	0.78	0.88	0.07
Knee angle of the take off leg	Vertical Support	you	127.1	135.9	135.5	136.0	119.4	130.78	7.40
	TO	you	167.2	171.9	179.3	179.7	176.9	175.00	5.35
The knee angle of the Free leg		you	92.7	94.0	108.0	78.2	117.9	98.16	15.26
The Thigh angle of the Free leg		you	108.4	114.3	115.9	118.9	121.7	115.84	5.04
The take off distance		m	0.42	0.46	0.32	0.34	0.32	0.37	0.06
The Angle of take off		you	65.40	62.00	65.80	68.40	68.50	66.02	2.66
The Angle of flight		you	5.90	7.90	17.20	12.90	16.50	12.08	5.05
Support time		sec	0.158	0.142	0.141	0.116	0.131	0.14	0.02
Relative distances		m	3.97	3.68	4.47	3.76	3.61	3.90	0.35
Percentage distance		%	30.2%	29.4%	35.8%	30.4%	29.7%	0.31	0.03

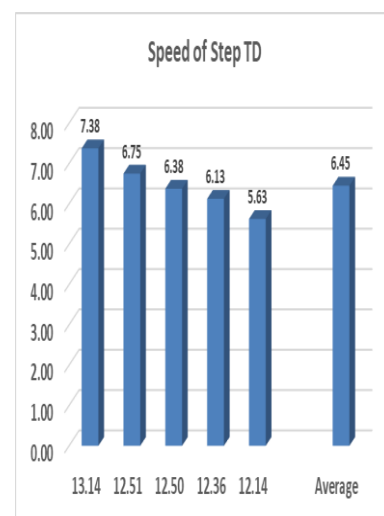
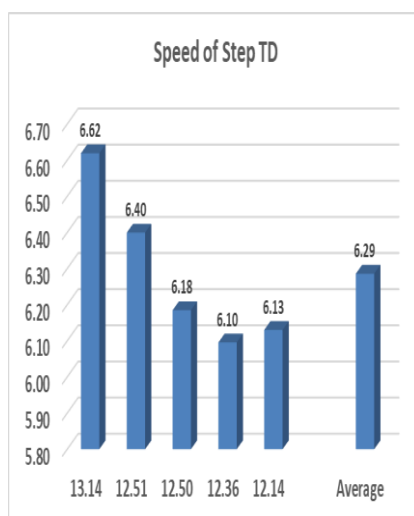
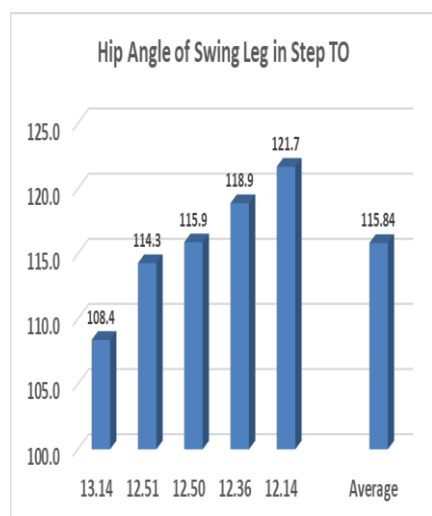
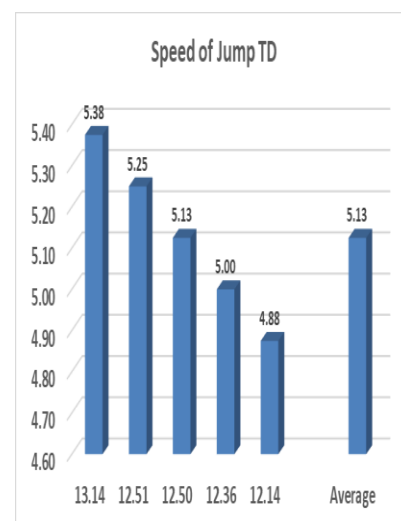
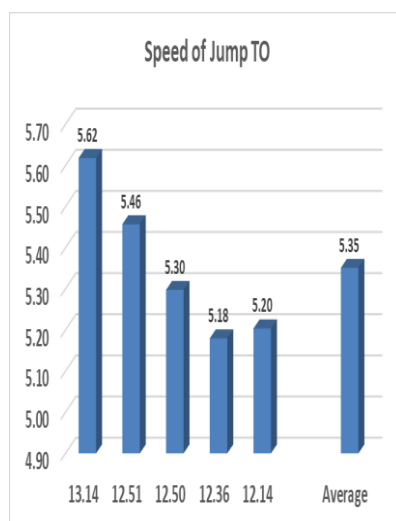
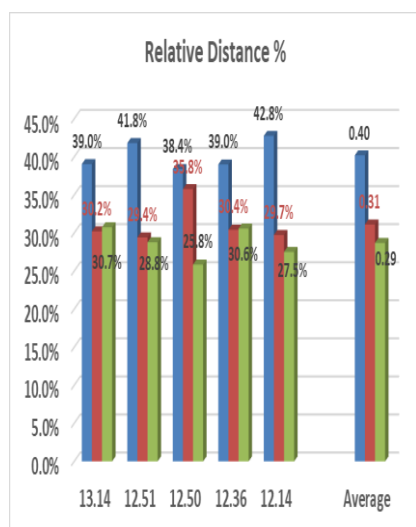


Table (6) the kinematic variables of the jump phase

		Unit of measurement	1	2	3	4	5	Average	Standard deviation
Verified Number		m	13.14	12.51	12.50	12.36	12.14	12.53	0.37
The horizontal CM speed of	TD	m/s	5.38	5.25	5.13	5.00	4.88	5.13	0.20
	TO	m/s	5.25	5.13	5.00	4.88	4.75	5.00	0.20
speed vertical The CM of	TD	m/s	2.38	2.25	2.00	1.88	2.00	2.10	0.21
	TO	m/s	2.00	1.88	1.75	1.75	2.13	1.90	0.16
CM of The speed	Front Pivot	m/s	5.88	5.71	5.50	5.34	5.27	5.54	0.25
	Rear pivot	m/s	5.62	5.46	5.30	5.18	5.20	5.35	0.18
Height of the CM	Vertical Support	m	0.96	0.84	0.80	0.85	0.77	0.84	0.07
	TO	m	1.08	0.93	0.95	0.93	0.88	0.95	0.08
Knee angle of the take off leg	Vertical Support	you	143.3	126.1	131.9	136.4	128.8	133.30	6.78
	TO	you	172.5	162.8	170.4	171.0	169.0	169.14	3.76
The knee angle of the Free leg		you	126.4	76.7	102.1	91.7	113.4	102.06	19.18
The Thigh angle of the Free leg		you	113.9	107.0	105.8	106.4	107.8	108.18	3.28
The take off distance		m	0.30	0.37	0.22	0.31	0.22	0.28	0.06
The Angle of take off		you	74.90	67.60	75.30	72.50	76.00	73.26	3.43
The Angle of flight		you	11.20	14.80	22.80	20.90	23.60	18.66	5.41
Support time		sec	0.166	0.191	0.175	0.150	0.175	0.17	0.01
Relative distances		m	4.04	3.60	3.23	3.78	3.34	3.60	0.33
Percentage distance		%	30.8%	28.8%	25.8%	30.6%	27.5%	0.29	0.02



Discussion of the results: -

The two Egyptian players achieved the fourth and fifth places in the championship from the research sample, which amounted to five players, and they are the last two places among the members of the research sample.

It is clear from **Table (3)** that **the length of the last step** when the player that the Egyptians were less length for the rest of the members of the research sample, where the Egyptian player ranked fourth 1.59 m, while when the Egyptian player ranked fifth was 1.71 m, while when the player ranked first with a length of 2.03 m, At higher levels, the lowest step length was for the last player in the World Championship in Berlin 2009 and achieved a record of 14.25 m the length of the step was 2.21 m. (9)

Which indicates that the length of the step when the Egyptian players are very short, which is the main reason for the increase in the speed of the last step as a result of shortening the time, as the time of the last step for the two Egyptian players was the least time among the members of the research sample, where the fourth-place player was 0.191 s, while the fifth-placed player was 0.208 s, while the players had the lowest time for the step 0.233 s.

It is also clear from **Table (3)** that the speed of the two Egyptian players was on average for the research sample, where **the average speed of the last step** was 8.32 m / s for the Egyptian player who ranked fourth while the Egyptian player with fifth place was 8.22 m / s, and the Algerian player had first place 8.12 m / s Which confirms that the speed of the last step was not decisive in the distance achieved, although the speed of the last step for the high levels of the player achieved first place in the World Championship in Diego 2011 recorded for the number 14.94 m was 9.09 m / s, which confirms the importance of speed for high levels.

As can be seen from **Table (4)** the arrival of the two Egyptian players to the board upgrading the lowest value of the horizontal speed in the TD , where the speed when the Egyptian player ranked fourth 8.11 m / s, while the Egyptian player ranked fifth 7.50 m / s, while the player with the first place 8.38 m / s while in the high levels the speed was 9.04 m / s for the player registered for a distance of 14.94 m in the World Championship Diego 2011. (9)

The references emphasize that triple jumpers should work to increase the horizontal speed at the end of the approach and reduce as much as possible the vertical speed during the last step before the hopscotch take off . (7)

While **the starting speed of the TO** for the two Egyptian players for the fourth place Egyptian player was 8.45 m / s, while for the fifth Egyptian player 7.50 m / s, while the first place player was 8.50 m / s, which indicates the convergence of the level of starting speed between the fourth Egyptian player and the owner of the first place by a very small difference in the speed achieved on the upgrade board, which confirms the lack of effect of the speed of the To start significantly to achieve high digital levels for the Egyptian player, as the difference between it and the first place in the achieved number was 75 cm, despite the convergence of the starting speed on the board.

While at high levels, the starting speed on the board was 9.39 m/s for the owner of the number 14.95 m at the World Championship Berlin 2009. (9)

As can be seen from **Table (4)** the low **support time** of the two Egyptian players from the rest of the sample members, where the two players reached 0.116 s, while when the owner of the first place was the support time of 0.125 s, which indicates that the two Egyptian players did not benefit from the pivot for a sufficient period to produce the driving forces necessary to create a long flight, by increasing the time of the pivot, the player can produce the driving forces, Which confirms the arrival of the support time in the take off of hopscotch for players at high levels to 0.150 s for the player achieved a numerical level of 14.94 m, which indicates the unnecessary speed of movement of the take off, but the necessity of the player to be able to produce strength, whether increased or decreased the support time, while the support time was between (0.160:0.142 s) for his sample recorded a numerical average of (14.35) m . (3)

Looking at **Table (5)**, it is clear that **the horizontal speed** in the front support of the step for the two Egyptian players from the rest of the sample was 6.13 m / s for the Egyptian player who ranked fourth, while the Egyptian player who ranked fifth was 5.63 m / s, while the Algerian first place was 7.38 m / s with a difference of more than 1 m / s Which confirms the great decrease in the movement of the step take off, which led to the loss of speed during flight to reach the speed to very low rates in the step take off while at high levels the speed in the step 8.25 m / s for the player recorded 14.95 m. (9)

It is also clear from the speed of starting in the take off of the step and the low levels achieved by the Egyptian players that the Egyptians, where the speed of the Egyptian player ranked fourth 6.10 m / s, while the Egyptian player ranked fifth 6.13 m / s, while the owner of the first place was 6.62 m / s, which confirms the low physical capabilities of the Egyptian players in starting at high speed in the take off of the step.

It is also evident that the low rates of speed loss for Egyptian players, as the player needs to deliberately increase the support time in the take off of the step to work on producing the necessary strength for the next phase, which is confirmed by the low support time of the Egyptian players from the rest of the sample members, as the support time for the Egyptian player was the fourth place 0.116 s, while the fifth place was 0.131 s, aThe first place holder was the time of Zaha 0.158 s At the higher levels, the step anchor time was 0.170 s for the player who recorded 14.94 m. (9)

What confirms the existence of a deficiency in the phase of upgrading the step is the landing of the knee of the free leg of the Egyptian players from the rest of the sample members, where the angle of the free leg thigh of the fourth-placed player was 118.9 °, while the owner of the fifth place was the angle of 121.7 °, while the owner of the first place had a thigh angle of 108.4 °, which confirms the weakness of the muscles working on the pelvic belt to increase Free leg weighted speed and thus increase braking push during step up.

This is despite the fact that **the flight angle** of the two Egyptian players is almost close to high levels, as the Egyptian player in fourth place reached 12.9 °, while the Egyptian player with fifth place had an angle of 16.5 °, which is better values than the player who won first place, where the angle had 5.9 °, and also the second-place player had an angle of 7.9 °, which are very low values from high levels. The auditor indicates that the flight angle of the step reaches between (14.90 – 15.70 °) for a sample whose registered numbers reached (13.63 – 13.68 m). (8)

It is clear from **Table (6)** that **the horizontal speed** rates of the Egyptian players are low than the rest of the sample members at the moment of the TD to take off to the jump, where the speed of the Egyptian player ranked fourth was 5.00 m / s, while the Egyptian player ranked fifth was 4.88 m / s, while the Algerian player had first place 5.38 m / s, while in the high levels of the player achieved 14.23 m The speed was 6.11 m/s, which confirms the apparent deficiency in speed rates during all phases of the triple jump for Egyptian players. (9)

It is also evident that the low **starting speed in the take off of the jump** for the Egyptian players from the rest of the sample members, as the starting speed of the jump for the Egyptian player with fourth place was 5.15 m / s, while the Egyptian player with the fifth place was 5.20 m / s, while the Algerian player who ranked first had a starting speed of 5.62 m / s, while in the high levels of the player achieved 14.43 m, the starting speed was 7.00 m / s, Which confirms the low speed rates significantly for Egyptian players.

From the above tables (4, 5, 6) it is clear that the relative distances of the Egyptian players were not following a clear strategy, as the Egyptian player was the fourth for the three stability of (hopscotch 39.0%, step 30.4%, and leap 30.6%), while the Egyptian player ranked fifth was the percentages (hopscotch 42.8%, step 29.7%, and leap 27.5%) The first place holder was the percentages (Hopscotch 39.0%, step 30.2%, and leap 30.8%), while at the high levels in the World Championship in Dego 2011 the percentages ranged as follows (hopscotch 35:38%, step 26:31%, and jump 31:38%). (9), (10)

Conclusions :-

1. The speed gained from approaching Egyptian players is in no way commensurate with the achieved record levels .
2. The approximation of the starting speed of the take off from the board between the Egyptian player who ranked fourth and the owner of the first place and did not take advantage of that in the distance achieved.
3. Lower hop support time than the rest of the sample members and for high-level players as well.
4. The greater the loss of horizontal speed during the take off of the step within (1 m / s), the improvement of the record level of the whole jump in general.
5. The inability of the Egyptian players to work passed a strong face free leg during the take off of the step.
6. The speed of moving up from the acceptable limits in the step phase, which does not provide the opportunity to produce the necessary momentum for the next phase .
7. Lack of a clear strategy for the percentages between the three constancy of Egyptian players .

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Abstract

The purpose of the presented study is to analyze the kinematic variables of the performance of the Egyptian players participating in the triple jump competition to identify the strengths and weaknesses in the technical performance of the Egyptian players, and to compare the Egyptian performance with the Arab and international levels to identify technical gaps to provide practical recommendations for the development of training programs in a way that contributes to improving the technical performance to support the sports development of triple jump competitions in Egypt through accurate scientific results. The study was conducted during the first Arab U-23 Athletics Championships, which was held in Tunisia from 18 to 25 May 2023, using a Sony video camera with a frequency of 240 frame/sec to film all attempts, choose the best attempt for each athlete in terms of the achieved digital level, and subject them to biomechanical analysis procedures, using Dartfish TeamPro4 kinetic analysis software to analyze the basic variables for each attempt. The sample included all the players participating in the triple jump competition, and their number is five players from the following countries (two Egyptian players, a Tunisian player, an Algerian player, a Moroccan player), and the best attempt was selected for each player to conduct a kinematic analysis. **The most result is** The speed gained from approaching Egyptian players is in no way commensurate with the achieved record levels, The approximation of the starting speed of the take off from the board between the Egyptian player who ranked fourth and the owner of the first place and did not take advantage of that in the distance achieved, Lower hop support time than the rest of the sample members and for high-level players as well, The greater the loss of horizontal speed during the take off of the step within (1 m / s), the improvement of the record level of the whole jump in general, The inability of the Egyptian players to work passed a strong face free leg during the take off in the step.

Keywords: Triple Jump, Biomechanics, Analysis