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Discriminant Indicators in triple jump: A comparison between different age Groups for Egyptian athletes

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Abstract

Triple jump is one of track and field events that require a high level of both technical and physical ability, Since there is a lack of sufficient data on the nature of motor and technical performance among different age groups of triple jump, the researchers aimed to identify the differences of discriminating indicators between the different age groups regarding the technical performance of the triple jump players in the Arab Republic of Egypt (first division, under 20 years, under 18 years) from the players participating in the 2017/2018 Republic Championship (Cup and Shield).performance was recorded with a high speed cameras 125 fps and the technical performance was then analyzed. It was concluded that all players perform the approved technique along the hop and the small step in the triple jump, the most important discriminating indicators among the players of the different age groups are the average velocity of the last step in approaching, the distance of the step and the horizontal velocity of the jump at the pushing moment.

Keywords *:(Discriminant Indicators; Triple Jump; Egyptian Athletes)*

Introduction:

Triple jump is a complex motor skill, it consists of three phases which are the preparatory phase that begins with running allowing the player to reach maximum horizontal velocity till the take-off board (14), and at the moment of take-off, the main phase begins, which includes the three movements (hop – step –jump),then the final moment of achieving the goal of the movement ends with the landing in the sand pit,(11) and we can observe that each phase is divided internally into phases of (take-off, flight and landing) and each phase has a specific motor duty that the player tries to accomplish by reducing the final movements for each phase starting from the preparatory phase followed by the next phase in order to achieve the most appropriate take-off pose for the take-off momentum each time. (3:6), (7:80), (12)

Each phase of the triple jump motor performance has certain physical requirements, the approaching phase must help to reach the board at the higher possible velocity that can be controlled and taken advantage than in the rest of the following phases where the horizontal velocity at the high level reaches about 10-11 m/sec (19:63), (8:167), (13). So, success in triple jump depends on the ability to convert the velocity of an affecting factor for the optimal performance and the ability to tolerate a high impact force and maintain the level of horizontal velocity to achieve the longest distance (15) where the maximum ground reaction forces recorded during the step phase was 12.6 to 22.3 times of the body weight. (16), (20)

Errors can occur through the three phases of the triple jump. It is possible that the player's performance in the hopping phase affects the step and jump (9) since the transition from the hop to the step is the weak link and that phase is accompanied by a decrease in the amount of horizontal velocity by a percentage of 7-11% compared to the distance of the hops. (13), (10)

Achieving a high level of performance requires being aware of the mechanical factors that affect the performance, and failure to achieve this is due to the negligence of some athletes to such important variables, as the performance analysis is used to assess the technical level of athletes' performance, and to identify the advantages and weaknesses in the player's performance compared to the other players or different levels and help improving the performance, So biomechanical analysis is one of the most important tools that can help coaches to evaluating motor performance. (6), (2), (17:451)

Since there is a lack of sufficient basic data on the differences in motor performances between the athletes of different age groups in some track and field competitions in the Arab Republic of Egypt as there are many and different levels of values and variables of the technical performance which may positively or negatively affect the technical performance, which in turn is reflected in the digital achievement in the triple jump event.

The researchers have studied and evaluated the technical performance of the different age groups (first division, under 20 years, under 18 years) for the best triple jump contestants in the Arab Republic of Egypt to provide the personnel involved in the sports training field with the values of the most important variables that can discriminate the technical performance at different levels and help trainers to develop appropriate training programs for each

age group and develop performance in light of the higher levels in the triple jump event.

Study objectives:

Identifying the discriminant indicators in the technical performance between the different age groups of the triple jump players in the Arab Republic of Egypt by:

1. Analyzing the technical performance of the age groups (first division, under20, under18 years) in the triple jump event.
2. Determining the discriminant indicators in the technical performance between the age groups (first division, under20, under18 years) in the triple jump event.

Study hypothesis:

There are significant differences (discriminant indicators) in the technical performance between the age groups (first division, under20, under18 years) in the triple jump event.

Study procedures:

Research methodology: The researchers used the descriptive method relevance to the nature of the research.

Study domains:

Postural domain: Athletics field at the Military Sports Authority Stadium, Cairo, and the Olympic Center Stadium, Maadi, Cairo.

Temporal domain: The study was conducted during the 2017 Republic Championship Cup from 15 to 19/12/2017, and the 2018 Republic Championship Shield from 14/2 to 13/4/2018.

Human domain: first division, under20 years, and under 18 years triple jumpers.

Study sample:

The research sample was purposively selected and included the best triple jump players in the different age groups in the Republic Championship (Cup and Shield) and they were (19) players with (3) first division players, (8) under 20 years players and (8) under 18 years players from the track and field players in the Arab Republic of Egypt.

Table (1)

Statistical description of the research sample for the main measurements and triple jump distance

measurements		Min.	Max.	Mean	Std. deviation	Skewness
first division (n=3)	Age (years)	21	32	26	5.568	0.782
	Height (cm)	171	199	183.33	14.295	0.992
	Weight (kg)	60	81	71	10.536	-0.423
	Triple jump distance (m)	14.27	14.95	14.71	0.382	-1.711
under20 years (n=8)	Age (years)	18	19	18.63	0.518	-0.644
	Height (cm)	180	192	186.38	3.889	-0.455
	Weight (kg)	62	87	72	8.194	0.519
	Triple jump distance (m)	13.61	15.38	14.23	0.600	0.777
under18 years (n=8)	Age (years)	16	18	17	0.535	0
	Height (cm)	175	191	178.5	5.210	2.505
	Weight (kg)	61	81	70.13	5.718	0.488
	Triple jump distance (m)	12.06	13.29	12.72	0.407	-0.095

Table (1) mean and the standard deviation for the main variables of the research sample in the age groups (first division, under20, under18 years). The Skewness coefficients were close to zero, which means the values were moderate and the sample members were homogenous within each age group of the triple jump players.

Study measurements:

1. **Basic measurements: age (years), height (cm), weight (kg)**
2. **Biomechanical measurements:**

Approach variables: distance and velocity of the three hops before taking off.

Hop, step, and jump variables: support time (sec), knee angle at the end of braking and pushing (degrees), height of the body center of mass at the end of braking and pushing (cm), horizontal, vertical and resultant velocities at the entry and pushing moment (m/sec), take-off and flight angle (degree), distance of the hop, step, and jump (cm).

3. **Technical measurements: triple jump distance (meters)**

Equipment and tools:

Restameter, medical scale, measuring tape, plastic cones and control marks, players' attempts registration forms, three 125 frame/second digital cameras (SONY HDR-

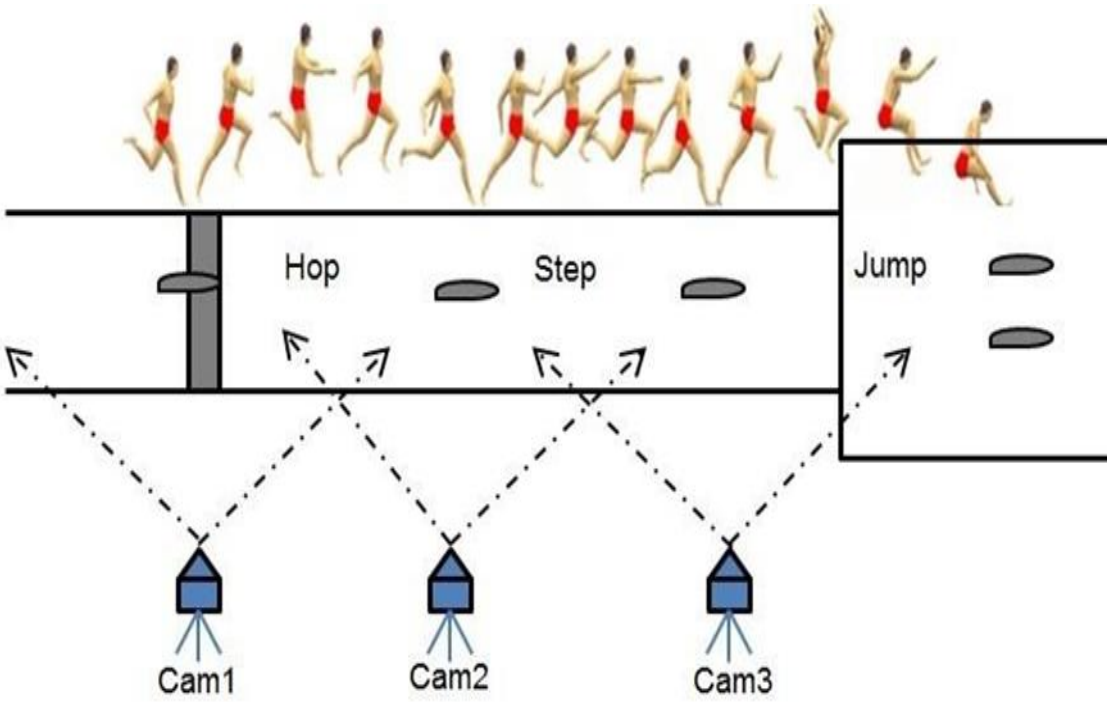
AS100V) and three holders, laptop (DELL) for biomechanical analysis, Dartfish Software Team Pro 6.

Pilot study:

The pilot study was conducted to determine where to place the cameras to obtain a clear registration, and the referees' location was changed slightly to the side and back so that they don't hinder the field of imaging. The locations of the cameras were set for each age group where the take-off board is 11 meters away for the under18 year players, 13 meters for the first division and under20 year players. The first camera was placed perpendicular to the take-off board, the second camera was perpendicular to the step up and the third camera was perpendicular to the jump height, the height of the cameras was 1.20 meters from the ground and the imaging field was 12 meters for each camera, and the following figure shows where to place the cameras.

Figure (1)

Where to place the cameras while imaging the research sample in the triple jump



Main steps of applying the study:

The basic study was applied after obtaining the administrative approvals to capture all the attempts of the players in the Republic Championship (Cup and Shield) in the triple jump for the age groups (first division, under20, under18 years) according to the following steps:

A. Basic Measurements: recording each player's data and measurements (age, height, weight) in the registration form.
B. Imaging procedures: three cameras were placed in the appropriate places for imaging according to the results of the pilot study, so that each camera is 5 meters away and perpendicular to the action field and 12 meters from the imaging field, a 2 meters imaging ruler used as a scale for drawing, and all the players' attempts were captured, whether in the Cup or Shield tournaments.
C. Motor analysis procedures: after completing the imaging process and copying the videos to the computer, the researchers excluded the failed attempts and selected the best attempt for each player according to the digital level. The attempts were analyzed via DartFish Software Team Pro 6to obtain the biomechanical variables to get the data in preparation for its statistical processing.

Statistical treatments:

The data was statistically processed using the SPSS PASW Statistics 20 software to obtain the following statistical treatments: mean, std. deviation, Skewness coefficient, percentage, Discriminant analysis, Bonferroni test.

Presentation of the results:

Table (2)
Group mean, Wilks-Lambda test values, F-test in the technical performance variables for the age groups in the triple jump

Variables			First division N=3		Under20 years N=8		Under18 years N=8		Wilks' Lambda test	F	Sig.
			mean	SD	mean	SD	mean	SD			
Approach variables	Third step before the last step	Step length	2.19	0.17	2.08	0.12	2.07	0.08	0.849	1.43	0.269
		Average velocity	9.43	0.29	8.87	0.41	8.44	0.10	0.385	12.79	0.000
	Second step before the last step	Step length	2.38	0.34	2.18	0.16	2.12	0.16	0.800	2.00	0.168
		Average velocity	9.10	0.01	8.50	0.39	8.16	0.12	0.377	13.22	0.000
	First step before the last step	Step length	2.29	0.04	2.07	0.11	2.05	0.11	0.569	6.05	0.011
		Average Velocity	10.26	0.48	9.18	0.43	8.76	0.13	0.274	21.15	0.000
Hop variables	Support time (sec)		0.144	0.02	0.139	0.01	0.1389	0.01	0.973	0.22	0.805
	Knee angle (degree)	Braking end	135.90	1.65	132.76	4.18	135.76	4.90	0.874	1.16	0.339
		Pushing end	163.30	9.01	161.89	3.52	161.96	8.36	0.994	0.05	0.950
	Height of body center of mass (cm)	Braking End	96.26	9.73	92.06	3.84	87.78	4.53	0.714	3.20	0.068
		Pushing end	112.33	12.66	107.25	4.33	104.13	5.69	0.818	1.77	0.201
	Horizontal velocity (m/sec)	Entry moment	9.34	0.66	8.80	0.46	8.43	0.14	0.566	6.14	0.011
		Pushing moment	8.86	0.54	8.24	0.38	8.00	0.18	0.532	7.04	0.006
	Vertical velocity	Entry moment	-0.29	0.09	-0.40	0.09	-0.57	0.22	0.672	3.91	0.042
	(m/sec)	Pushing moment	2.00	0.36	2.02	0.19	1.92	0.17	0.943	0.48	0.627
	Resultant velocity	Entry moment	9.34	0.66	8.81	0.46	8.44	0.15	0.578	5.84	0.012
	(m/sec)	Pushing moment	9.08	0.60	8.48	0.41	8.22	0.21	0.579	5.81	0.013
	Take-off angle(degree)		68.17	1.12	64.58	4.01	69.64	2.39	0.596	5.42	0.016
	Flight angle (degree)		16.70	1.54	16.68	1.21	17.28	1.54	0.951	0.41	0.669
	distance (cm)		5.41	0.08	5.20	0.27	4.56	0.31	0.331	16.15	0.000
Step variables	Support time (sec)		0.174	0.04	0.173	0.01	0.169	0.01	0.983	0.14	0.874
	Knee angle (degree)	Braking end	127.03	5.73	129.56	3.63	130.29	2.93	0.904	0.85	0.445
		Pushing end	127.03	5.73	129.56	3.63	130.29	2.93	0.904	0.85	0.445
	Height of body	Braking end	91.83	8.72	88.30	3.83	85.79	4.26	0.821	1.74	0.207

	Variables		First division N=3		Under20 years N=8		Under18 years N=8		Wilks' Lambda test	F	Sig.
			mean	SD	mean	SD	mean	SD			
	center of mass (cm)										
		Pushing end	101.00	11.79	98.25	4.59	95.38	5.04	0.886	1.03	0.381
	Horizontal velocity (m/sec)	Entry moment	8.46	0.58	7.67	0.52	7.63	0.16	0.626	4.77	0.024
		Pushing moment	7.52	0.61	6.70	0.66	7.01	0.21	0.738	2.84	0.088
	Vertical velocity	Entry moment	-1.67	0.14	-1.50	0.08	-1.44	0.17	0.700	3.43	0.058
	(m/sec)	Pushing moment	1.19	0.10	1.31	0.11	1.34	0.09	0.759	2.54	0.110
	Resultant velocity	Entry moment	8.62	0.59	7.80	0.52	7.76	0.16	0.612	5.08	0.020
	(m/sec)	Pushing moment	7.61	0.62	6.83	0.65	7.13	0.20	0.744	2.75	0.094
	Take-off angle (degree)		61.60	5.27	59.75	2.33	62.65	4.26	0.866	1.24	0.317
	Flight angle (degree)		14.37	0.60	14.79	0.97	15.21	0.97	0.889	1.00	0.391
	distance (cm)		4.36	0.12	4.31	0.19	3.85	0.20	0.353	14.66	0.000
Jump variables	Support time (sec)		0.2027	0.03	0.2029	0.01	0.199	0.02	0.987	0.10	0.902
	Knee angle (degree)	Braking end	137.60	2.82	139.69	3.41	139.51	5.18	0.965	0.29	0.754
		Pushing end	174.83	3.83	170.84	5.69	170.98	3.89	0.902	0.86	0.440
	Height of body center of mass (cm)	Braking end	97.54	10.75	95.98	5.22	92.90	6.22	0.918	0.72	0.503
		Pushing end	119.00	9.17	117.38	4.00	110.38	5.68	0.658	4.15	0.035
	Horizontal velocity (m/sec)	Entry moment	6.81	0.51	5.90	0.81	6.59	0.21	0.674	3.88	0.042
		Pushing moment	6.27	0.59	5.40	0.69	6.10	0.22	0.623	4.85	0.023
	Vertical velocity	Entry moment	-1.44	0.13	-1.55	0.13	-1.52	0.23	0.958	0.35	0.710
	(m/sec)	Pushing moment	2.22	0.23	2.31	0.15	2.38	0.08	0.830	1.64	0.225
	Resultant velocity	Entry moment	6.95	0.49	6.10	0.78	6.76	0.23	0.679	3.78	0.045
	(m/sec)	Pushing moment	6.65	0.61	5.87	0.68	6.55	0.23	0.653	4.25	0.033
	Take-off angle (degree)		70.87	1.42	67.63	3.77	70.11	2.67	0.815	1.82	0.194
	Flight angle (degree)		19.50	2.27	19.25	1.11	19.98	0.63	0.911	0.78	0.473
	distance (cm)		4.94	0.35	4.72	0.29	4.31	0.33	0.584	5.69	0.014

Table (2) shows that there is a statistical significance in some technical performance variables. Wilks' Lambda test value was 36.985 and the F-test value was 4.707 which are significant values that show the inequality of heterogeneity and indicate the variance and the ability to discriminate between the age groups and the number of the resulting functions of the technical performance of the age groups in triple jump.

Table (3)

Entry order, Wilks' Lambda test value, and F value of the significance of addition in the technical performance variables for the age groups in triple jump

Steps	Variables	Entry direction	Wilks' Lambda	F	df		Sig.
1	Average velocity of the last step in approaching (m/sec)	Addition	0.274	21.147	2	16	0.000
2	Horizontal velocity of the jump at the pushing moment (m/sec)	Addition	0.065	21.912	4	30	0.000
3	Step distance (m)	Addition	0.021	27.372	6	28	0.000

Table (3) shows the variables resulting from the analysis of differentiation according to the steps of entry and the order of importance using the Wilks' Lambda test, which were significant in the variables of the technical performance of the age groups in the triple jump.

Table (4)

Summary of the resulting Discriminant function for the technical performance variables for the age groups in the triple jump

Function	Eigenvalues	% of Variance	Correlation	Wilks' Lambda	Chi- square	df	Sig.
1	19.494	93.748	0.975	0.021	57.80	6	0.000
2	1.300	6.252	0.752	0.435	12.49	2	0.002

Table (4) shows that the Discriminant function in the technical performance variables, which were two functions, that Eigenvalue was 19.494, 1.300 and the value of the correlation coefficient was 0.975, 0.752 and the variance percentage for each function were 95.12%, 56.52% respectively, The two functions were significant and the Wilks' Lambda value was 0.021, 0.435 which follows the distribution of the Chi-square at df 6 and 2, and therefore this model can be relied upon to discriminate between aspects of the correlation in the variables of technical performance of the age groups in triple jump.

Table (5)

Structure Matrix and standardized and unstandardized coefficients for the resulting Discriminant function for the technical performance variables of the age groups in triple jump

	Variables	Structure Matrix		Standardized coefficients		Unstandardized coefficients	
		1	2	1	2	1	2
1	Average velocity of the last step in approaching (m/sec)	0.295	0.853*	1.640	0.829	4.811	2.430
2	Step distance (m)	0.306*	-0.098	1.081	-0.694	5.719	-3.674
3	Horizontal velocity of the jump at the pushing moment (m/sec)	-0.086	0.597*	-2.168	0.377	-4.136	0.720
	Constant					-43.611	-11.332

Table (5) shows the Structure Matrix whose value rises over the second function, which clarifies the relative importance of the technical performance variables and the standardized and Unstandardized coefficients and the constant of the

Discriminant function that entered the model, while the rest of the variables are not significant and did not enter the model and its contribution percentage does not exceed 5.30%, and the resulting Unstandardized Discriminant function for the second function is as follows:

Z = (-11.332) + (2.430 × average velocity of the last step in approaching (m/sec)) + (- 3.674 × step distance (m)) + (0.720 × horizontal velocity of the pushing moment (m/sec))

Table (6)

Level centers and F-testing between the different levels in the variables of the technical performance of the age groups in the triple jump

Age groups	Group Centroids		first division		under20 years		under18 years	
	1	2	Value	Sig.	Value	Sig.	Value	Sig.
first division	4.780	2.077	0.000	1.00				
under20 years	2.899	-.972	8.166	0.002	0.000	1.00		
under18 years	-4.692	.193	59.348	0.000	68.815	0.000	0.000	1.00

Table (6) shows the levels positions of the differentiation function resulting from the technical performance variables, where the positions of the first-phase and under 20 years players were positive and the under 18 years were negative in the first function of differentiation, while the differences between the centers were significant at 0.05, and the cut-off point of the centers can be calculated where the first function 3.840, - 0.896 in order to classify the age groups after obtaining the differentiation value (Z) resulting from the previous equation.

Table (7)

Classification Results of Discriminant function in reclassifying the technical performance variables for the age groups in the triple jump

Age groups		Original			Cross-validated			Total
		First division	under20 years	under18 years	First division	under20 years	under18 years	
first division	Number	3	0	0	2	1	0	3
	%	100	0.00	0.00	66.7	33.3	0.00	
under20 years	Number	1	7	0	1	7	0	8
	%	12.5	87.5	0.00	12.5	87.5	0.00	
under18 years	Number	0	0	8	0	0	8	8
	%	0.00	0.00	100	0.00	0.00	100	
Total		4	7	8	3	8	8	19
Classification Percentage		94.7%			89.5%			

Table (7) shows the efficiency of the correct division of the Discriminant function model, since 3 first division players were divided by 100%, 7 under 20 years players by 87.5%, and 8 under 18 years players by 100%, one player by 5.26% was divided by fault, and 2 players by 10.53% were excluded by fault. The correct classification percentage for the model was 94.7% and the exclusion division was 89.5%, which is higher than the acceptable percentage for the success of the model in the classification, which is 47.44%, and this proves the validity of the model and the function of differentiation in the classification of the age groups in the technical performance of the triple jump.

Discussion:

Table (1)showed that the triple jump average distance of the first division players was

14.71 meters, the average distance of the under 20 years players was 14.23 meters and the average distance of the under 18 years players was 12.72 meters, although the best distance was achieved by an under 20 years player with 15.38 meters, but the average distance for the first division players came with the highest value because the shortest distance was 14.27 meters and the longest distance was 14.95 meters, because some under20 years players had their shortest distance with 13.61 meters and the longest distance was 15.38 meters, the average age level was decreased. The under18 years players' distances were between (12.06: 13.29) meters. This shows that the training age is an important factor that affects triple jump performance.

The results of the main phase (hop, step, jump)of the three age groups showed that all of the players use the most common technique, which is focusing on the distance length of the hop, followed by the jump, where the percentage of hop in the three phases ranged between (36.79%: 35.89%), the step ranged between (30.37%: 29.67%) and the jump (33.82%: 33.32%)of the total distance, the under 20 years group had the highest percentage in the step length and this is because of the best distance was for a player in this group.

The results of the first division players in the hop phase came with the greatest horizontal velocity with 9.34 m/sec, the lowest vertical velocity and the longest support time, which led to an increase in unfolding the knee and an increase in the center of gravity while pushing in the take-off. In the step, the horizontal velocity and the increased center of gravity were preserved during pushing too. However, pushing was performed with a low flight angle due to the low vertical velocity, and consequently, the highest vertical velocity and the resultant velocity loss was compared to the other age groups. In the jump phase, the horizontal and resultant velocities, and the unfolded knee angle were preserved during the push, which led to the increase of the center of gravity and the increase in the flight angle, although the loss of the horizontal and resultant velocities during the support was high compared to the other age groups.

The results of the under-20 players in the hop phase had the greatest loss of horizontal and resultant velocities and the lowest knee angle during pushing in increasing the hop, which led to the lowest take-off angle and flight angle between the age groups, and the step also had the least horizontal velocity and resultant pushing moment and the most loss in horizontal velocity during the support.

The results of the under-18 players in the hop phase had the least time at the take-off and the lowest vertical velocity despite the increase of the take-off and flight angle, the loss in the vertical velocity was great compared to the other age groups, and in the step phase, the vertical velocity was increased and the take-off and flight angle increased although the support time was less than the other age groups, the jump took the least time to take-off too despite the increased vertical velocity and flight angle, although the loss in the vertical velocity was great during focusing to jump compared to the other age groups.

There is a linear correlation between the increase in vertical velocity and the loss of horizontal velocity at each phase of the triple jump which is called (the factor of converting the horizontal velocity to the vertical velocity) and the athletes with the best distance in the jump have the highest coefficient of transfer from the horizontal to the vertical velocity.

Tables (3,4,5,6,7) show the variables resulting from the discrimination analysis between the different age groups (first division, under20, under18 years) for the triple jump players, and they are (the average velocity of the last step in approaching, the distance of the step and the horizontal velocity of the jump at the pushing moment) where these variables are the most important variables that affect the jump distance and can discriminate the level of the player according to the age group in the triple jump event.

The distance of the step has a major effect on the jump distance and represents a large proportion of the variation in the length of the triple jump, and the jump distance can be developed by reducing the distance of the hop relatively and increasing the length of the step distance (18), (22). The motor basis for obtaining a longer flight range for the step depends on the player's ability to master the performance of landing and linking the correct timing of the free leg's weight with the swinging arms and the movement of the take-off leg. (3:11)

The higher the focus in the step phase, the better the triple jump gets, and the forces of the land vertical reaction during the landing reduces the athlete's ability to exert the possible maximum effort in the step, which leads to a great loss in the horizontal velocity, and causes significant negative changes in the jump for the players who depend on the increased length of the hop, so the length of the step is closely related to the length of the triple jump distance. (18: 649), (1), (11)

The jump represents the second longest distance in the triple jump and its distance is less than the hop and greater than the step, and despite the loss of a lot of power and velocity during the performance of the hop and the step, when performing the take-off phase a great amount of power and vertical velocity should be exerted and as a result of the decrease in velocity, the support time increases to reach 0.16 - 0.19 seconds. (5:39), (4)

There is a correlation between increasing the horizontal velocity and the triple jump distance, as the velocity factor is the main factor in improving and increasing the distance of thee jump, which contribute by more than 80%, and the loss of horizontal velocity in the hop and step is at a rate of (9.25, 7.27, 7.01) m/sec, respectively. The decrease in these phases affects the achievement rate, and the jump angle is (16.1), which is higher than the angles of the hop and the

step. This is due to the decrease in the horizontal velocity in the last phase of the jump process, and the players must exert more effort to reach the best angle just like in the long jump. (17), (21)

We can conclude from the above that the time and training age of the triple jump player affects the physical and technical abilities to perform the jump perfectly, and that the most important variables that can discriminate between the players of the age groups (first division, under 20 years, under 18 years) are the average velocity of the last step in approaching, step distance and horizontal velocity of the jump at the moment of pushing, and the players can be classified according to the level by using the differentiation equation under discussion, and thus it becomes clear to us that the study hypothesis has been achieved that there are significant differences (discriminant indicators) in the technical performance between the age groups (first division, under20, under18 years) in the triple jump event.

Conclusions:

In light of the study objectives and results, the following points were concluded:

1. The players of the age groups (first division, under20, under18 years) used the hopscotch-based technique followed by the jump, and the first division players had the longest distance despite using the small step model.
2. The players of the age groups (first division, under20, under18 years) in approaching depended on controlling the last three steps (short – long – short) and obtaining horizontal velocity and employing them in the subsequent phases.
3. The results of the biomechanical variables for the players of the age groups (first division, under20, under18 years) in the three phases were as follow:
   - The first division players had the highest horizontal velocity, the lowest vertical velocity, and the longest support time in the hop. In the step the horizontal velocity was preserved but the vertical velocity was neglected.
   - The under20 years players had the greatest loss of horizontal velocity and the least take-off angle and flight in the hop, and the step had the lowest horizontal velocity at the pushing moment and the greatest loss in the horizontal velocity and take-off with the least flight angle, and the jump had the longest support time with increased vertical velocity and increased flight angle despite the increasing losses in the vertical velocity for the players of the other age groups.
   - The under18 years players had the least take-off time in the hop and the lowest vertical velocity and increased vertical velocity losses, and in the step the vertical velocity was increased and the take-off angle and flight increased. The jump had the least time with increase in vertical velocity and the flight angle compared to the other age groups.
4. The most important discriminating indicators among the players of the age groups (first division, under20, under18 years) are the average velocity of the last step in approaching, the distance of the step and the horizontal velocity of the jump at the moment of pushing.

Recommendations:

In light of the results, the researchers recommend the following:

1. Using the results of the current research when developing and preparing the training programs for the triple jump players of the different age groups.
2. Taking into consideration the discriminant indicators between the world and national levels to determine the most relevant and most important variables that affect the technical performance in the triple jump event.
3. Conducting further research on the discriminant indicators in the physical and physiological variables between the age groups and the different levels to reach the optimal performance in the triple jump event.

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