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The effect of a program based on qualitative analysis on improving the performance of switch leap skill of the floor exercises apparatus for girls under 10 years

Prof.Dr. Aziza Abd-elghany Ali Mustafa
Retired Professor of Rhythmic exercises and artistic gymnastics department - Faculty of Physical Education For Girls - Helwan University
yzakaria59@yahoo.com

Prof.Dr. Sohir Labib Farag Gerges
Retired Professor of Rhythmic exercises and artistic gymnastics department - Faculty of Physical Education For Girls - Helwan University
shahynasr71@yahoo.com

yasmine yahia zakaria gad
yasmineyahia430@gmail.com

Abstract :

Gymnastics is one of the sports in which motor analysis has contributed using the research method of motor analysis, which has contributed to raising the level of skill performance. However, there are still some skills that we can benefit from the research methods of motor analysis in studying and benefiting to its development. Some of its skills have been subjected to research and study from their results in... Developing training methods to reach the highest possible level of skill performance in the shortest time and with the least effort.

The scientific basis on which training programs are developed is to know the biomechanical characteristics of the skill through kinetic analysis and determine the stages of performance (the preliminary stage - the main stage - the final stage), identifying the muscles working on the joints of the body during performance, as well as identifying the physical fitness elements of the skill. Selected on the basis of physiological training.

Based on the fact that the qualitative analysis of sports skills is determined by the coach's ability to know the characteristics of motor performance by observing and evaluating the sequence of movement independently according to its meaning in biomechanics, it also enables the coach to study the geometric characteristics of sports movement in an easy way.

Keywords : - qualitative analysis - program training - floor exercises apparatus - gymnastics skills

تأثير برنامج بدلالة التحليل الكيفي على تحسين أداء احدى مهارات جهازالحركات الأرضية للناشئات تحت ١٠ سنوات

المستخلص :

رياضة الجمباز إحدى الرياضات التي أسهم التحليل الحركي في تطورها وقد خضعت بعض مهاراتها للبحث والدراسة بأسلوب البحث الخاصة بالتحليل الحركي مما ساهم في الأرتقاء بمستوى الأداء المهاري إلا أنه لا يزال هناك بعض المهارات التي يمكن أن نستفيد بأساليب البحث الخاص بالتحليل الحركي في دراستها والإستفادة من نتائجها في تطوير أساليب التدريب عليها للوصول إلى أعلى مستوى أداء مهاري ممكن في أقصر وقت وبأقل جهد.

و الأساس العلمي الذي يتم من خلاله وضع البرامج التدريبية هو معرفة الخصائص البيوميكانيكية للمهارة عن طريق التحليل الحركي لها وتحديد مراحل الأداء (المرحلة التمهيدية – المرحلة الرئيسية – المرحلة النهائية), تحديد العضلات العاملة على مفاصل الجسم أثناء الأداء, كذلك تحديد عناصر اللياقة البدنية الخاصة بالمهارة المختارة على أسس فسيولوجية التدريب.

واعتمادا على أن التحليل الكيفي للمهارات الرياضية يتحدد بقدرة المدرب على معرفة خصائص الأداء الحركي بملاحظة وتقييم تسلسل الحركة ذاتيا وفقا لمعناها في الميكانيكا الحيوية كما يمكن المدرب من دراسة الخصائص الهندسية للحركة الرياضية بطريقة سهلة.

كلمات مفتاحية Keywords: التحليل الحركي – المهارات الجمبازية – جهاز الحركات الأرضية ناشئات الجمباز الفني .

The effect of a program based on qualitative analysis on improving the performance of switch leap skill of the floor exercises apparatus for girls under 10 years

The introduction:

Gymnastics is one of the activities that requires great effort to learn and master, due to its many skills, difficulties, and different equipment, in addition to the distinctive characteristics required for performance, such as controlling the body and its various parts in unfamiliar situations, as well as performing movements in space, at different heights and at different speeds, in addition to... Real-time control of technical performance, which plays the main role in evaluation.

Gymnastics is one of the sports in which motor analysis has contributed to its development. Some of its skills have been subjected to research and study using the research method of motor analysis, which has contributed to raising the level of skill performance. However, there are still some skills that we can benefit from the research methods of motor analysis in studying and benefiting from their results in... Developing training methods to reach the highest possible level of skill performance in the shortest time and with the least effort.

The scientific basis on which training programs are developed is to know the biomechanical characteristics of the skill through kinetic analysis and determine the stages of performance (the preliminary stage - the main stage - the final stage), identifying the muscles working on the joints of the body during performance, as well as identifying the physical fitness elements of the skill. Selected on the basis of physiological training. (1-5)
Kinetic analysis is considered a true translation of the technological developments that movement sciences have reported, whether in devices, tools, or research methods. As it relies on a set of basic principles derived from the theories and laws of science related to the activity of the human body to provide sufficient capacity to achieve the best educational and training methods for those involved in this process.

Given that movement analysis represents the utmost importance to those responsible for training and teaching sports skills, it requires sufficient knowledge of the rules of movement analysis, which depend on the basic principles of anatomical movement science, biomechanics, and other sciences related to movement. (2-119-120)

Based on the fact that the qualitative analysis of sports skills is determined by the coach's ability to know the characteristics of motor performance by observing and evaluating the sequence of movement independently according to its meaning in biomechanics, it also enables the coach to study the geometric characteristics of sports movement in an easy way.

As qualitative performance analysis is one of the main factors in the sports field, which aims to improve and increase the effectiveness of performance based on the analysis of data that expresses the nature of performance, although it is a subjective process carried out by the coach, which includes an evaluation of the quality of the skill, it requires familiarity with the basic mechanical principles of movement, whether that

is The anatomical, mechanical or training aspect so that he can design training programs that contribute to developing skill performance. (3-165)

Simonian (2000) pointed out that biomechanical movement analysis is one of the most important methods for evaluating movement performance, especially in gymnastics, because of its objectivity, as it relies on quantitative variables such as time, displacement, and speed in studying movements, especially those characterized by speed of performance, and this is what Elliott confirmed. Ellot.B.H (2002) that studying biomechanical variables provides the opportunity to objectively judge the level of performance proficiency, and also contributes to improving sports performance by correcting and developing training theories. (6-32)(5-175)

Research problem:

Coaches in general and coaches of young girls in particular in the sport of gymnastics face difficulty related to the mistakes that young or old players make when they learn new skills. There are mistakes that, if they were not taken into consideration by the coach, would become a characteristic that distinguishes the performance of this athlete. There are types of errors that appear in the performance and transform the skill. From the skill to be learned to another skill, and there are mistakes that appear and persist that prevent the player from developing and progressing with this skill to another skill that is more advanced and developed.

Studying the movement carried out by the human body requires accurate analysis by knowing what happens during the movement in terms of the correspondences of the movements of the different parts of the body, as the biomechanical analysis (quantitative-qualitative) constitutes the initial hypotheses and premises related to the clarity of the scientific basis for rationalizing the essence of the process of training and teaching sports skills.

Analysis is the logical means by which the phenomenon under study is dealt with after dividing it into its primary, basic components, whereby these elements are examined individually to achieve a deeper understanding of the phenomenon as a whole.

Qualitative analysis of sports skill is a descriptive approach to interpreting movements with special performance. It is important that the

results of this analysis be based on the principles of mechanics with the natural needs of performance, and mastery in skill description is reflected in observing what will happen and not what has been done. (4-96)

Motor performance in gymnastics is subject to specific and precise conditions. These conditions help us obtain the following benefits:
1- Discovering errors in motor performance.
2- Determine the kinetic effect.
3- It helps to find means and methods to improve motor performance.
4- Improving motor coordination.

Research Aims:
This research aims to:

Study "**The effect of a program based on qualitative analysis on improving the performance of switch leap skill of the floor exercises apparatus for girls under 10 years**" through:

- Identifying the biomechanical variables of the switch leap skill on the floor exercises apparatus for girls the under-10.

Research hypotheses:

- The use of qualitative analysis contributes to discovering performance errors in the skill of the switch leap on the floor exercises apparatus.

Associated studies:

1- Sahar Morsy Elsaid (2021): The effect of ballistic strength and stretching exercises on some physical and biomechanical variables and the performance level of the switch leap skill for artistic gymnastics.

Research Objective:

The research aims to improve the performance level of the switch leap skill on the floor exercises through strength exercises and ballistic stretching and to identify their effect on some physical and biomechanical variables and the level of performance of the switch leap skill.

2- karim Ali abdelrahman (2020): A proposed training program for some skills of the third group on the vault table using qualitative motor analysis as a function of developing the level of performance.

Research Objective:

Analyzing some of the skills of the third group on the vault table to develop performance and develop a training program.

3- Mohamed foad Mahmoud (2017): Biomechanical variable of the skill of the front handspring by rising and double landing as a function of developing some specific exercises for gymnasts**.**

Research procedures

Research Methodology :

The researcher used the descriptive approach to analyze the motor performance of the switch leap skill, as this approach is appropriate for achieving the research objectives and procedures.

Research areas:

- The human field:

(5) Women's artistic gymnasts under-10 registered in the Egyptian Gymnastics Federation in the year 2022-2023. The research sample was chosen intentionally from women's artistic gymnasts registered in the Egyptian Gymnastics Federation, in order to suit the research plan to the level of performance of the players and to the nature of the performance of the gymnastic series performed. Within the motor system on the floor exercises device, which is one of the basic requirements for this device.

- Spatial field:

Pre- and post-measurements were made for the research inside the gymnastics hall of the Empire Academy in order to suit the place for applying the motor analysis of the skill. The research plan was implemented in the artistic gymnastics hall of the Slimnastic Academy, which is affiliated with the Egyptian Gymnastics

- Time domain:

The research plan was implemented in the time period from 9/9/2022 to 11/18/2022.

The research sample was chosen due to the presence of deficiencies in the level of female athletes while performing the switch leap skill, as this skill is considered an essential part of the gymnastic series performed within the movement system on the floor exercises apparatus for this age stage, according to the requirements of the Egyptian Gymnastics Federation for the year 2022. – 2023, which affects the level of female athletes on the floor exercises apparatus. (2)

Table (1): Basic and anthropometric measurements for the research Sample

N.	Basic and anthropometric measurements	Measuring unit	SMA	Standard deviation	Torsion coefficient	Flatness coefficient	Less value	Highest value
1	Age	year	9.90	0.54	-0.70	-0.30	9.10	10.40
2	Training age	year	5.40	0.55	0.61	-3.33	5.00	6.00
3	Height	meter	1.37	0.05	-1.81	3.51	1.28	1.41
4	Weight	k.g	0.32	0.02	-1.82	3.62	0.28	0.34
5	Torso length	meter	51.60	7.13	-2.11	4.52	39.00	56.00
6	Thigh length	meter	0.42	0.02	-0.42	1.44	0.39	0.45
7	Leg length	meter	0.41	0.02	0.32	-3.08	0.40	0.43
8	Bottom limb length	meter	0.84	0.03	-1.04	-0.42	0.79	0.86
9	Hummers length	meter	0.26	0.03	-0.81	0.67	0.22	0.29
10	Forearm length	meter	0.35	0.02	0.47	-3.09	0.33	0.38
11	Arm length	meter	0.61	0.03	-1.17	2.03	0.56	0.65

It is clear from the table regarding the basic and anthropometric measurements of the research sample that there is homogeneity between the basic and anthropometric measurements of the research sample, as the value of the skewness coefficient ranged between (-2.11 and 0.61), which indicates the presence of homogeneity among the individuals of the research sample before implementing the experiment.

- Tools and devices used in research

Tools and devices used in kinetic analysis:

- Rastameter to measure length in centimeters.
- A medical scale to measure weight in kilograms.
- (4) camera holders.
- (4) GoPro Hero 6 cameras with a shooting frequency of 120 fps.
- laptop.
- Sync remote for cameras.
- A measuring box is an equilateral cube with a side length of one meter.
- Control marks on the joints.
- Maxtraq motor analysis program.

Data collection methods:

- Arabic and English references and scientific theses.

Biomechanical variables:

1-Kinematics:

- Positions: R=√Z-Y-X
- Velocity: R=√Z-Y-X
- Acceleration wheels: R=√Z-Y-X

- Angels.
- Angular velocities Angels V.

2-Kinetics:

- Momentums: R=√Z-Y-X
- Power: R=√Z-Y-X
- Payment (Impact / Impulse)

3-Chronological analysis:

- Approach time.
- Rising time (braking time - propulsion time).
- Ratio coefficient = propulsion time / braking time = lift effectiveness.
- Flight time (time to reach the highest altitude – landing time).

Identify moments:

1- Approach- Flight End.
2- Take-off Touch moment.
3- The moment of maximum amortization.
4- Take-off Toe-off moment.
5- The moment the flight begins.
6- The moment of reaching the highest altitude.
7- The moment the flight ends.
8- The moment the descent begins.

The proposed training program

- Program implementation:

Implementing the program within 10 weeks, 3 units per week, and the unit time is 60 minutes.

- Program principles:

- Taking into account the availability of a suitable place to practice performance with security and safety.
- Suitability of the program to the research sample.
- Taking into account individual differences between female players.
- Taking into account that the exercises used in the research are similar to the skill performance of the skill under research (Switch leap).
- Taking into account the suspense and excitement in the program components.

- The contents of the program :

The contents of the proposed program consist of the following:

- Warm-up (10 minutes): The female athletes perform jumping exercises, stretching exercises, and flexibility exercises for all the muscles and joints of the body to prepare the body's muscles to practice the muscular work required for the skill in question (switch leap).

- The main part (45 minutes): Training in specific exercises designed for each part of the skill stages under study according to the results of its qualitative motor analysis.

- The final part (5 minutes): Do stretching exercises to relax the body's muscles.

Table (2) components distribution of the training load for training in the skill under study during the weekly training units of the proposed training program

Week	intensity	repetition	sits	rest	exercises
1	Average intensity (50:60%)	10-15	3	30 sec	(1:4)
2					
3					
4	High intensity (70:80%)	6-10	4	25 sec	(5:9)
5					
6					
7					
8	Maximum physical load (85:90%)	1-5	5	20 sec	(10:13)
9					
10					

Steps to implement the research experiment

- Pre-measurement:

The researcher conducted a pre-measurement of the research sample, which included measurements of height and weight, and performed a kinetic analysis of the skill of the gap jump with switching legs (Switch leap), according to the reality of the female athletes' performance of 15 attempts of the skill, on Friday, September 9, 2022, at 2 pm in the artistic gymnastics hall at the Empire Academy. Academy.

- Program application:

The researcher implemented the program from Saturday, corresponding to (9/10/2022) to Wednesday (11/16/2022), for a period of (10) weeks, with (3) training units per week on days (Saturday, Monday, and Wednesday),

and the unit time (60 sec) from 4 pm to 5 pm in the artistic gymnastics hall at Slimnastic Academy.

Post- measurement: -

The post-measurement of the research sample was conducted in the same manner as the pre-measurement

- Statistical treatments:

- SMA.
- standard deviation.
- The difference between the averages (highest value - lowest value).
- T-test for the difference between one group (T.paird).
- Multiple linear regression.
- Contribution percentage.

Table (3) Multiple regression analysis of biomechanical characteristics and contribution to identifying biomechanical indicators (n=15)

Contribution percentage	Biomechanical properties					Fixed amount	step
69%	Regression coefficient	The amount of horizontal movement of the body's center of gravity				10.39	1
		0.35-					
80%	Regression coefficient	Angular velocity of the left wrist			The amount of horizontal movement of the body's center of gravity	10.27	2
		0.002			0.37-		
86%	Regression coefficient	Transverse acceleration of the body's center of gravity	Angular velocity of the left wrist		The amount of horizontal movement of the body's center of gravity	10.17	3
		0.055	0.002		0.040-		
94%	Regression coefficient	Angular velocity of the right shoulder	Transverse acceleration of the body's center of gravity	Angular velocity of the left wrist	The amount of horizontal movement of the body's center of gravity	10.07	4
		0.001	0.054	0.002	0.040-		

It is clear from Table (3), which is related to the multiple regression analysis of the biomechanical characteristics of the moment of the beginning of flight, and the contribution to determining the biomechanical indicators of skill in the research sample amounted to four

variables, in the following order: the amount of horizontal movement of the center of gravity of the body and the angular velocity of the left wrist and the wheel. The transverse center of gravity of the body and the angular velocity of the right shoulder, where the contribution percentage of the first indicator was (69%), the second indicator (80%), the third indicator (86%), and the fourth indicator (94%).

The first indicator

It is clear from Table (8), which is related to the multiple regression analysis of the biomechanical characteristics of the moment of the beginning of flight and the contribution to determining the biomechanical indicators of the skill in the research sample, that the index of the horizontal momentum of the body's center of gravity is the most biomechanical indicator contributing to the effectiveness of the skill performance in the research sample, as its contribution percentage was 69%.

Based on the above, the predictive regression equation is:
Y = a + b1 x1
Y= (10.39) +(0.35-) (60)
Where a = constant quantity
Where b1 = regression coefficient for the index of horizontal momentum of the body's center of gravity.
Where x1 = the value of the horizontal momentum index of the body's center of gravity.

The second indicator

It is clear from Table (8), which is related to the multiple regression analysis of the biomechanical characteristics of the moment of the beginning of flight and the contribution to determining the biomechanical indicators of the skill in the research sample, that the angular velocity index of the left wrist is the second most important biomechanical indicator contributing to the effectiveness of the skill performance in the research sample, as it reached His contribution rate is 80%.
Based on the above, the predictive regression equation is:
Y = a + b1 x1
Y= (10.27) + (-0.37) (60) + (0.002) (157)
Where a = constant quantity
Where b1 = regression coefficient for the index of horizontal momentum of the body's center of gravity

Where x1 = the value of the horizontal momentum index of the body's center of gravity
Where b2 = regression coefficient for the angular velocity index of the left wrist.
Where x2 = the value of the angular velocity index of the left wrist

The third indicator

It is clear from Table (8), which is related to the multiple regression analysis of the biomechanical characteristics of the moment of flight start and its contribution to determining the biomechanical indicators of the skill in the research sample, that the transverse wheel index of the body's center of gravity is the third most biomechanical indicator contributing to the effectiveness of the skill performance in the research sample, as its contribution percentage reached 86. %.

Based on the above, the predictive regression equation is:
Y = a + b1 x1
Y= (10.17) + (-0.040) (60) + (0.002) (157) + (0.055) (3.14).
Where a = constant quantity
Where b1 = regression coefficient for the index of horizontal momentum of the body's center of gravity
Where x1 = the value of the horizontal momentum index of the body's center of gravity
Where b2 = regression coefficient for the angular velocity index of the left wrist.
Where x2 = the value of the angular velocity index of the left wrist
Where b3 = the regression coefficient for the transverse acceleration index of the body's center of gravity
Where x3 = the value of the transverse acceleration index of the body's center of gravity.

Fourth indicator

It is clear from Table (8), which is related to the multiple regression analysis of the biomechanical characteristics of the moment of the beginning of flight and the contribution to determining the biomechanical indicators of the skill in the research sample, that the angular velocity index of the right shoulder is the fourth most biomechanical indicator contributing to the effectiveness of the skill performance in the research sample, as its contribution percentage was 94%.

Based on the above, the predictive regression equation is:
Y = a + b1 x1
Y= (10.08) + (-0.040) (60) + (0.002) (157) + (0.054) (3.14) + (0.001) (140)
Where x3 = the value of the transverse acceleration index of the body's center of gravity.
Where b4 = regression coefficient for the angular velocity index of the right shoulder
Where x4 = the value of the angular velocity index of the right shoulder

Table (4) Statistical significances of the linear kinematic variables for the end-of-flight (approach) moment for the pre-post measurement for the research group

Improvement rate	Significance level	"T" value	Difference of averages	Post measurement (N=12)		Pre-measurement (N=12)		Measuring unit	Kinematic variables	N.
				A ±	S ±	A ±	S ±			
-32%	0.24	1.25	0.06	0.04	0.12	0.15	0.18	meter	The horizontal displacement of the body's center of gravity	1
-98%	0.00	**63.78***	0.65	0.01	0.01	0.03	0.66	meter	The vertical displacement of the body's center of gravity	2
-96%	0.00	**35.62***	0.38	0.01	0.02	0.04	0.39	meter	Transverse displacement of the body's center of gravity	3
-84%	0.00	**36.16***	0.67	0.03	0.13	0.05	0.80	meter	The resultant displacement of the body's center of gravity	4
-5%	0.22	1.29	0.17	0.29	3.32	0.25	3.48	M/S	The horizontal velocity of the body's center of gravity	5
-20%	0.09	1.87	0.10	0.21	0.39	0.11	0.49	M/S	The vertical velocity of the body's center of gravity	6
99%	0.00	**3.65***	-0.20	0.21	0.40	0.08	0.20	M/S	The tangential velocity of the body's center of gravity	7
-4%	0.25	1.21	0.15	0.27	3.38	0.25	3.52	M/S	The resultant velocity of the body's center of gravity	8
-41%	0.25	1.22	2.39	2.54	3.47	6.25	5.86	²M/S	Horizontal acceleration of the body's center of gravity	9
-18%	0.70	0.39	1.18	7.64	5.43	5.18	6.61	²M/S	Vertical acceleration of the body's center of gravity	10
-50%	0.11	1.74	1.19	0.93	1.19	1.88	2.38	²M/S	Transverse acceleration of the body's center of gravity	11

-26%	0.38	0.92	2.74	6.80	7.80	6.29	10.54	²M/S	The resultant acceleration of the body's center of gravity	12

It is clear from Table (4) regarding the statistical significances of the Kenyan variables that the linearity of the end-of-flight moment for the pre- and post-measurements among the research group leads to significant differences in favor of the post-measurement in the variables of vertical, transverse and resultant displacement, as well as the transverse velocity of the body's center of gravity, where its calculated value represented the values between (3.65 to 63.78 (which is greater than its tabular value at the significance level of 0.05, where the tabular t value is equal to 2.201.

The rate of improvement was high in favor of the dimensional measurement, as it ranged from (-98% to -84%), as the closer the center of gravity is to the ground, the greater the base of support for the athlete.

Table (5) Statistical significances for the angular kinematic variables of the end-of-flight (approach) moment for the pre-post measurement for the research group

Improvement rate	Significance level	"T" value	Difference of averages	Post measurement (N=12)		Pre-measurement (N=12)		Measuring unit	Kinematic variables	N.
				A ±	S ±	A ±	S ±			
-17%	0.00	**3.83***	20	11	101	10	121	degree	Right ankle angle	1
-2%	0.49	0.71	3	14	156	5	159	degree	Right knee angle	2
0%	0.97	0.04	0	24	141	8	141	degree	Right thigh angle	3
19%	0.28	1.15	-9	19	53	13	45	degree	Right shoulder angle	4
5%	0.53	0.65	-7	21	151	25	144	degree	Right elbow angle	5
0%	0.85	0.20	-1	5	163	9	163	degree	Right wrist angle	6
15%	0.01	**3.19***	-17	12	130	12	113	degree	Left ankle angle	7
16%	0.00	**3.70***	-17	13	124	11	107	degree	Left knee angle	8
4%	0.08	1.93	-7	6	172	11	165	degree	Left thigh angle	9
0%	1.00	0.00	0	13	30	16	30	degree	Left shoulder angle	10
-5%	0.45	0.78	8	19	145	24	153	degree	Left elbow angle	11
-4%	0.10	1.80	7	12	157	8	164	degree	Left wrist angle	12

431%	0.32	1.03	-686	2284	845	91	159	degrees/s	Angular velocity of the right ankle	13
895%	0.30	1.10	-662	2078	736	66	74	degrees/s	Angular velocity of the right knee	14
354%	0.37	0.94	-859	3142	1101	91	243	degrees/s	Angular velocity of the right thigh	15
58%	0.57	0.58	-221	1328	606	107	385	degrees/s	Angular velocity of the right shoulder	16
142%	0.47	0.75	-330	1546	562	160	232	degrees/s	Angular velocity of the right elbow	17
-31%	0.20	1.35	51	99	113	134	164	degrees/s	Angular velocity of the right wrist	18
446%	0.30	1.09	-794	2475	973	151	178	degrees/s	Angular velocity of the left ankle	19
86%	0.33	1.02	-385	1226	830	180	445	degrees/s	Angular velocity of the left knee	20
1109%	0.35	0.97	-1828	6518	1993	95	165	degrees/s	Angular velocity of the left thigh	21
117%	0.42	0.85	-336	1308	623	122	287	degrees/s	Angular velocity of the left shoulder	22
77%	0.17	1.47	-179	478	411	160	233	degrees/s	Angular velocity of the left elbow	23
90%	0.54	0.64	-199	1055	419	235	221	degrees/s	Angular velocity of the left wrist	24

It is clear from Table (5) regarding the statistical significances of the variables. Words: angle, end of flight, for measurement, researcher ability, the presence of the variables, ankle angle and left ankle angle, where the calculated T values represented a range between (3.19 and 3.83), which is greater than the tabulated T value at the significance level of 0.05, where The tabular value of t is 2.201.

Table (6) Statistical significances of the linear kinematic variables for the end-of-flight (approach) moment for the pre-post measurement for the research group

Improvement rate	Significance level	"T" value	Difference of averages	Post measurement (N=12)		Pre-measurement (N=12)		Measuring unit	kinematic variables	N.
				A ±	S ±	A ±	S ±			
107.98	0.60	0.54	2.60	11.77	105.38	12.56	107.98	kg.m/s	The horizontal momentum of the body's center of gravity	1

15.23	0.13	1.65	2.74	6.91	12.48	4.09	15.23	kg.m/s	The amount of vertical movement of the body's center of gravity	2
6.30	0.00	**3.74***	-6.60	6.99	12.90	2.55	6.30	kg.m/s	Transverse momentum of the body's center of gravity	3
109.31	0.68	0.43	1.96	11.43	107.35	12.73	109.31	kg.m/s	The resultant momentum of the body's center of gravity	4
178.08	0.26	1.19	69.75	75.57	108.33	183.75	178.08	Newton	The force exerted horizontally on the body's center of gravity	5
204.83	0.76	0.32	30.75	244.97	174.08	170.43	204.83	Newton	The force exerted vertically on the body's center of gravity	6
71.58	0.13	1.62	33.50	30.23	38.08	55.20	71.58	Newton	The force exerted tangential to the body's center of gravity	7
323.50	0.43	0.82	76.25	217.94	247.25	194.03	323.50	Newton	The resultant force exerted on the body's center of gravity	8

It is clear from Table (6) of the statistical significances of the linear kinematic variables of the end-of-flight (approach) moment for the pre-post measurement in the research group that there are significant differences in the variable of the transverse momentum of the body's center of gravity, where the calculated T value represented 3.74, which is greater than the tabulated T value at the level The significance is 0.05, where the tabular value of t is 2.201.

Table (7) Statistical significances for the linear kinematic variables of the moment of the end of the rise for the pre-post measurement for the research group

Improvement rate	Significance level	"T" value	Difference of averages	Post measurement (N=12)		Pre-measurement (N=12)		Measuring unit	Kinematic variables	N.
				A ±	S ±	A ±	S ±			
22%	0.09	1.88	-0.13	0.09	0.69	0.22	0.56	meter	The horizontal displacement of the body's center of gravity	1
-68%	0.00	**30.44***	0.59	0.05	0.27	0.06	0.86	meter	The vertical displacement of the body's center of gravity	2
-77%	0.00	**24.74***	0.33	0.03	0.10	0.04	0.43	meter	Transverse displacement of the body's center of gravity	3
-34%	0.00	**11.67***	0.38	0.09	0.75	0.09	1.13	meter	The resultant displacement of the body's center of gravity	4
8%	0.11	1.76	-0.16	0.30	2.11	0.35	1.94	M/S	The horizontal velocity of the body's center of gravity	5
20%	0.00	**4.52***	-0.38	0.29	2.30	0.14	1.92	M/S	The vertical velocity of the body's center of gravity	6

199%	0.00	**5.72***	-0.23	0.11	0.35	0.12	0.12	M/S	The tangential velocity of the body's center of gravity	7
15%	0.00	**5.49***	-0.40	0.20	3.16	0.20	2.75	M/S	The resultant velocity of the body's center of gravity	8
-10%	0.70	0.40	0.38	4.95	3.46	2.62	3.84	²M/S	Horizontal acceleration of the body's center of gravity	9
-17%	0.40	0.88	1.78	4.93	8.76	4.02	10.54	²M/S	Vertical acceleration of the body's center of gravity	10
-58%	0.05	2.18	1.63	0.80	1.20	2.51	2.83	²M/S	Transverse acceleration of the body's center of gravity	11
-20%	0.23	1.27	2.44	6.36	9.92	2.93	12.36	²M/S	The resultant acceleration of the body's center of gravity	12

It is clear from Table (7) regarding the statistical significances of the linear kinematic variables of the moment of the end of the ascent for the pre-post measurement in the research group that there are significant differences in the vertical displacement of the body's center of gravity, the transverse displacement of the body's center of gravity, the resultant displacement of the body's center of gravity, the vertical velocity of the body's center of gravity, and the speed. The tangential value of the body's center of gravity and the resultant velocity of the body's center of gravity, where the calculated T value is between 4.52 and 30.44, which is greater than the tabular T value at a significance level of 0.05, where the tabular T value is equal to 2.201.

Table (8) Statistical significances for the angular kinematic variables of the end moment of the rise for the pre-post measurement for the research group

Improvement rate	Significance level	"T" value	Difference of averages	Post measurement (N=12)		Pre-measurement (N=12)		Measuring unit	Kinematic variables	N.
				A ±	S ±	A ±	S ±			
-1%	0.78	0.29	1.17	14	144	12	145	degree	Right ankle angle	1
-2%	0.30	1.08	3.17	8	165	5	168	degree	Right knee angle	2
4%	0.14	1.61	-6.58	10	164	8	158	degree	Right thigh angle	3
16%	0.23	1.26	-11.58	20	84	22	72	degree	Right shoulder angle	4
-10%	0.52	0.66	13.42	45	119	36	132	degree	Right elbow angle	5

Improvement rate	Significance level	"T" value	Difference of averages	Post measurement (N=12)		Pre-measurement (N=12)		Measuring unit	Kinematic variables	N.
				A ±	S ±	A ±	S ±			
-3%	0.46	0.77	4.17	15	155	7	159	degree	Right wrist angle	6
-8%	0.19	1.39	11.00	16	127	14	138	degree	Left ankle angle	7
-5%	0.07	1.97	7.83	11	166	5	174	degree	Left knee angle	8
-4%	0.42	0.84	4.17	12	112	15	116	degree	Left thigh angle	9
25%	0.09	1.88	-14.42	28	71	11	57	degree	Left shoulder angle	10
6%	0.36	0.95	-8.58	19	158	24	149	degree	Left elbow angle	11
0%	0.93	0.09	0.33	11	162	7	163	degree	Left wrist angle	12
244%	0.34	0.99	-1538	5342	2169	161	630	degrees/s	Angular velocity of the right ankle	13
438%	0.31	1.06	-455.42	1474	560	109	104	degrees/s	Angular velocity of the right knee	14
436%	0.33	1.03	-501.83	1680	617	83	115	degrees/s	Angular velocity of the right thigh	15
351%	0.29	1.12	-575	1727	739	198	164	degrees/s	Angular velocity of the right shoulder	16
372%	0.39	0.90	-972	3686	1234	216	262	degrees/s	Angular velocity of the right elbow	17
872%	0.35	0.98	-1097	3843	1223	108	126	degrees/s	Angular velocity of the right wrist	18
266%	0.36	0.96	-492	1743	678	121	185	degrees/s	Angular velocity of the left ankle	19
1373%	0.30	1.10	-1010	3180	1084	43	74	degrees/s	Angular velocity of the left knee	20
573%	0.36	0.95	-1065	3912	1252	80	186	degrees/s	Angular velocity of the left thigh	21
10%	0.81	0.25	-24.42	218	281	237	257	degrees/s	Angular velocity of the left shoulder	22
542%	0.30	1.09	-816.67	2546	967	148	151	degrees/s	Angular velocity of the left elbow	23
616%	0.35	0.97	-1358	4970	1579	168	220	degrees/s	Angular velocity of the left wrist	24

It is clear from Table (8) regarding the statistical significances of the angular kinematic variables of the end moment of the rise for the pre-post measurement in the research group that there are no significant differences, as the calculated T-value represented values lower than the tabulated T-value at a significance level of 0.05, where the tabulated T-value is It is equal to 2.201.

Table (9) Statistical significances for the linear kinematic variables for the moment of the end of the rise for the pre-post measurement for the research group

Improvement rate	Significance level	"T" value	Difference of averages	Post measurement (N=12)		Pre-measurement (N=12)		Measuring unit	Kinematic variables	N.
				A ±	S ±	A ±	S ±			
12%	0.06	2.11	-6.93	10.49	66.92	11.03	59.99	kg.m/s	The horizontal momentum of the body's center of gravity	1
22%	0.00	**4.28***	-13.43	11.30	73.15	7.83	59.72	kg.m/s	The amount of vertical movement of the body's center of gravity	2
223%	0.00	**5.92***	-7.65	3.60	11.07	3.30	3.42	kg.m/s	Transverse momentum of the body's center of gravity	3
18%	0.00	**4.65***	-15.10	10.16	100.43	8.90	85.34	kg.m/s	The resultant momentum of the body's center of gravity	4
-2%	0.94	0.08	2.58	166	113	82	116	Newton	The force exerted horizontally on the body's center of gravity	5
-14%	0.47	0.75	47.42	163	280	136	327	Newton	The force exerted vertically on the body's center of gravity	6
-53%	0.06	2.09	42.92	26	39	68	82	Newton	The force exerted tangential to the body's center of gravity	7
-16%	0.34	1.00	62.08	213	318	104	380	Newton	The resultant force exerted on the body's center of gravity	8

It is clear from Table (9) regarding the statistical significances of the linear kinematic variables of the end moment of the ascent for the pre-post measurement in the research group that there are significant differences in the variables: the amount of vertical movement of the body's center of gravity, the amount of tangential movement of the body's center of gravity, and the resultant amount of movement of the body's center of gravity. The calculated T value ranged from 4.28 to 5.92, which is greater than the tabular T value at a significance level of 0.05, where the tabular T value is equal to 2.201.

Table (10) Statistical significances for the linear kinematic variables of the end-of-flight moment for the pre-post measurement for the research group

Improvement rate	Significance level	"T" value	Difference of averages	Post measurement (N=12)		Pre-measurement (N=12)		Measuring unit	Kinematic variables	N.
				A ±	S ±	A ±	S ±			
14%	0.03	**2.43***	-0.19	0.17	1.57	0.23	1.38	meter	The horizontal displacement of the body's center of gravity	1
-61%	0.00	**27.08***	0.52	0.03	0.33	0.05	0.85	meter	The vertical displacement of the body's center of gravity	2
-53%	0.00	**9.52***	0.27	0.07	0.23	0.06	0.50	meter	Transverse displacement of the body's center of gravity	3
-4%	0.28	1.13	0.08	0.17	1.63	0.18	1.70	meter	The resultant displacement of the body's center of gravity	4
-5%	0.16	1.50	0.11	0.20	2.06	0.36	2.17	M/S	The horizontal velocity of the body's center of gravity	5
-1%	0.85	0.20	0.02	0.16	2.16	0.32	2.17	M/S	The vertical velocity of the body's center of gravity	6
7%	0.71	0.39	-0.02	0.13	0.30	0.15	0.28	M/S	The tangential velocity of the body's center of gravity	7
-4%	0.08	1.92	0.11	0.14	3.01	0.18	3.12	M/S	The resultant velocity of the body's center of gravity	8
-53%	0.06	2.05	2.34	1.58	2.10	4.04	4.45	²M/S	Horizontal acceleration of the body's center of gravity	9
-21%	0.45	0.78	2.01	4.36	7.41	7.19	9.42	²M/S	Vertical acceleration of the body's center of gravity	10
-73%	0.02	**2.60***	4.30	1.28	1.60	5.46	5.91	²M/S	Transverse acceleration of the body's center of gravity	11
-40%	0.03	**2.54***	5.54	3.67	8.42	6.46	13.96	²M/S	The resultant acceleration of the body's center of gravity	12

It is clear from Table (10) of the statistical significances of the linear kinematic variables of the end-of-flight moment for the pre-post measurement in the research group that there are significant differences for the variables of the horizontal displacement of the body's center of gravity, the vertical displacement of the body's center of gravity, the transverse displacement of the body's center of gravity, and the transverse acceleration. For the center of gravity of the body and the resultant acceleration of the center of gravity of the body, the calculated value of T

represents between 2.43 and 27.08, which is greater than the value of the tabular T at the significance level of 0.05, where the value of the tabular T is equal to 2.201.

Table (11) Statistical significances for the angular kinematic variables of the end-of-flight moment for the pre-post measurement for the research group

Improvement rate	Significance level	"T" value	Difference of averages	Post measurement (N=12)		Pre-measurement (N=12)		Measuring unit	Kinematic variables	N.
				A ±	S ±	A ±	S ±			
-10%	0.00	**4.12***	15.17	12	142	5	157	degree	Left ankle angle	1
0%	0.85	0.20	0.50	8	169	3	169	degree	Left knee angle	2
-2%	0.32	1.03	3.58	8	151	8	154	degree	Left thigh angle	3
14%	0.25	1.21	-12.17	15	97	26	85	degree	Left shoulder angle	4
3%	0.14	1.59	-5.50	5	171	10	166	degree	Left elbow angle	5
5%	0.13	1.66	-7.25	9	164	10	156	degree	Left wrist angle	6
-17%	0.02	**2.86***	21.75	26	109	13	131	degrees/s	Angular velocity of the right ankle	7
2%	0.19	1.39	-3.75	7	166	7	162	degrees/s	Angular velocity of the right knee	8
6%	0.29	1.12	-7.92	20	135	13	127	degrees/s	Angular velocity of the right thigh	9
14%	0.41	0.85	-12.33	22	99	43	87	degrees/s	Angular velocity of the right shoulder	10
0%	1.00	0.00	0.00	32	165	15	165	degrees/s	Angular velocity of the right elbow	11
-7%	0.08	1.91	11.67	20	149	6	161	degrees/s	Angular velocity of the right wrist	12
86%	0.32	1.04	-372.75	1152	808	389	435	degrees/s	Angular velocity of the left ankle	13
574%	0.37	0.93	-1027	3795	1207	111	179	degrees/s	Angular velocity of the left knee	14
71%	0.04	**2.30***	-209	319	506	108	297	degrees/s	Angular velocity of the left thigh	15
80%	0.14	1.58	-147	263	332	158	185	degrees/s	Angular velocity of the left shoulder	16

Improvement rate	Significance level	"T" value	Difference of averages	Post measurement (N=12)		Pre-measurement (N=12)		Measuring unit	Kinematic variables	N.
				A ±	S ±	A ±	S ±			
180%	0.31	1.06	-215	715	335	60	120	degrees/s	Angular velocity of the left elbow	17
1244%	0.35	0.98	-1892	6735	2045	101	152	degrees/s	Angular velocity of the left wrist	18
936%	0.31	1.06	-3363	11159	3723	280	359	degree	Left ankle angle	19
16%	0.62	0.51	-16.75	110	121	81	104	degree	Left knee angle	20
138%	0.06	2.14	-152.42	271	263	106	111	degree	Left thigh angle	21
245%	0.20	1.35	-543.58	1417	765	147	222	degree	Left shoulder angle	22
403%	0.39	0.90	-477.25	1846	596	142	118	degree	Left elbow angle	23
1024%	0.34	1.00	-1453	5148	1596	151	142	degree	Left wrist angle	24

It is clear from Table (11) regarding the statistical significances of the linear kinematic variables of the end-of-flight moment for the pre-post measurement in the research group that there are significant differences for the variables of the right ankle angle, the left ankle angle, and the angular velocity of the right thigh, where the value represented The calculated t ranges between 2.30 and 4.12, which is greater than the tabular t value at a significance level of 0.05, where the tabular t value is equal to 2.201.

Table (12) The statistical significances of the linear kinematic variables for the moment of the end of flight for the pre-post measurement for the research group

Improvement rate	Significance level	"T" value	Difference of averages	Post measurement (N=12)		Pre-measurement (N=12)		Measuring unit	Kinematic variables	N.
				A ±	S ±	A ±	S ±			
-2%	0.58	0.58	1.59	7.60	65.48	11.06	67.07	kg.m/s	The horizontal momentum of the body's center of gravity	1
1%	0.72	0.37	-0.96	7.32	68.58	12.62	67.62	kg.m/s	The amount of vertical movement of the body's center of gravity	2
10%	0.62	0.51	-0.87	4.19	9.62	4.49	8.76	kg.m/s	Transverse momentum of the body's center of gravity	3
-1%	0.67	0.43	1.04	8.14	95.61	9.56	96.65	kg.m/s	The resultant momentum of the body's center of gravity	4
-52%	0.07	2.02	72.58	52	67	130	140	Newton	The force exerted horizontally on the body's center of gravity	5
-19%	0.51	0.68	56.00	137	233	235	289	Newton	The force exerted vertically on the body's center of gravity	6

-71%	0.03	**2.41***	126.25	43	52	171	178	Newton	The force exerted tangential to the body's center of gravity	7
-38%	0.04	**2.30***	164.33	115	266	215	430	Newton	The resultant force exerted on the body's center of gravity	8

It is clear from Table (12) of the statistical significances of the linear kinematic variables of the end-of-flight moment for the pre-post measurement in the research group that there are significant differences for the variables of the force exerted incidental to the center of gravity of the body and the force exerted resulting from the center of gravity of the body, where the value represented The calculated t ranges between 2.30 and 2.41, which is greater than the tabular t value at a significance level of 0.05, where the tabular t value is equal to 2.201.

Table (13) Statistical significances for the linear kinematic variables of the moment of beginning contact with the ground for the pre-post measurement for the research group

Improvement rate	Significance level	"T" value	Difference of averages	Post measurement (N=12)		Pre-measurement (N=12)		Measuring unit	Kinematic variables	N.
				A ±	S ±	A ±	S ±			
16%	0.02	**2.88***	-0.23	0.17	1.64	0.23	1.42	meter	The horizontal displacement of the body's center of gravity	1
-69%	0.00	**28.19***	0.56	0.03	0.25	0.05	0.81	meter	The vertical displacement of the body's center of gravity	2
-51%	0.00	**8.97***	0.26	0.08	0.24	0.06	0.50	meter	Transverse displacement of the body's center of gravity	3
-2%	0.61	0.52	0.03	0.17	1.68	0.19	1.71	meter	The resultant displacement of the body's center of gravity	4
-4%	0.37	0.93	0.09	0.21	2.07	0.40	2.16	M/S	The horizontal velocity of the body's center of gravity	5
-2%	0.58	0.57	0.05	0.17	2.25	0.29	2.30	M/S	The vertical velocity of the body's center of gravity	6
0%	0.99	0.01	0.00	0.14	0.26	0.17	0.26	M/S	The tangential velocity of the body's center of gravity	7
-4%	0.18	1.44	0.12	0.17	3.08	0.22	3.20	M/S	The resultant velocity of the body's center of gravity	8
-44%	0.10	1.82	3.10	3.67	3.87	6.10	6.98	²M/S	Horizontal acceleration of the body's center of gravity	9
-24%	0.19	1.41	2.17	5.21	6.70	5.36	8.87	²M/S	Vertical acceleration of the body's center of gravity	10

-62%	0.02	**2.64***	4.43	2.25	2.76	5.81	7.18	²M/S	Transverse acceleration of the body's center of gravity	11
-41%	0.00	**4.82***	6.42	5.29	9.15	5.51	15.57	²M/S	The resultant acceleration of the body's center of gravity	12

It is clear from Table (13) regarding the statistical significances of the linear kinematic variables of the moment of beginning contact with the ground for the pre-post measurement in the research group that there are significant differences for the variables of the horizontal displacement of the center of gravity of the body, the vertical displacement of the center of gravity of the body, the transverse displacement of the center of gravity of the body, and the transverse acceleration of the center of gravity. The body and the resultant acceleration of the center of gravity of the body, where the calculated T value is between 2.64 and 28.19, which is greater than the tabular T value at a significance level of 0.05, where the tabular T value is equal to 2.201.

Table (14) Statistical significances for the angular kinematic variables of the moment of beginning contact with the ground for the pre-post measurement for the research group

Improvement rate	Significance level	"T" value	Difference of averages	Post measurement (N=12)		Pre-measurement (N=12)		Measuring unit	Kinematic variables	N.
				A ±	S ±	A ±	S ±			
-17%	0.00	**4.50***	24.75	16	120	13	145	degree	Left ankle angle	1
0%	0.91	0.12	-0.25	6	166	4	166	degree	Left knee angle	2
-4%	0.55	0.62	6.00	34	153	8	159	degree	Left thigh angle	3
3%	0.85	0.20	-2.17	19	85	29	83	degree	Left shoulder angle	4
0%	0.90	0.13	-0.67	16	167	10	167	degree	Left elbow angle	5
6%	0.04	**2.40***	-9.75	9	165	9	155	degree	Left wrist angle	6
-24%	0.00	**4.37***	29.83	21	94	13	124	degrees/s	Angular velocity of the right ankle	7
1%	0.81	0.24	-0.83	11	162	5	161	degrees/s	Angular velocity of the right knee	8
9%	0.11	1.76	-11.17	18	139	13	128	degrees/s	Angular velocity of the right thigh	9
3%	0.84	0.21	-2.75	21	87	42	85	degrees/s	Angular velocity of the right	10

Improvement rate	Significance level	"T" value	Difference of averages	Post measurement (N=12)		Pre-measurement (N=12)		Measuring unit	Kinematic variables	N.
				A ±	S ±	A ±	S ±			
									shoulder	
1%	0.88	0.15	-1.58	28	165	17	164	degrees/s	Angular velocity of the right elbow	11
-4%	0.39	0.90	5.92	21	153	6	159	degrees/s	Angular velocity of the right wrist	12
56%	0.54	0.63	-586.17	3190	1637	601	1051	degrees/s	Angular velocity of the left ankle	13
270%	0.42	0.83	-519.75	2104	712	140	192	degrees/s	Angular velocity of the left knee	14
403%	0.34	0.99	-1127	3952	1408	141	280	degrees/s	Angular velocity of the left thigh	15
305%	0.28	1.13	-613.75	1820	815	161	201	degrees/s	Angular velocity of the left shoulder	16
712%	0.38	0.92	-848.58	3221	968	98	119	degrees/s	Angular velocity of the left elbow	17
68%	0.61	0.53	-162.25	1103	400	193	238	degrees/s	Angular velocity of the left wrist	18
54%	0.42	0.83	-212.83	869	608	246	395	degree	Left ankle angle	19
750%	0.31	1.06	-1193	3890	1352	144	159	degree	Left knee angle	20
610%	0.25	1.23	-777	2251	905	107	127	degree	Left thigh angle	21
289%	0.24	1.24	-694	1975	935	216	241	degree	Left shoulder angle	22
703%	0.33	1.01	-1021	3521	1167	167	145	degree	Left elbow angle	23
563%	0.36	0.95	-1504	5692	1771	259	267	degree	Left wrist angle	24

It is clear from Table (14) of the statistical significances of the kinematic variables of the angle of the moment of beginning contact with the ground for the pre-post measurement in the research group that there are significant differences for the variables of the angle of the right ankle, the angle of the right wrist, and the angle of the left ankle, as represented by the calculated T value. Between 2.40 and 4.50, which is greater than the tabular t value at the significance level of 0.05, where the tabular t value is equal to 2.201.

Table (15) Statistical significances for the linear kinematic variables for the moment of beginning contact with the ground for the pre-post measurement for the research group

Improvement rate	Significance level	"T" value	Difference of averages	Post measurement (N=12)		Pre-measurement (N=12)		Measuring unit	Kinematic variables	N.
				A ±	S ±	A ±	S ±			
-1%	0.78	0.28	0.98	8.13	65.78	12.21	66.75	kg.m/s	The horizontal momentum of the body's center of gravity	1
0%	0.91	0.12	-0.30	8.52	71.68	11.79	71.38	kg.m/s	The amount of vertical movement of the body's center of gravity	2
4%	0.85	0.19	-0.36	4.75	8.40	4.52	8.04	kg.m/s	Transverse momentum of the body's center of gravity	3
-1%	0.72	0.37	1.12	9.94	97.94	9.73	99.06	kg.m/s	The resultant momentum of the body's center of gravity	4
-44%	0.10	1.77	96.75	118	124	201	220	Newton	The force exerted horizontally on the body's center of gravity	5
-25%	0.16	1.50	68.25	152	208	175	276	Newton	The force exerted vertically on the body's center of gravity	6
-59%	0.03	**2.54***	128.92	74	89	178	218	Newton	The force exerted tangential to the body's center of gravity	7
-41%	0.00	**4.29***	196.75	159	287	188	484	Newton	The resultant force exerted on the body's center of gravity	8

It is clear from Table (15) of the statistical significances of the linear kinematic variables for the moment of beginning contact with the ground for the pre-post measurement in the research group that there are significant differences for the variables of the force exerted incidental to the center of gravity of the body and the force exerted resulting from the center of gravity of the body, where the value of T represented The calculated value ranges from 2.54 to 4.29, which is greater than the tabular t value at the significance level of 0.05, where the tabular t value is equal to 2.201.

Discuss the results

It is clear from Table (4), (5), (6) regarding the statistical significances of the linear kinematic variables, angular kinematic variables, and linear kinematic variables for the end-of-flight (approach) moment for the pre-post measurement by the research group for the skill under study, where the results were in favor of the pilots. The results show clear improvement rates, and the researcher attributes this to the extent of the impact of the specific exercises chosen for this stage of the skill under research.

This is also consistent with what Paula Lord (2013) explained that the success of performing a jump depends on the amount of movement generated while rising to raise the legs and perform the movement. (14-114)

It is clear from Table (7), (8), (9) regarding the statistical significances of the linear kinematic variables, the angular kinematic variables, and the linear kinematic variables for the moment of the end of the ascension for the pre-post measurement of the research group for the skill under study. The results were in favor of the post-measurements for the beginning stage of the ascension, as The players' motivation to perform this stage increased, and the researcher attributes this improvement to exercises to improve the skill under study.

This is consistent with what Susi Fiddler (1992) pointed out that the ascension phase takes a very short period of time, which may reach less than half a second, and begins from the moment the foot touches the ground until the moment it loses contact with it. During this phase, the athlete tries to achieve the most appropriate height. The center of gravity of the body at the moment of launch, and the time period for the ascent phase decreases due to the speed of movement in the legs and arms. (15)

This is consistent with what was stated by Yasmine Al-Bahar and Susan Salah El-Din (2004) that achieving the maximum height is due to the time of flight. The greater the time of flight, the more the athlete is able to achieve the highest height, and thus gives the athlete an opportunity to perform the motor duty, and that the time and height of the flight are determined through the phase Ascension: The shape of the gap also affects the altitude. The more difficult the shape, the shorter the ascent time and the longer the flight time. (11-111)

This was confirmed by the study of Debby Mitchell and others (2009) that performing gaps requires high-altitude stability during the flight phase in order for the athlete to be able to perform the technical form of gaps. (12-41)

It is clear from Table (10), (11), (12) regarding the statistical significances of the linear kinematic variables, the angular kinematic variables, and the linear kinematic variables of the end-of-flight moment for the pre-post measurement by the research group, and the results were in favor of the post-measurements for this stage. One of the stages of the skill under investigation.

Likewise, what Susan Hill (2014) pointed out is that generating momentum and transferring it from one link to another through the paths of the centers of gravity of the body's links has an effective role in completing the performance of movements. Angular momentum = moment of inertia x angular velocity, so the relationship is direct between angular velocity and angular momentum. (3-534-535)

Yasmine Al-Bahar and Susan Salah El-Din (2004) mention that leaps are one of the most important gymnastic movements for forming motor sentences in gymnastics. They are one of the important dynamic operations that depend on special technical and mechanical fundamentals. They require flight after rising, and their performance requires feeling, range, agility, and dynamism. (11-108)

The researcher believes that the improvement in this stage is the result of training in specific exercises for this stage developed in light of the variables resulting from qualitative motor analysis.

It is clear from Table (13), (14), (15) regarding the statistical significances of the linear kinematic variables, the angular kinematic variables, and the linear kinematic variables of the moment of beginning contact with the ground for the pre-post measurement by the research group.

This is consistent with what Adel Abdel Basir (1999) stated that the landing stage is considered one of the bright signs of successful performance in artistic gymnastics. A successful landing affects the athlete at a point of contact with the ground, and the amount of movement must be absorbed the moment the foot contacts the ground. (7-239)

This is confirmed by Nahid Al-Sabbagh and Jamal Alaa El-Din (1999) in that the general function of the final stage of movement (descent) is to nullify and brake the movement of the body as a whole by consuming the momentum to bring the body to a state of relative stillness and achieve the lost balance. (9-302)

It also agrees with what Nemat Abdel Rahman and Magda Ragab (2003) stated that the primary goal of the landing phase is to reduce the body's speed that is gained during flight and to land in a flexible and light manner to absorb the shock of the ground. The landing phase begins with

an attempt to overcome the angular acceleration to reduce the athlete's speed at the end. The flight stage to prepare for landing. (10-63)

The researcher believes that in light of the above and based on the results, the significance of the differences between the pre- and post-measurements in the level of skill performance becomes clear in favor of the post-measurements and the percentages of improvement in the level of skill performance for the skill under study, due to the specific exercise program designed according to some of the mechanical characteristics of performing the lib skill with alternating the legs. Which indicates the importance of using qualitative motor analysis in obtaining the previously mentioned variables clearly, discovering errors in the motor performance of the skill, and knowing the weak points of the female players in the research sample, developing them through specific exercises.

From the above, the second hypothesis is validated, which states (the use of qualitative analysis contributes to discovering performance errors in the skill of the jump with switching legs) on the ground movement apparatus).

Study conclusions:

In light of the study methodology, the sample used, the available capabilities, and the time available for the proposed program, the researcher was able to reach the following conclusions:

- The fewer the parts involved in performing the skill, the greater the improvement rates.
- The more precise identification and path adjustments to body parts, the greater the improvement rates.

Study recommendations:

In light of the results reached in both the theoretical and applied study, the researcher recommends the following:

1- Using periodic kinetic analysis to follow up on the development of biomechanical variables, to work on strengthening the correct ones, and correcting the defects occurring in some of them by developing the technical aspects responsible for that or that lead to the development of these biomechanical variables.

2- Paying attention to mechanical information for skill performance, as it helps coaches direct the process of learning, experimentation, speed of learning, reaching the correct techniques for difficult movements, knowing the best working muscles, and the ability to determine the correct training.

The reviewer :

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