The Effect of Interactive Agility Training in Terms of Some Biodynamic Variables on The Technical Performance Level of The Front Somersault Skill on The Vaulting Table

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Summary:

The study investigates the impact of interactive agility training on biodynamic variables and technical performance in gymnastics, specifically focusing on the front somersault skill on the vaulting table. Using an experimental approach, the research evaluates the effectiveness of a targeted training program on 10 students at Qassim University. Key Findings Significant improvements in interactive agility, including speed, balance, coordination, and reaction time, Enhanced technical execution of the front somersault skill, with a 16.64% performance increase. Positive changes in biodynamic variables, such as reduced performance time, increased force application, and improved momentum and velocity. The conclusion was Interactive agility training is highly effective in improving both skill execution and biodynamic efficiency in gymnastics. The study highlights the importance of biomechanics and agility in developing better training programs. Recommendatiwere were to Implement interactive agility training in gymnastics curricula, Conduct further research on its effects on other skills and use biomechanical tools for continuous performance evaluation and enhancement

Keywords: interactive agility, biodynamic, front somersault

First: Introduction to the study:

Biomechanics is the scientific key to any athletic achievement, as the scientific diagnosis of athletic movement is the first step to developing and improving that movement.(N. Alalyani et al. 2020; Saleh 2019, 2020; Saleh and Ahmed Al Sabw 2020; Saleh and Mohamad Al Henawy 2019)

Biomechanics seeks to identify the strengths and weaknesses in the performance of sports movements, which is considered the starting point for finding training solutions to treat this deficiency in sports performance. Therefore, it can be said that diagnosing movement is the first and most important step in the steps to improve the level of sports performance, especially in individual games, including gymnastics, in which the formal evaluation of performance is the main criterion for winning and achieving sports achievement. (Saleh 2016, 2019; Saleh and Mohamad Al Henawy 2019)

Dynamic motor performance also requires many special skills, and each skill includes a set of performances. The most effective way to improve and develop performance is motor analysis, as it requires determining the correct mechanical performance of the skill . (H. A. I. Saleh 2015; Saleh 2016, 2021)

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Biomechanics seeks to uncover performance errors and reach the mechanical causes of those errors through digital evaluation converting the athletic movement into a set of numbers that can be understood and interpreted, and then developing scientific plans to treat them.(Saleh 2019; Saleh and Mohamad Al Henawy 2019)

Reactive agility is the ability to respond quickly and effectively to sudden changes in the environment, whether visual, auditory, or even tactile. The body can move smoothly, quickly, and with high coordination, and adapt to the changing demands of the situation. (Azra et al. n.d.; Lai et al. n.d.; Lund, Research, and 2014 n.d.)

This is what Figure 1 shows.

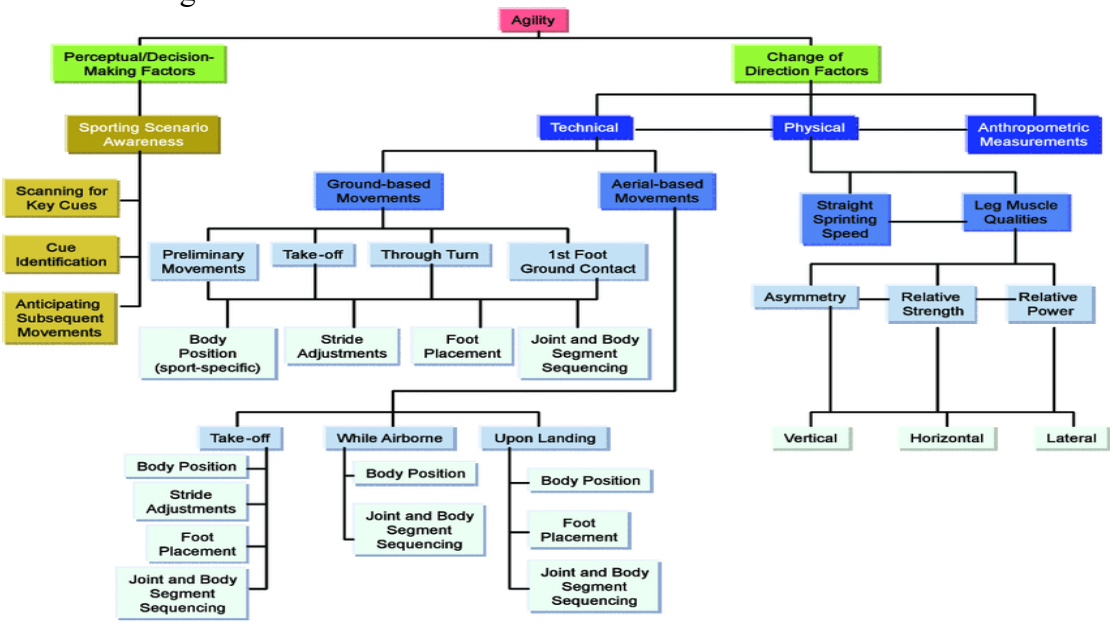

Fig. 1

Agility and Interactive Agility Components (Manouras et al. 2016)

The importance of interactive agility in sports is represented in several points, the most important of which are: (Lichtenstein et al. n.d.; Schoene et al. n.d.; Wang et al. n.d.; Wee et al. n.d.)

- Improving performance, as interactive agility contributes to improving the performance of athletes in various sports, as it allows them to react quickly to competitors and make the right decisions at crucial moments.
- Preventing injuries, as interactive agility helps reduce the risk of injuries, and allows the body to adapt to sudden changes and avoid movements that may lead to injury.
- Increasing self-confidence, as well as the feeling of agility and the ability to control movement, enhances self-confidence in athletes.

Reactive agility consists of a set of physical and mental components that work together to achieve reactive agility in the player. These are:(Maillot et al. n.d.; Singh et al. 2012, n.d.; Zago et al. n.d.)

- Motor speed.
- Balance.
- Coordination.

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- Timing.
- Attention.

To develop interactive agility, it is necessary to develop physical exercises that develop both the physical and mental axis. Scientific foundations must also be considered in formulating, designing, and implementing these exercises, as interactive agility exercises include a variety of exercises that aim to improve the components of interactive agility. These include, but are not limited to: (Friebe et al. n.d.; Lichtenstein et al. 2023; Thomas et al. n.d.)

- Jumping: jumping over obstacles, sideways jumping, repeated jumping.
- Lateral movements: moving sideways quickly and changing direction.
- Changes in direction: changing direction quickly and responding to signals.
- Balanced movements: walking in a straight line, standing on one foot.
- Compound movements: combining different movements such as running, jumping, and changing direction.

Second: The importance and problem of the study:

The importance of the theoretical study is evident in studying the relationship between interactive agility and the level of performance of the front flip skill on the vault table, and its ability to improve the level of performance of the skill. This is done by verifying through biodynamic comparison between the measurements before and after applying the proposed interactive agility exercises. The importance of the study is also evident in studying and analyzing the components of interactive agility as well as identifying the biodynamic variables that determine the performance of the front flip on the vault table to develop and improve the skill performance of the skill under study. The study also works to design proposed exercises to develop interactive agility, which may contribute to developing the skill performance and thus the skill level of the skill under study.

The importance of the practical study is evident in measuring the biodynamic variables and components of interactive agility and establishing a scientific basis for researchers in the field of biomechanics and gymnastics that shows the procedures for imaging and biomechanical analysis of the front flip skill in terms of placing the cameras, devices, and programs used to reach the optimal biomechanical analysis of the skill under study. Through the researcher's work as a faculty member at Qassim University, the researcher noticed a deficiency in the performance of the front somersault skill on the vaulting table, which is taught at the second level in the Sports Sciences and Physical Activity Program in the Department of Physical Education and Movement Sciences, which prompted the researcher to try to find a scientific way to improve performance, by designing exercises to develop interactive agility and determining the level of development through three main criteria, which are:

- The skill level of performing the skill under study.
- The level of interactive agility of the study sample before and after the proposed exercises.
- Biodynamic variables of performing the forward somersault skill on the vaulting table.

Also, to the best of the researcher's knowledge, through his review of previous and related studies, no study has been conducted to determine the extent of the impact of

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interactive agility training, in terms of some biodynamic variables, on the level of technical performance of the front somersault skill on the vaulting table.

Third: Study objectives:

This study aims to develop the technical performance level of the forward aerial ball skill through:

1- Developing exercises using interactive agility.
2- Pre- and post-measurement of physical variables for the study sample.
3- Pre- and post-measurement of the technical performance level of the front flip skill on the vaulting table for the study sample.
4- Pre- and post-measurement of biodynamic variables for the study sample.

Fourth: Study assumptions:

1- There are statistically significant differences between the pre-and post-measurements in the level of interactive agility of the skill under study in favor of the post-measurement.
2- There are statistically significant differences between the pre-and post-measurements in the level of technical performance of the skill under study in favor of the post-measurement.
3- There are differences between the pre-and post-measurements in the biodynamic variables specific to the performance of the skill under study in favor of the post-measurement.

Fifth: Terms and symbols used in the study:

1 - Terms used in the study:

- **Reactive Agility:**

It is the speed of re-changing direction (reactivating agility) again according to the changing external stimuli that the brain perceives through the sensory-motor receptors.

2 - Symbols used in the study:

Table1
Biodynamic variables under study

measuring unit	symbol	term
Sec	t	Time
Cm	Dx	Horizontal displacement Component
Cm	Dy	Vertical displacement Component
Cm/sec	Vx	Horizontal Velocity
Cm/sec	Vy	Vertical Velocity
Cm/sec	VR	Absolute resulting Velocity
Cm/sec2	Ax	Horizontal Acceleration
Cm/sec2	Ay	Vertical Acceleration
Cm/sec2	AR	Absolute resulting Acceleration
Kg. Cm/sec	Mx	Horizontal Moment of momentum
Kg. Cm/sec	My	Vertical Moment of momentum
Kg. Cm/sec	Mr	Absolute resulting Moment of momentum
N	Fx	Horizontal Force
N	Fy	Vertical Force
N	Fr	Absolute resulting Force

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Sixth: Study procedures:

1- Study method:

The researcher used the experimental method using a single-group experimental design using pre- and post-measurement to suit the nature of the study.

2- Study sample:

The primary study sample was selected intentionally from students of the Department of Sports Sciences and Physical Activity at Qassim University. The sample included (10) students, as well as (10) students to conduct the exploratory study to standardize the training loads for the proposed qualitative exercises.

- Arithmetic mean, median, standard deviation, and skewness coefficient of the study sample:

Table 2

The mean, median, standard deviation, and skewness coefficient before the experiment for each of the variables under study

Descriptive Statistics

	N	Range	Minimum	Maximum	Mean	Std. Deviation	Skewness		Kurtosis	
	Statistic	Statistic	Statistic	Statistic	Statistic	Statistic	Statistic	Std. Error	Statistic	Std. Error
tall	10	8.00	166.00	174.00	170.2000	2.65832	-.224	.687	-1.136	1.334
weight	10	8.30	56.70	65.00	62.1300	2.50956	-1.053	.687	1.203	1.334
age	10	1.20	19.20	20.40	19.8400	.38355	-.324	.687	-.296	1.334
training age	10	1.40	9.50	10.90	10.0100	.44335	1.112	.687	.417	1.334
Navette	10	5.00	51.00	56.00	53.5000	1.58114	.000	.687	-.895	1.334
Purpee	10	2.00	11.00	13.00	12.2000	.78881	-.407	.687	-1.074	1.334
Zigzag 10	10	2.00	7.00	9.00	8.1000	.56765	.091	.687	1.498	1.334
Direction to light	10	1.00	4.00	5.00	4.5000	.52705	.000	.687	-2.571	1.334
Visual tracking	10	.30	1.50	1.80	1.6600	.10750	-.322	.687	-.882	1.334
Skill performance	10	.40	6.70	7.10	6.8600	.15776	.620	.687	-1.159	1.334
Valid N (listwise)	10									

It is clear from Table (1) that the values of the skewness coefficient for each of these variables (under study) were limited to (±3), which indicates the moderation of the repetition curve of the study sample individuals in these variables.

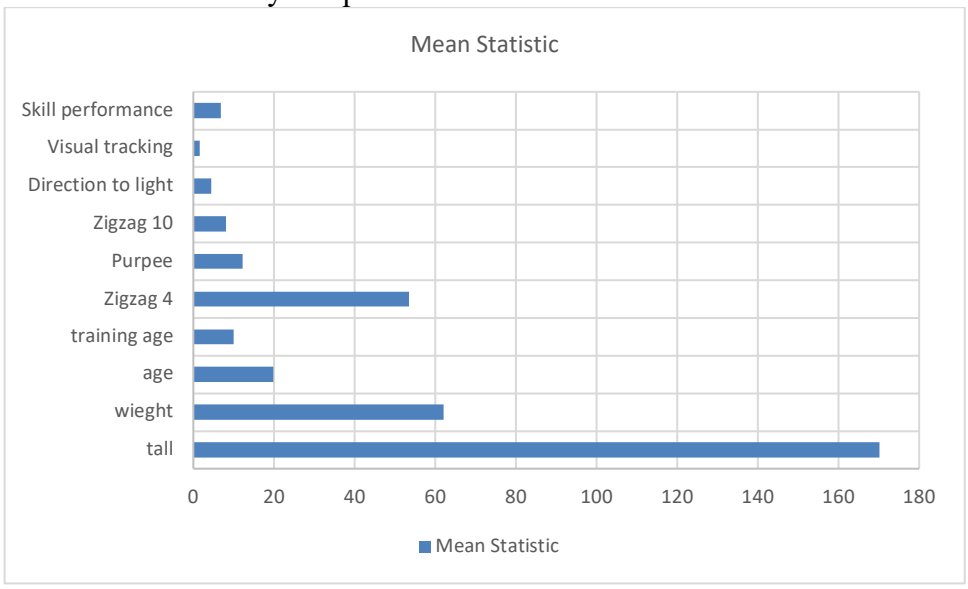

Fig. 2

The mean before the experiment for each of the variables under study

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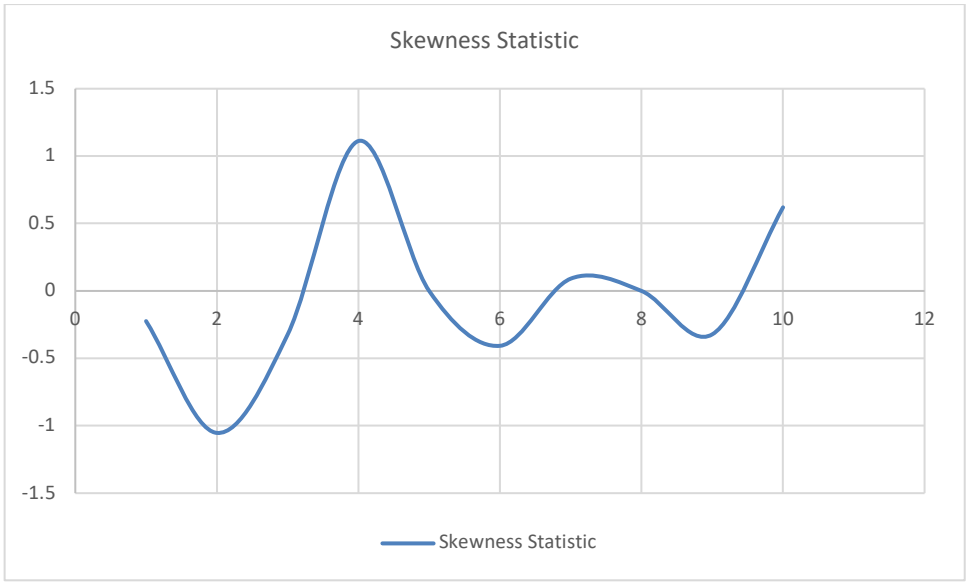

Fig. 1
The skewness coefficient before the experiment for each of the variables under study

3- Data collection methods:

The researcher used the following methods to collect data:

a) Collecting anthropometric data.
b) Collecting data on the artistic performance under study.
c) Collecting data on interactive agility.
d) Collecting biodynamic data for the study.

a) Collecting anthropometric data.

The means and tools for collecting data that are appropriate to the nature of the study were determined by reviewing scientific references, research, and previous studies in the field of gymnastics training and some other games. The researcher used the following tests, measures, and devices:

- Restameter device to measure the total body length to the nearest 1 cm.
- A medical scale device to measure the student's weight to the nearest 1 kg.

Fig. 3
Means of collecting anthropometric data

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b) Collecting data on the artistic performance under study.

The technical skill under study was filmed using a video camera twice, the first time before the start of the training program and the second time after the completion of the training program. The videotape was shown to four judges accredited by the Egyptian Gymnastics Federation to evaluate the technical performance of the skills under study. Each judge gave a score out of ten for the technical skill on the vaulting table for each player. The highest and lowest scores were deleted so that the player's score became the average of the two average scores.

c) Collecting data on interactive agility.

Interactive agility was determined through five tests:

- Navette
- Purpee
- Zigzag 10
- Light direction.
- Visual tracking.

Scientific transactions for the tests under consideration:

a) Honesty:

Table 3
Discriminant validity coefficients of the physical tests used under study

$N_1=N_2=10$

			Sum of Ranks		Mean Ranks		(U)	Sig.
			Featured Group	Unfeatured Group	Featured Group	Unfeatured Group		
1	Navette	Sec.	155.00	55.00	15.50	5.50	0.000	0.001
2	Purpee	number	15.50	5.50	155.00	55.00	0.000	0.001
3	Zigzag 10	Sec.	15.50	5.50	155.00	55.00	0.000	0.001
4	Direction to light	degree	155.00	55.00	15.50	5.50	0.000	0.001
5	Visual tracking	degree	15.50	5.50	155.00	55.00	0.000	0.001

It is clear from Table 5 that the significance level between the distinguished group and the non-distinguished group was less than 0.05, i.e. there were significant differences between the two groups, which indicates the validity of the tests used. Also, the tabular value of (Y) is greater than the calculated value of (Y), which indicates the validity of the tests used.

b) Stability:

Table 4
Reliability coefficients of the tests used (understudy)

N=10

			First application		Second application		Correlation Coefficient	Sig.
			Mean	St.d	Mean	St.d		
1	Navette	Sec.	53.7	1.005	53.5	1.58	0.564	0.090
2	Purpee	number	11.7	0.823	12.2	0.788	0.445	0.198
3	Zigzag 10	Sec.	8.4	0.699	8.1	0.567	0.728	0.017
4	Direction to light	degree	4.8	0.421	4.5	0.527	0.500	0.141
5	Visual tracking	degree	1.7	0.081	1.66	0.107	0.760	0.011

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It is clear from Table 6 that the Spearman correlation coefficient between the first and second application of the tests was between ±1, which indicates the stability of the tests used.

d) Collecting biodynamic data for the study.

Video recording (2D) using Gopro hero4 black camera at 240 frames/second, Figure (4).

Fig. 4
Gopro hero4 black

Instant motion analysis system using video camera and computer via Tracker program for biodynamic analysis, according to the proposed analysis model as shown in Figure 5

Stages of performing the forward aerial curl skill

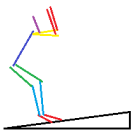
The first Phase (Vertical ascent) This stage begins with touching the jump ladder and ends with the player reaching the highest height.	The second Phase (double torque) This stage starts with the player reaching the highest height and ends with the end of the rotation.	The third Phase (landing stage) This stage begins at the end of the rotation and ends with the arms standing to the sides.
		
t	t	t
x y	x y	x y
Vx, Vy, Vr	Vx, Vy, Vr	Vx, Vy, Vr
Ax, Ay, Ar	Ax, Ay, Ar	Ax, Ay, Ar
Ix, Iy, Ir	Ix, Iy, Ir	Ix, Iy, Ir
Fx, Fy, Fr	Fx, Fy, Fr	Fx, Fy, Fr
Mx, My, Mr	Mx, My, Mr	Mx, My, Mr

Fig. 5
Biodynamic analysis model for research

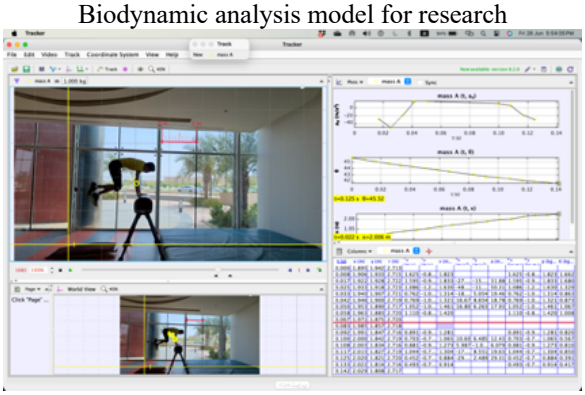


Fig. 6
Tracker Motion Analysis

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4- Choosing assistants:

Three assistants were selected from the department's students to assist the researcher in implementing the study procedures.

5- Exploratory study :

The researcher conducted a survey study to identify the conditions and problems that the researcher might face during the basic study. It was implemented on Sunday 8/18/2024, at the headquarters of the sports hall at Qassim University. The survey experiment was conducted on a few (2) students from the department. The survey study aimed to identify:

c) Camera dimensions.
d) Camera frequency.
e) Anatomical landmarks used.
f) Camera clarity to facilitate later analysis.

The survey achieved its objectives.

6- Basic study :

The baseline study was conducted during the period from Sunday 8/25/2024 to Thursday 10/31/2024, and the pre-filming was done on Saturday 8/24/2024. The post-filming was done on Sunday 11/3/2024 at the Qassim University Sports Hall.

7- Statistical Processing:

The researcher used the Statistical Package for Social Sciences (SPSS 25) program to process the data statistically using the appropriate statistical coefficients for the study.

Seventh: Presentation and discussion of the results:

1 - Show results:

This chapter includes the presentation and discussion of the results of studying the differences in the results of the technical performance level and biodynamic analysis, considering the data and results of the pre-and post-measurements of the variables under study on the sample and based on the results of the statistical analysis that are consistent with the nature of the current study. Considering the study hypotheses, the researcher will present the results he reached as follows:

a) Display data on the interactive agility level of the skill under study
b) Display data on the technical performance level
c) Display data on biodynamic variables

a) Display data on the interactive agility level of the skill under study

Average score of interactive agility level for the pre-and post-measurements of the study sample:

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Table 5
Average score of interactive agility level for the pre-measurements of the study sample

Players	Dimensional measurement				
	Navette	Purpee	Zigzag 10	Direction to light	Visual tracking
1	55	13	8	5	1.7
2	54	12	8	4	1.6
3	55	11	8	4	1.5
4	56	12	9	5	1.7
5	54	13	8	5	1.6
6	53	12	8	4	1.5
7	51	13	9	4	1.8
8	52	13	8	5	1.7
9	52	12	8	4	1.8
10	53	11	7	5	1.7

Table 6
Average score of interactive agility level for the Dimensional measurements of the study sample

Players	Dimensional measurement				
	Navette	Purpee	Zigzag 10	Direction to light	Visual tracking
1	60	9	5	8	3
2	61	9	5	8	3.2
3	61	9	5	7	3.1
4	61	9	5	7	3.2
5	62	7	6	7	3.1
6	61	8	5	8	3.2
7	61	8	6	8	3
8	62	8	5	7	3
9	62	7	5	8	3
10	61	9	6	7	3

- Significance of the differences between the pre-and post-measurements of the interactive agility level of the skill under study:

Table 7
Wilcoxon test for the significance of differences between the pre-and post-measurements of the level of interactive agility under study

			Mean Ranks		Sum of Ranks		(Z)	Sig.
			-	+	-	+		
1	Navette	Sec.	0.00	5.50	0.00	55.00	-2.820	0.005
2	Purpee	number	5.50	0.00	55.00	0.00	-2816	0.005
3	Zigzag 10	Sec.	5.50	0.00	55.00	0.00	-2.911	0.004
4	Direction to light	degree	0.00	5.50	0.00	55.00	-2.841	0.004
5	Visual tracking	degree	0.00	5.50	0.00	55.00	-2.826	0.005

It is clear from Table (7) that the level of significance between the pre-and post-measurements in the level of interactive agility under study was less than 0.05, which indicates the existence of statistically significant differences between the two measurements in favor of the post-measurement.

- The percentage of improvement between the pre-and post-measurements in the level of technical performance of the study sample:

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Table 8
Percentage of improvement between pre- and post-measurement of technical performance level

	Average pre-measurement	Mean dimension measurement	The difference between the two averages	Improvement rate
Navette	53.5	61.2	7.7	12.58%
Purpee	12.2	8.3	-3.9	46.98%
Zigzag 10	8.1	5.3	-2.8	52.83%
Direction to light	4.5	7.5	3	40%
Visual tracking	1.66	3.08	1.42	46.10%

Table (8) shows the percentage of improvement between the pre- and post-measurements in the level of technical performance of the study sample, where the percentage of improvement in the Zigzag 10 test reached 52.83%, the Purpee test 46.98%, the Visual tracking test 46.10%, the Direction to light test 40%, and the Zigzag 4 test 12.58%.

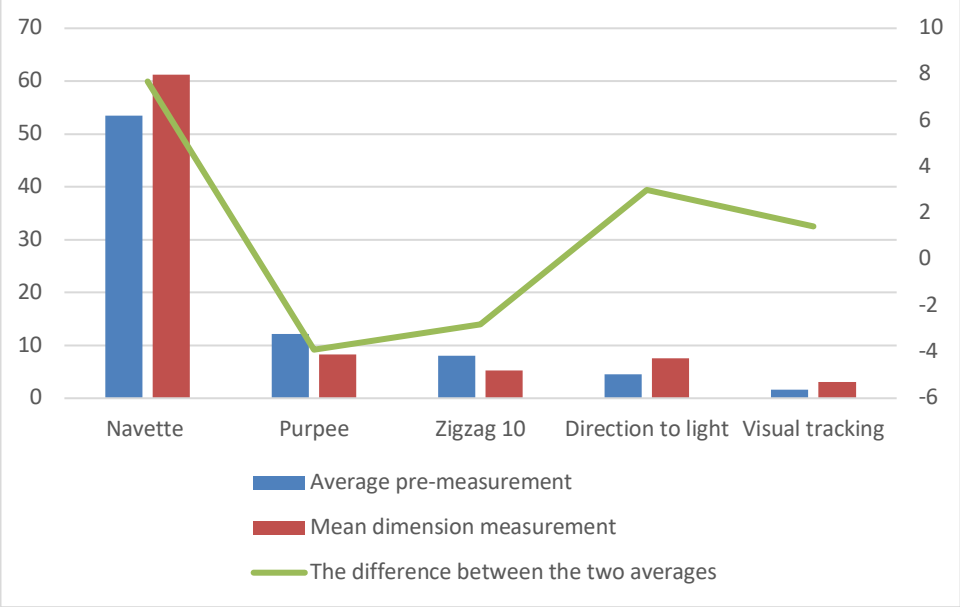

Fig. 7
Percentage of improvement between pre- and post-measurement of technical performance level

b) Display data on the technical performance level

- Average score of technical performance level for the pre- and post-measurements of the study sample:

Table 9
Average scores of the research sample in the level of technical performance

Players	pre-measurement	dimension measurement
1	6.6	8.00
2	6.8	8.00
3	7.2	8.00
4	6.7	9.00
5	6.5	8.00
6	7.2	7.00
7	6.2	8.40
8	6.4	8.40
9	6.5	8.80
10	7.5	8.70

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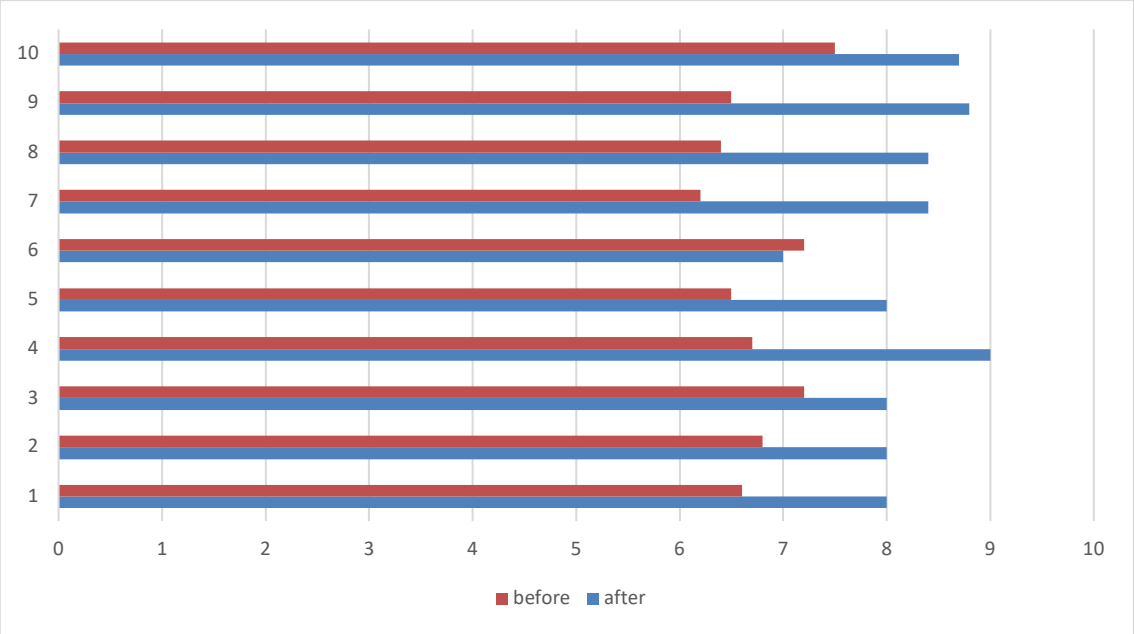

Fig. 8
Average scores of the research sample in the level of technical performance

- Significance of differences between the pre- and post-measurements of the skill performance level of the skill under study:

Table 10
Wilcoxon test of significance of differences between the pre- and post-measurements of the level of skill performance for the skill under study:

			Mean Ranks		Sum of Ranks		(Z)	Sig.
			-	+	-	+		
1	Skill performance	degree	1.00	6.00	1.00	45.00	-2.710	0.007

Table 10 shows that there are statistically significant differences between the pre- and post-measurements of the experimental group in the level of technical performance of the skill under study in favor of the post-measurement.

- The percentage of improvement between the pre- and post-measurements of the skill performance level of the skill under study:

The percentage of improvement between the pre- and post-measurements in the level of technical performance of the study sample:

Table 11
Percentage of improvement between pre- and post-measurement of technical performance level

	Average pre-measurement	Mean dimension measurement	The difference between the two averages	Improvement rate
Average scores of the research sample	6.86	8.23	1.37	16.64%

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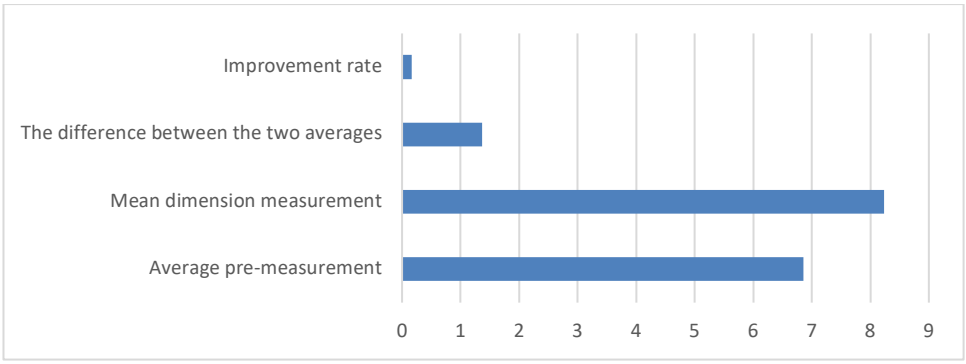

Fig. 9
Percentage of improvement between pre- and post-measurement of technical performance level

c) Display data on biodynamic variables:

Averages of biodynamic variables for the pre-measurement of the body's center of gravity in the performance stages:

Table 12
Averages of biodynamic variables for the pre-measurement of the body's center of gravity in the performance stages

	Pre-measurement		
	Phase. 1	Phase. 2	Phase. 3
			
t	0.462	0.42075	0.31185
Dx	1.2705	1.749	2.607
Dy	1.98	0.7425	0.8085
Dz	6.765	1.221	1.7655
Vx	-1.8084	8.58	2.9205
Vy	-1.155	8.91	-6.93
Vr	12.54	2.4255	8.9925
Ax	120.945	-32.373	-143.715
Ay	-34.32	-169.62	-82.005
Ar	-22.275	-87.6315	-148.6155
Ix	102.135	-23.5455	-325.875
Iy	101.475	-300.465	-207.24
Ir	71.445	-154.143	-340.89
Fx	669.57	-183.975	-819.885
Fy	-192.39	-538.395	-500.61
Fr	-139.425	-486.42	-824.835
Mx	-8.58	50.7375	21.12
My	-6.765	51.414	-48.048
Mr	73.59	108.0585	41.5635

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Fig. 10
Averages of biodynamic variables for the pre-measurement of the body's center of gravity in the performance stages

- Averages of biodynamic variables for the dimensional measurement of the body's center of gravity in the performance stages:

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Table 13
Averages of biodynamic variables for the dimensional measurement of the body's center of gravity in the performance stages:

	Pre-measurement		
	Phase. 1	Phase. 2	Phase. 3
			
t	0.37785	0.0825	0.35475
Dx	11.352	13.266	15.84
Dy	-0.165	2.475	2.475
Dz	1.683	6.105	6.765
Vx	4.29	20.955	17.952
Vy	4.62	14.19	-5.907
Vr	23.925	26.235	24.882
Ax	306.24	96.855	14.487
Ay	-181.5	-192.39	-280.665
Ar	1554.465	451.275	798.633
Ix	83.358	149.82	27.39
Iy	101.97	-266.31	-112.86
Ir	855.525	658.02	1580.37
Fx	1727.88	553.245	86.889
Fy	-1052.04	-1096.26	-1598.355
Fr	8844.66	2559.48	4518.69
Mx	27.225	123.519	107.415
My	30.525	82.863	-37.785
Mr	95.238	156.816	149.0775

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Fig. 11
Averages of biodynamic variables for the dimensional measurement of the body's center of gravity in the performance stages:

- Time averages for the performance stages of the skill under study for the pre-test:

Table 14
Average performance times of the skill under study for the pre-test in the performance stages:

time	Sec.	%
phase 1	0.462	38.89
phase 2	0.418	35.19
phase 3	0.308	25.93
Sum.	1.188	100

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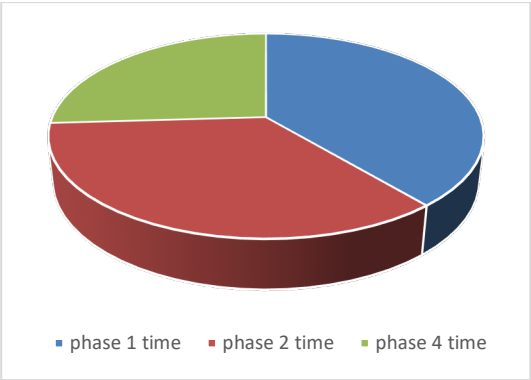

Fig. 12
Average performance times of the skill under study for the pre-test in the performance stages:

- Time averages for the stages of performing the skill under study for the post-test:

Table 15
Average performance times of the skill under study for the post-test in the performance stages:

time	Sec.	%
phase 1	0.374	46.13
phase 2	0.0825	10.17
phase 3	0.3542	43.69
Sum.	0.8107	100

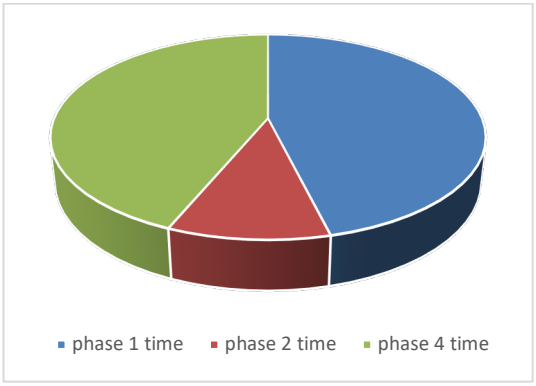

Fig. 13
Average performance times of the skill under study for the post-test in the performance stages:

2 - Discussion of the results:

a) Discussion of the results of the first hypothesis:

Which states: **"There are statistically significant differences between the pre- and post-measurements in the level of interactive agility of the skill under study in favor of the post-measurement".**

Table 5 shows the averages of the pre-measurement in the level of interactive agility for the forward rotation skill on the vaulting table, as it is clear from the table that the level of interactive agility components was very low.

Which agrees with (Al-Omoush, …, and 2024 n.d.; GROZA et al. n.d.; Yusuf et al. n.d.; Zago, Giuriola, and Sforza 2016)

that interactive agility is one of the complex components that need continuous development through scientifically standardized training. As shown in Table 6, the post-

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measurement averages for the same sample in the interactive agility level of the forward turn skill on the vaulting table, as the table shows that the post-measurement averages in the interactive agility components have improved clearly and noticeably, as the study sample scores increased between the pre- and post-measurements in all interactive agility components.

This is proven by the results of Table 8 in that the improvement rate for the interactive agility components, as the improvement rate in the Zigzag 10 test reached 52.83%, the Purpee test 46.98%, the Visual tracking test 46.10%, the Direction to light test 40%, and the Zigzag 4 test 12.58%.

The results of Table 7 also confirmed the existence of statistically significant differences in all interactive agility components.

The researcher attributes the previous results to the regularity of the sample in the proposed exercises and their commitment to the researcher's directions and instructions, in terms of implementing the proposed exercises through their basic components of intensity, volume, and density.

This is consistent with (Abdulla, Sciences, and 2023 n.d.; EL-Shafey, Applications, and 2022 n.d.; Hassan et al. n.d.; Zhou et al. n.d.)

That the trainer is the main controller of the continuity of the program and the guide to the helm, to ensure the sample's commitment to implementing the program and the proposed exercises, which in turn leads to achieving the general goal of the training program.

The researcher also attributes this development to the fact that the proposed exercises are based on a sound scientific basis in terms of distributing performance times and rest times, which worked to achieve the desired goal in the best possible way.

In agreement with (Lennemann et al. n.d.; Stefanica et al. 2024; Steff et al. n.d.)

As part of the main program time was allocated for physical preparation to implement interactive agility exercises that were implemented under the direct supervision of the researcher, which in turn led to a noticeable growth in the components of interactive agility.

Interactive agility is based on increasing the stimulation of the nervous system and stimulating visual perception, as confirmed by the results of the Visual tracking test and the Direction to light test.

This is consistent with the results of the study of (Arts 2018 n.d.; Metwaly 2023; Scanlan et al. 2014; Selmi et al. n.d.)

The researcher also attributes the effect of interactive agility in developing the skill of the front somersault on the vault table, as the skill of the front somersault on the vault table is considered one of the complex motor skills that require high coordination between the muscles and the nervous system. Interactive agility plays a pivotal role in developing this skill and improving its performance. Interactive agility is the basis for excellence in motor performance, and interactive agility goes beyond being a mere physical ability, as it represents a motor intelligence that enables the individual to respond flexibly and quickly to the challenges he faces during movement. This ability includes a set of integrated elements such as:

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- Balance: The ability to maintain the center of gravity above the base of support under changing conditions.
- Coordination: The smooth cooperation of different muscle groups to achieve smooth and precise movement.
- Speed: The ability to execute movements quickly and efficiently.
- Explosive strength: The ability to generate maximum force in a short period.
- Sensory awareness: The ability to receive and interpret sensory information from the environment, joints, and muscles.

Which is consistent with (Boreham 2006; de Oliveira, Oudejans, and Beek 2006; Young and Rogers 2014)

The mechanism by which interactive agility affects the front flip improves motor planning, as interactive agility helps improve the brain's ability to plan movement and modify it during execution based on incoming sensory information. It also increases motor efficiency, and by developing interactive agility, the time required to make and execute a motor decision is reduced, which leads to increased movement efficiency.

It also reduces the risk of injury, as interactive agility helps avoid injuries by allowing the body to adapt to sudden changes in body position and the force acting on it.

Interactive agility improves self-confidence, as successfully executing difficult movements such as the front flip thanks to interactive agility enhances the athlete's confidence in himself and his abilities.

In agreement with (Bangsbo, Mohr, and Krustrup 2006; Zouhal et al. 2018)

Thus, the first hypothesis is achieved, which states that **"there are statistically significant differences between the pre- and post-measurements in the level of interactive agility of the skill under study in favor of the post-measurement".**

b) Discussion of the results of the second hypothesis:

Which states that **"there are statistically significant differences between the pre- and post-measurements in the level of technical performance of the skill under study in favor of the post-measurement."**

It is clear from Table 9 that there is a noticeable improvement in the level of performance of the skill of the forward turn on the vault table for the study sample, which is confirmed by the results of Table 11, which shows the percentage of improvement in the performance of the skill under study, as the percentage of improvement reached 16.64% between the average of the pre- and post-measurements, which is confirmed by the results of Table 10 in the presence of statistically significant differences between the pre- and post-measurements in the level of performance of the skill of the forward turn on the vault table for the study sample.

The researcher attributes this to the fact that developing the elements of interactive agility played a role in developing and improving the performance of the skill under study.

This is because the skill depends largely on the element of agility in general.

This is consistent with (Bullock et al. 2012; Henry et al. 2011; Kutlu et al. 2012; Sheppard et al. 2006)

Interactive agility depends in its formation on the body's ability to change the shape of the body from a curled position to an individual position and vice versa, and this

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is accomplished by maintaining the body's balance, whether it is a static balance or a moving balance. This is consistent with all (Büchel et al. 2022; Holmberg 2009, 2015; Sheppard and Young 2006; Sobolewski et al. 2018; Uchida et al. 2013; Ye et al. 2024)

Any disruption of the body's balance during the performance of the skill leads to the failure of the attempt, which requires the player to focus his attention greatly to be able to change the shape and position of his body while maintaining his balance.

Which is consistent with (Chelladurai, Yuhasz, and Sipura 1977; Paul, Gabbett, and Nassis 2016; Rustam and Kassim 2018; Ye et al. 2024)

This indicates that the proposed exercises worked to develop the capabilities that make up interactive agility. It also agrees with

The researcher also attributes the positive effects of developing interactive agility on the performance of the forward somersault skill on the vault table. It can contribute to improving strength, speed, and organization in movements since interactive agility is characterized by three main elements:

- Organization: The player needs to organize his movements effectively to achieve maximum speed and power.
- Coordination: The player needs to coordinate his movements.
- Balance: The player needs to maintain his balance while moving.

Therefore, interactive agility can contribute to improving the skill of the front flip on the vault table in terms of increasing speed and strength, and interactive agility can also contribute to improving the organization and coordination of movements.

This is consistent with (Al-Omoush et al. n.d.; Yusuf et al. n.d.; Zago et al. 2016)

Thus, the second hypothesis is achieved, which states **that "There are statistically significant differences between the pre- and post-measurements in the level of technical performance of the skill under study in favor of the post-measurement".**

c) Discussion of the results of the third hypothesis:

Which states that "**There are differences between the pre- and post-measurements in the biodynamic variables of the performance of the skill under study in favor of the post-measurement."**

It is clear from Tables 12 and 13 that there are differences in the biodynamic measurements, as there is a development between the pre- and post-measurements, in all stages of performing the skill.

The researcher also noticed a significant increase in the amount of linear movement obtained, which is of great importance in performing gymnastics skills in general and the skill of the front somersault on the vaulting table in particular.

Which is consistent with (Chen et al. 2017; Guilhem et al. 2014; Kim, Lee, and Jo 2023)

the importance of the amount of movement in giving the body the appropriate speed before the moment of rising on the vaulting horse in the front somersault.

Also, the front somersault in the second stage requires a great deal of speed in the first stage.

The researcher attributes the increase in the amount of linear movement during the stages of performance to the fact that interactive agility training increased focus during

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performance, which worked to coordinate between body parts in the approach movement, as the running movement is considered one of the repetitive reciprocal movements.

In it, the legs and arms are alternated in the muscular work, which requires the harmony of nerve signals and the body's synergy to achieve the best form of performance.

As it is clear from Tables 14 and 15, the time to perform the skill has decreased significantly.

The researcher attributes this to the fact that increasing the speed during the performance of the skill has in turn led to a decrease in the time of the skill, without compromising the stages of the skill or changing its form, and this is confirmed by the results of Table 9, which proved that the levels of skill performance level of the skill under study have increased significantly, not only that, but also the existence of statistically significant differences through discussing the second hypothesis.

As it is clear from Tables 14 and 15, the time to perform the third stage has decreased significantly in the post-measurement compared to the pre-measurement.

The researcher attributes this to the fact that the third stage includes completing the standing after completing the entire aerobic cycle, and the researcher attributes this to the effect of the training that worked to develop and improve interactive agility, which is included in the definition of agility in general, as agility is defined as the player's ability to change the position of the body, whether on the ground or in a fluid. Reactive agility also refers to the speed of re-changing direction (reactivating agility) again according to the changing external stimuli that the brain perceives through the sensory-motor receptors in the eye, which is what happens in the third stage of performing the front somersault on the vaulting table.

This is consistent with(Fei and Zhao 2022; Frère et al. 2011; Rakha and Saleh 2015; H. A. Saleh 2015; Sorel et al. 2019)

Thus, the third hypothesis is achieved, which states that **"there are differences between the pre- and post-measurements in the biodynamic variables specific to the performance of the skill under study in favor of the post-measurement"**.

Fourth: Conclusions and recommendations:

1 - Conclusions:

Based on the research results and considering the research objective and hypotheses, the researcher reached the following conclusions:

a) Suggested exercises for developing interactive agility
b) The interactive agility element was developed and improved with all its components.
c) The suggested exercises for developing interactive agility were developed on scientific foundations.
d) Interactive agility has a direct impact on the level of skill performance of the front flip skill on the vault table.
e) Developing interactive agility on scientific foundations has a positive impact on the biodynamics of skill performance of the front flip skill on the vault table.
f) Reducing the time to perform the front flip skill on the vault table is considered one of the most important biodynamic variables that must be considered when training the skill.

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2 - Recommendations:

Considering the research results and conclusions reached, the researcher recommends the following:

a) Relying on the proposed exercises in developing interactive agility to develop the skill of the front somersault on the vault table.
b) Conducting studies on the effect of developing interactive agility on the rest of the gymnastics skills.
c) Relying on the science of biomechanics in evaluating the performance of gymnastics skills for the accuracy and impartiality it provides to researchers.

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