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Original Article

Title:
The Effect of Training Program Using Core Stability Exercises on Some Physical Variables and Skill Performance Level in Backstroke Swimming

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Abstract

The study aimed to design a training program consisting of Core Stability exercises to identify its effect on some physical and skill variables of backstroke swimming for female students in physical education faculty. The autor designed an experimental approach using the experimental design of one experimental group. The participants in the study were (50) form third-year-female students at Jazeera physical education faculty, University of Helwan in the academic year 2022/2023. The results revealed that the training program using Core Stability exercises had a positive effect on various physical variables (muscular strength of legs, muscle strength, back abdominal muscle strength, arm and shoulder belt muscle strength, right and left arm muscle strength, and balance). The training program improved the skill performance level (motor timing, motor linking “coordination/coupling”) of backstroke swimming.

Keywords:
Core Stability, Physical variables, Skill performance, Backstroke swimming.

Introduction

Sports training always aims to achieve the athlete's maximum performance in competitive sports. This requires coordination between physical abilities and speed of performance, comprehensive development of physical elements, effective acquisition and use of technical skills, integration and excellence in strategic abilities, in addition to successful and effective application of the playing system, adapting it to the specificity and individuality in the training process. (Al-Sayyid M., 2015)

Core Stability exercises can assist in achieving maximum performance and preventing injuries. Muscle strength derived from the core area contributes in controlling this force properly, allowing movements to be smoother and more efficient. It also enhances coordination

and alignment in the limbs. Furthermore, core muscles help reduce the risk of injuries resulting from improper body positioning during performance and contribute to maintaining proper posture during movement. As for speed, they play a significant role in protecting the spinal cord and skeletal from excessive movement range and excessive or unnatural forces that can effect the body. (Kibler, W. B. et al. 2006)

Core Stability can be described as the collection of anterior abdominal muscles, posterior back muscles, and pelvic muscles. This group includes 29 pairs of muscles that play a vital role in achieving balance and stability for the spinal column, pelvis, and the motor chain of basic movements. Without these muscles, the spinal column becomes mechanically unstable when subjected to pressures below 90 degrees. This means it cannot effectively bear the weight of the upper part of the body. (Venu A., 2008)

The term Core refers to several groups of muscles, including the rectus abdominis, back muscles, and pelvic floor muscles. These muscles work cooperatively to produce maximum stability in the abdominal and lower back region, and they also assist in coordinating the movement of the arms, legs, and the spinal column. Most individuals often do not know how to activate these muscles correctly. Therefore, it is of utmost importance to understand how to engage these muscles effectively during exercise. (Princeton University,2023)

The term Core Stability refers to the ability to control the position and movement of the central part of the body. This training focuses on strengthening the deep muscles in the abdominal region that connect to the spine, pelvis, and shoulders. These muscles play a crucial role in maintaining proper body posture and providing the foundation for all arm and leg movements. (Princeton University,2023)

According to Marek J. (2012), training programs can be performed with the assistance of peers, coaches, or individually. Additionally, other mechanical tools or devices can be used to enhance the effectiveness of these exercises or training, helping to increase muscle activity and consequently improve performance outcomes, whether physical or skill-based. (Marek J., 2012)

The author utilized some tools during the implementation of the proposed program, as indicated by Daved W. 2023.

Both Venu A. (2008) and Bary A. (2016) indicate that Core Stability exercises affect the muscle groups of the core and have a positive effect on muscular strength. Core Stability is considered one of the key pillars of physical activities, regardless of their type. These exercises have a positive influence on skill performance levels and the development of physical requirements in core muscles, as well as muscular strength in the arms and legs. The

improvement in physical requirements generally leads to an enhancement in skill performance. (Bary A., 2016; Venu A., 2008)

The author noticed a significant weakness in backstroke swimming among the female students during her work at the Faculty of Physical Education while teaching the third-year swimming course. This weakness was attributed to the changes made in the faculty's swimming pool as a result of the second-year students moving to the Al-Jazeera Youth Center. This led to a modification of the course schedule for the students, with them attending swimming class only once a week. Consequently, the students did not have sufficient time for the swimming course, and this, in the author's opinion, resulted in the evident weakness in backstroke swimming when the students moved to the third year.

This weakness, particularly in the Core muscles, became more apparent when the second-year students transitioned to the third year. Common errors were observed in the lower part of the body during backstroke swimming. This observation led to the current research idea: designing a training program focused on developing these Core muscles and improving skill performance by enhancing certain physical variables. This program aims to raise the level of the female students in backstroke swimming.

According to the over mentioned criteria, the author designed a training program using Core Stability exercises with the aim of improving certain physical variables and skill performance levels among female students at the Faculty of Physical Education in backstroke swimming.

Research objective:

The aim of this research is to investigate the effect of a training program using Core Stability exercises on certain physical variables (leg strength, back muscle strength, abdominal muscle strength, arm and shoulder strength, arm strength, balance) and skill performance level (motor timing, motor coordination/coupling) among female students at the faculty of physical education in backstroke swimming.

Research hypothesis:

1. There are statistically significant differences between the mean scores of the pre- post test measurements for the studied physical variables in backstroke swimming in favor of the post-measurement.

2. There are statistically significant differences between the mean scores of the pre- post test measurements for skill performance in backstroke swimming in favor of the post-measurement.

Material and Methods

Research procedures

The author used an experimental research design with a single experimental group and pre-post test measurements.

Participants

The research community consists of third-year female students at the faculty of Physical Education, Helwan University, for the academic year 2022/2023, of (846) students. The actual participans for the main experiment was selected randomly and consisted of 50 students. The participans for the pilot study consisted of 20 students from the research community who were not part of the experimental group. Therefore, the total participans number was 70 students.
Homogeneity

Table (1) Chracteristics of participants of the two groups (n=70)

Variables	Units	Statistical Analysis			
		Mean	SD	Median	Skewness
Age	Years	20.03	0.84	20.00	11.00
Height	cm	162.10	3.22	162.00	0.09
Weight	Kg	61.55	3.39	62.00	-0.40
Broad Jump	cm	117.90	3.02	118.00	-0.10
Back Extension	R	14.29	2.47	14.00	0.35
Sitting from Supine (Sit-Up)	R	7.14	1.07	7.00	0.39
Medicine Ball Push	m	4.05	0.85	4.00	0.18
Medicine Ball Push with Right Hand	m	3.66	0.65	3.70	-0.18
Medicine Ball Push with Left Hand	m	2.87	0.73	3.00	-0.53
Balance Beam Walking	Sec.	10.25	1.05	10.20	0.14
Motor Timing (Movement Timing)	R	12.15	3.24	12.31	-0.15
Motor Coordination (Motor coupling)	(m/s)	2.23	0.11	2.29	-1.91

It is clear from Table (1) that the previous variables were in range between (+3, -3). Therefore, the previous variables are considerd moderate or homogene.

Equipment and Tools

The author used a data collection form to record the research data. This form included the following information: age, height, weight, physical fitness tests, and skill tests.

1. Measurement Tools and Equipment

Stadiometer for measuring height and weight (in cm and kg), Dynamometer for measuring strength, Hurdles, Wall (Chalkboard) and chalk, Stopwatch for measuring time,

Measuring tape, Wall-mounted scale, Foam mattresses, Cones, Medicine balls, Swiss Ball, Half Swiss Ball, and Kettlebell.

2. The physical and skill tests:

The physical and skill tests were selected after reviewing the references, then the tests were reviewd by the experts. The approval rate for these tests was 100%. The physical tests are shown in table 2.

Validity and Reliability:

Table 2 clearly shows the differences between the distinguish and non-distinguish groups in favor of the distinguish group. Therefore, the studied tests are capable of distinguishing between individuals, confirming their validity for the intended purpose.

Table (2) Significance of differences between Distiguished and Non-Distiguished Groups of the physical Tests (N=20)

physical Tests	Units	Distiguished Group N1=10		Non-Distiguished Group N2=10		Mean Difference	Value "*t*"*
		Mean	SD	Mean	SD		
Broad Jump	Cm	125.69	2.96	117.91	3.03	7.78	13.89
Back Extension	R	17.25	2.44	14.3	2.43	2.95	6.04
Sit-Up	R	10.02	1.01	7.13	1.06	2.89	5.58
Medicine Ball Push	m	5.08	0.92	4.07	0.87	1.01	3.05
Medicine Ball Push with Right Hand	m	4.55	0.32	3.65	0.64	0.90	2.21
Medicine Ball Push with Left Hand	m	3.95	0.54	2.86	0.72	1.09	3.25
Balance Beam Walking	Sec.	8.02	0.24	10.26	1.07	2.24	4.39
Motor Timing	R	9.84	2.95	12.17	3.25	2.33	4.71
Motor Coordination (Motor coupling)	(m/s)	2.94	0.08	2.22	0.10	0.72	2.16

*Tabulated "t" value at (18, 0.05)= 2.10 (two-tailed)

The value of "r" in Table 3 is statistically significant, indicating a correlation between the first and second applications and, consequently, the reliability of the studied tests.

Table (3) Reliability Correlation Coefficient between Test and Re-test measurments Of the physical Tests (N=10)

physical Tests	Terst		Re-Test		The calculated correlation coefficient "r"
	Mean	Standard Deviation	Mean	Standard Deviation	
Broad Jump	117.91	3.03	117.94	3.04	0.952*
Back Extension	14.3	2.43	14.28	2.41	0.955*
Sit-Up	7.13	1.06	7.19	1.07	0.924*
Medicine Ball Push	4.07	0.87	4.09	0.88	0.951*
Medicine Ball Push with Right Hand	3.65	0.64	3.63	0.63	0.952*
Medicine Ball Push with Left Hand	2.86	0.72	2.87	0.7	0.956*
Balance Beam Walking	10.26	1.07	10.24	1.06	0.949*
Motor Timing	12.17	3.25	12.19	3.27	0.948*
Motor Coordination (Motor coupling	2.22	0.1	2.2	0.09	0.951*

"r" value at the significance level (8, 0.05)= 0.632

Training Program

The training program consisted of 8 weeks with 4 training units per week and a program with a combination of specific stability exercises, strength exercise, weightlifting exercises. The balance training interventions consisted of balance exercises on both a stable and unstable surface, with or without recurrent destabilization during performance such as Overhead Pitcher's Squat on Ball - Overhead Lunge

The Principles of the program

- Ensuring the appropriate intensity, volume, and rest in training loads.
- Enhancing the development of energy systems used in backstroke swimming.
- Maintaining a balance between load levels and rest intervals.
- Focusing on warm-up and cool-down protocols.

The Design of the Program

The author designed the Core Stability program through the following procedures:

1. Program Objectives

The program aims to develop certain physical variables (leg strength, back muscle strength, abdominal muscle strength, arm and shoulder strength, arm strength, balance) and motor skills

(motor timing, motor coordination) for female students faculty of Physical Education in backstroke swimming.

2. Determining the Level of the studiedVariables.

Whereas the research sample level was determined for both physical and studied skill variables using the employed tests, as illustrated in Table (7).

3. Program Content

a. Warm-up exercises to prepare various muscle groups, enhance joint flexibility, and stretch the muscles.
b. Utilization of tools such as Swiss Ball, Half Swiss Ball, and Kettlebell in the program's exercises.
c. Identification of Core Stability exercises and their distribution within the units.

4. Shaping the load cycle throughout the program stages

The author used an undulating periodization method to structure the monthly training load (1-3) during the training cycle (for Weeks 1 to 12). This was done with a frequency of 2 units per week. This decision was made after consulting with the expert panel (Annex 6) who also indicated that the load should be of moderate and high intensity. Furthermore, they recommended that the highest intensity load should be applied during Weeks 4, 10, and 12. This is illustrated in Figure (1).

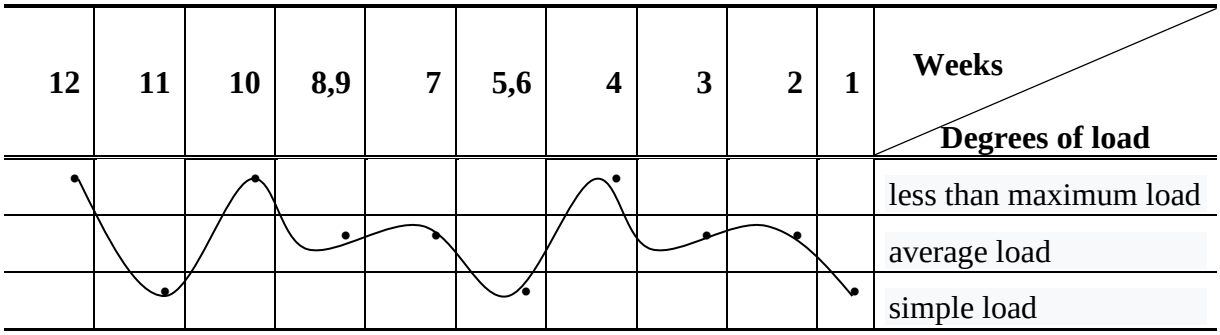

Figure (1) load formation

5. The weekly training volume

The author determined the weekly training volume as follows:

a. Total duration of moderate load = 4 weeks (weeks: 1,5,6,11) = 840 minutes.
b. Total duration of high load = 5 weeks (weeks: 2,3,7,8,9) = 1100 minutes.
c. Total duration of maximum load = 3 weeks (weeks: 4,10,12) = 740 minutes.

d. Total overall training time = 840 minutes + 1100 minutes + 740 minutes = 2680 minutes.

6. The program duration

The program duration is 12 weeks, with two units per week, for a total of 24 units.(Table 5)

Table (5) Time Distribution of the Training Program

N	Content	The time distribution
1	Duration of Application	12 weeks
2	Number of Units per Week	2 units per week
3	Total Number of Program Units	24 training units
4	Training Unit Time	90 minutes (weeks 1, 5, 9) = 6 110 minutes (weeks 2, 3, 6, 7, 12). 130 minutes (weeks 4, 8, 10, 11).
5	The total training program time	2680 minutes (44.66 hours)

7. Using Swiss Ball, Half Swiss Ball, Kettlebell in the Training Program

Where the tools of Swiss Ball, Half Swiss Ball, Kettlebell were used in the proposed exercises in the Core Stability program. The opinions of experts were surveyed regarding the exercises using these tools in the training program, and the experts unanimously approved them.

8. Expert Opinion Survey

Expert opinions were surveyed on the studied physical and skill tests, expert opinions were also surveyed on the program's time distribution, the training program's training units, and the exercises using Swiss Ball, Half Swiss Ball, and Kettlebell tools, as illustrated in Tables 4, 5.

The Pilot Study

The author conducted the pilot study on October 4, 2021, for the following objectives:

- To identify any difficulties that the author might encounter.
- To perform the scientific procedures for the used tests.
- To verify the load of some units of the program.

All of these points were verified through the exploratory group, which consisted of 20 female students from the faculty of Physical Education in Al-Jazeera, Cairo, Egypt.

The following table shows one of the program units:

Table (6) An example of the program units (Unit: 1, duration: 90 minutes)

Week	Parts	Content	Duration	Repetitions	Rest Between Repetitions	Sets	Rest Between Sets	Total Time
1	Warm up	−Running around the swimming pool. −Stretching exercises, flexibility exercises, and various exercises to raise body temperature and prepare the muscles for physical effort.	3m					9m
	General physical preparation	Exercises to develop some general physical fitness attributes.	3m					
	Specific physical preparation	Exercises to develop some specific physical attributes related to swimming.	3m					
	The main part Core stability exercises	1, 3, 4, 6, 8, 10	30s	4	15s	4	10s	8.67m
	The cool-down part	-Flexibility and stretching exercises for different body parts	2.5m					4.5m
		-Relaxation and calming exercises for the body.	2m					
	Total time							90m

The main study (Measurements)

- Pre-measurements: The pre-measurements for the physical and skill-related research variables were conducted on October 5, 2021, as shown in Table (7).
- Program Implementation : The implementation of the training program took place over 12 weeks, from October 10, 2021, to December 30, 2021. It consisted of 2 units per week, totaling 24 training units, as illustrated in Table (5).
- Post-measurements: The post-measurements for the physical and skill variables were conducted after the completion of the training program for the research sample on January

4, 2022. The same conditions and circumstances that were followed in the pre-program measurements were applied, as illustrated in Table (7).

Results

It is evident from Table (7) that there are statistically significant differences between the pre-program and post-program measurements for the research sample in both physical and skill variables at a significance level of 0.05.

Table (7) Significance of Differences Between Pre- and Post- measurements Means for the experimental group in Physical and Skill Variables, n=50

Variables	Test	Unit	Measurement	Mean	Standard Deviation	Difference Between Means	T-Value
Leg Strength	Broad Jump	cm	Pre	117.88	3.01	7.77	13.84
			Post	125.65	2.95		
Back strength	Trunk Lift from Prone Position	Nr	Pre	14.30	2.46	2.91	5.97
			Post	17.21	2.41		
Abdominal strength	Sit-Up	Nr	Pre	7.15	1.08	2.83	5.46*
			Post	9.98	0.98		
Arm and shoulder strength	Pushing a medicine ball with both hand	m	Pre	4.04	0.84	1.02	3.09*
			Post	5.06	0.90		
Arm strength	Medicine Ball Push with Right Hand	m	Pre	3.64	0.61	0.87	2.16*
			Post	4.51	0.30		
Arm strength	Medicine Ball Push with Left Hand	m	Pre	2.88	0.74	1.04	3.16*
			Post	3.92	0.53		
Balance	Balance Beam Walking	s	Pre	10.24	1.04	2.12	4.28*
			Post	8.12	0.26		
Motor Timing	Organizing the timing of the strokes	Nr	Pre	12.16	3.26	2.25	4.58*
			Post	9.91	2.99		
Motor Coordination (Motor coupling)	Variating leg strokes with every two arm strokes	m/s	Pre	2.25	0.12	0.65	2.03*
			Post	2.90	0.07		

"T" value at the significance level (49, 0.05)= 1.68 (one-tailed)

Discussion

1. First Hypothesis

Regarding the first hypothesis, which suggests statistically significant differences between the pre and post measurements for the experimental research sample in certain studied physical variables in backstroke swimming in favor of the post-test measurements.

According to the results of the statistical analysis between the pre-test and post-test measurements of the studied physical variables, it is evident from Table (7), which indicates the significance of the differences between the pre-measurement and post-measurement, that there are statistically significant differences between the pre-test and post-test measurements for the experimental research group. The calculated (t) value was greater than the tabulated (t) value at a significance level of 0.05, in favor of the post-test measurements. This suggests that the training program led to an improvement in the studied variables.

It is evident from the table that the muscular strength of the legs was influenced during the program's implementation, reflected in an increase in the broad jump distance (broad jump test) where the average measurement rates increased. In the pre-measurement, it was (117.88), while in the post-measurement, it reached (125.65).

The author believes that this significant improvement in muscular strength is attributed to the proposed program using Core Stability exercises. This aligns with the findings of a study by Venu A. (2008) , which concluded that Core Stability exercises have an effect on trunk muscle groups and have a positive effect on muscular strength. Core Stability exercises are considered one of the key components for various physical activities.

The author also suggests that Core Stability exercises serve as a link between both muscular strength and muscular endurance. They are the main driver for improving both of these qualities. Muscular strength is considered the primary attribute, while Core Stability exercises act as a guide to enhance this strength in ways that are suitable for improving performance in swimming. This is in line with the findings of Paul W., Marshall (2005) and Bary A. (2016), who indicated a strong connection between the development of physical requirements (strength and muscular endurance) and the level of skill performance. As physical requirements increase, skill performance also tends to improve. (Bary A., 2016)(Paul W., Marshall, 2005).

Muscular endurance of the trunk plays a significant role for swimmers, forming the foundation for skill performance in backstroke swimming. The table illustrates that the average

rate of change in trunk muscular endurance, which includes the sit-up test (15 seconds), was 14.30 in the pre-measurement and increased to 17.21 in the post-measurement. Similarly, for the sit-up test (15 seconds), the averages increased from 7.15 in the pre-measurement to 9.98 in the post-measurement.

As for arm muscular endurance, Table (7) shows that the average arm muscular endurance, measured using the medicine ball push-up test from a seated position, was 4.04 in the pre-measurement and increased to 5.06 in the post-measurement.

This aligns with what Abdel Fattah Abu Elala mentioned in 2017, stating that exercises performed at maximum speed lead to an increase in the effectiveness of fast-twitch muscle fibers, which in turn develop both strength and speed simultaneously, In addition to developing balance. This aspect is present in Core Stability exercises.

This also aligns with the study by Reabum in 2004, which indicated that the training program using Swiss Ball had a positive effect on Core Stability through internal stability and energy efficiency. The program also affected the electrical activity level of the abdominal and back muscles.

Therefore, the first hypothesis, which states that "there are statistically significant differences between the pre and post-measurement means of the experimental research sample in some physical variables (leg strength, abdominal muscle strength, back muscle strength, arm and shoulder strength, balance) in backstroke swimming in favor of the post-measurement".

2. Second Hypothesis:

As for the second hypothesis, which indicates the presence of statistically significant differences between the pre and post measurements means of the experimental research sample in terms of skill performance level in backstroke swimming in favor of the post- measurements.

According to the results of the statistical analysis of the research sample, there are statistically significant differences between the pre and post measurements in the skill variables, specifically in terms of motor timing and motor coordination. This is evident from Table 7, which shows the significance of the differences between the pre and post-measurement. The calculated t-value was lower than the critical t-value (1.68) at a significance level of 0.05 in favor of the post-measurement. Therefore, the results indicate a significant improvement in the studied skill variables studied .

The table displaying the change rates for the mean measurements of the research group in the motor timing and motor coordination tests in the post-measurement indicates that these values were higher than those in the pre-measurement. This suggests that there was greater improvement in these skill variables in the post- measurements compared to the pre-measurements.

Based on the results, it's clear that the differences between the pre and post-test measurements were in favor of the post-measurement. In the case of motor timing (the number of strokes), a lower number indicates better timing during backstroke swimming. This is evident when comparing the pre and post-test measurements (12.16 pre-measurement, 9.91 post-measurement), where the number of strokes was lower in the post-measurement, indicating an improvement and a positive change in performance and motor timing.

As for the result in motor coordination (the rate in meters per second), the higher the rate, the better the motor coordination during swimming. This is evident when comparing the pre-test and post-test measurements (2.25 pre-measurement, 2.90 post-measurement), where the rate (m/s) was higher in the post-measurement. This indicates an improvement and a positive change in performance and motor coordination.

The above indicates that the training program using Core Stability exercises has a positive effect on the skill-related performance outcomes of the female students. This is in line with the study by A. Bary in 2016, which highlighted that training programs lead to improvements in swimming skill levels and that the development of physical variables related to the type of sports activity contributes to enhancing skill performance.

Therefore, the author attributes the higher skill level of the research sample in the post-measurement compared to the pre-measurement to the use of Core Stability exercises. These exercises have contributed to enhancing the skill level of the research sample. The author links these statistical findings to the training program using Core Stability exercises and associates them with both the timing of movements and motor coordination. Consequently, Core Stability exercises have a positive effect on the timing of strokes and the fluidity of body movement in the water.

The above findings align with what Stephen Harris mentioned in 2021 regarding the effect of Core Stability exercises. These exercises contribute to the swimmers' ability to maintain smooth body movement in the water, which is a crucial factor in improving swimming

performance. Additionally, Core Stability exercises enhance swimmers' timing and proper coordination in their swimming movements over race distances, resulting in better competition outcomes. This positive effect is due to the development of timing and motor coordination through Core Stability training for swimmers.

The second hypothesis stating that "there are statistically significant differences between the pre and post-measurement averages of the experimental research sample in terms of skill performance (motor timing, motor coordination) in backstroke swimming in favor of the post-measurement".

Conclusions

1. The proposed training program using Core Stability exercises has a positive effect on developing physical variables (leg strength, abdominal muscle strength, back muscle strength, arm and shoulder strength, arm strength, balance) in backstroke swimming.

2. The proposed training program using Core Stability exercises has a positive effect on developing skill variables (motor timing, motor coordination) in backstroke swimming.

3. The tools used in the training program (Swiss Ball, Half Swiss Ball, Kettlebell) serve as supportive factors in Core Stability exercises when developing the physical and skill variables in backstroke swimming.

Recommendations

1. Emphasizing the use of the proposed training program through Core Stability exercises due to their positive effect on improving physical and skill variables in backstroke swimming (within the limits of the research sample used).

2. Directing the results of this study, the tools used (Swiss Ball, Half Swiss Ball, Kettlebell), and the principles upon which training programs using Core Stability are built to those working in the field of coaching in general and in backstroke swimming in particular.

3. The importance of focusing and paying attention to the training exercises in backstroke swimming training programs on the exercises used with the Swiss Ball, Half Swiss Ball and Kettlebell tools,because of their significant role in enhancing the levels of the studied variables (physical and skill).

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