Contents lists available at Science-Gate

International Journal of Advanced and Applied Sciences

Journal homepage: http://www.science-gate.com/IJAAS.html

Enhancing physical abilities in junior wrestlers through virtual reality training: An experimental study

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ARTICLE INFO

Article history:
Received 27 July 2023
Received in revised form
6 December 2023
Accepted 11 December 2023

Keywords:
Virtual reality training
Physical capabilities
Junior wrestlers
Experimental group
Statistical analysis

ABSTRACT

This study aimed to investigate how virtual reality training (VRT) affects the physical skills of young wrestlers. It included 19 wrestlers, aged 15-17, who were part of the Egyptian Wrestling Federation and actively training during the 2022/2023 sports season. The participants were split into two groups: one experimental group with 12 athletes (further divided into two smaller groups of 7 and 5) and a control group with seven athletes. Before starting, measures were taken to ensure that the groups were similar and comparable. The experimental group participated in a VRT program for eight weeks, which consisted of 24 training sessions held three times a week. After the program ended, the researchers conducted tests to measure the outcomes, which were then analyzed statistically. The results showed a noticeable improvement in the physical abilities of the wrestlers in the experimental group, suggesting that the VRT program played a significant role. This research highlights the effectiveness of VRT as a tool for enhancing the physical capabilities of young wrestlers.

1. Introduction

Physical abilities play a critical role in the world of sports, where the demands on an athlete's body can vary widely depending on the discipline. In the case of wrestling, a sport that combines physical prowess with tactical skill, the importance of physical abilities cannot be overstated. Strength, agility, flexibility, and technique are not just parts of the sport; they are the foundations upon which success is built (Farley et al., 2020).

In wrestling, strength is paramount. It is the force behind the powerful throws, takedowns, and holds that wrestlers execute to gain control over their opponents. A wrestler's strength allows them to overpower an opponent, resist being moved or controlled, and execute techniques with high levels of force. Strength training, therefore, becomes a central part of a wrestler's regimen, focusing on both the upper and lower body to ensure a balanced development of power (Yoon, 2002). Agility refers to the ability to move quickly and change direction with ease. In the dynamic environment of a wrestling match, agility allows athletes to evade attacks, execute rapid counter-moves, and maintain positional advantage. This physical ability is crucial for maintaining a competitive edge, as it enables wrestlers to adapt and respond to their opponent's actions with speed and precision.

Flexibility is often underrated but is a critical component of a wrestler's physical toolkit. High levels of flexibility contribute to a wider range of motion, enabling wrestlers to perform a greater variety of moves and holds. It also plays a significant role in injury prevention, as more flexible muscles and joints are less likely to be strained or torn during the intense physical activity of a match. Through regular stretching and flexibility training, wrestlers can enhance their performance and longevity in the sport.

While physical abilities lay the groundwork, technique is the skill that allows wrestlers to effectively employ their strength, agility, and flexibility in a match. Technique encompasses the knowledge and execution of moves, holds, and strategies that define the sport of wrestling. Mastery of technique requires extensive training and experience, as it involves not just the physical execution of moves but also an understanding of timing, leverage, and opponent psychology.

The integration of strength, agility, flexibility, and technique is what makes a wrestler successful. No

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single attribute can stand alone; a wrestler with great strength but poor flexibility may find themselves outmaneuvered, while one with excellent technique but lacking in strength might struggle to execute their moves against a more powerful opponent. It's the harmonious development of all these attributes, combined with strategic thinking and mental toughness, that distinguishes the best in the sport. So, physical abilities are the cornerstone of success in wrestling, as they are in many sports. The rigorous demands of wrestling require athletes to develop a well-rounded set of physical skills underpinned by discipline, dedication, and a continuous strive for improvement. Through the balanced development of strength, agility, flexibility, and technique, wrestlers can achieve excellence and compete at the highest levels.

A comprehensive review by Chaabene et al. (2017) in the Journal of Strength and Conditioning Research highlights the crucial physical and physiological attributes for wrestlers, emphasizing the importance of an optimal level of cardiorespiratory fitness, anaerobic power and capacity, dynamic and isometric strength, explosive strength, and strength endurance. Interestingly, flexibility, while beneficial, was not identified as a key variable for achieving high-level success in wrestling. This research underscores the need for training programs to focus on developing these specific physical fitness parameters to enhance performance in wrestling.

Virtual reality (VR) has emerged as a groundbreaking training tool in the sports industry, revolutionizing the way athletes prepare mentally and physically for competition. This innovative technology offers a unique blend of physical and cognitive benefits, making it an invaluable asset for athletes across various disciplines (Wohlgenannt et al., 2020). VR technology excels in simulating complex, sport-specific environments and scenarios that are otherwise difficult to replicate in a traditional training setting. This allows athletes to immerse themselves in highly realistic simulations, where they can practice and refine their skills without the physical risks or logistical constraints associated with real-world training. For instance, VR can recreate challenging competition environments, enabling athletes to mentally prepare for the pressure and distractions they might face. This immersive experience enhances cognitive aspects such as decision-making, reaction time, and strategic thinking, which are crucial for competitive success.

Beyond mental preparation, VR also offers tools for physical training and technique refinement. By integrating motion capture technology, VR systems can analyze an athlete's movements, providing instant feedback on their performance. This allows for precise adjustments to technique, improving efficiency and reducing the risk of injury. Furthermore, VR can simulate physical scenarios that require specific physical responses, helping athletes develop muscle memory for complex movements specific to their sport.

One of the standout benefits of VR training is its accessibility. Athletes can train in a variety of environments and conditions without leaving the training facility, allowing for more frequent and diverse practice sessions. Additionally, VR minimizes the risk of injury by providing a safe platform for practicing high-risk maneuvers and techniques. This aspect is particularly beneficial for sports like gymnastics, skiing, or motorsport, where real-world training carries significant risks.

VR also plays a pivotal role in the rehabilitation process and the safe return to play for injured athletes. By simulating the sporting environment and tasks, VR can help athletes regain confidence in their abilities post-injury. Rehabilitation programs using VR can be tailored to the specific needs of the athlete, ensuring a gradual and controlled exposure to the demands of their sport, which can be crucial in preventing re-injury.

As VR technology continues to evolve, its potential applications in sports training and rehabilitation are boundless. Future developments may include even more sophisticated simulations, enhanced feedback mechanisms, and integration with other technologies like augmented reality (AR) to provide a more comprehensive training experience. So, VR represents a significant advancement in sports training, offering athletes a versatile, safe, and effective tool for enhancing performance. Its ability to simulate complex environments and provide targeted feedback makes it an invaluable asset for athletes aiming to achieve peak performance. As VR technology progresses, its impact on the sports industry is expected to grow, further solidifying its role as a cornerstone of modern athletic training.

A study by Witte et al. (2022) explored the use of VR training to improve response behavior in karate athletes. The study divided participants into a VR group and a conventional training group, focusing on karate-specific reactions to attacks. The VR training included realistic simulations and aimed at enhancing the athletes' reaction times and quality of responses to attacks, both in VR and real-world settings. This research highlights VR's potential to provide effective, sport-specific training that can transfer skills to real-world performance, showcasing VR's role in enhancing athletic training through realistic simulations.

The application of virtual reality training (VRT) has been perfected with the help of computers and software that can dynamically simulate the real world, where a real-time connection is formed between the player and the virtual world. Therefore, VRT has been applied in sports training, competitive sports, etc., as it plays an essential role in developing competitive sports and sports in general (Ahir et al., 2020).

The significance of VR lies in its ability to replicate real-world scenarios and environments, irrespective of their complexity or accessibility. This technology enables the creation of diverse settings that individuals may not be able to experience

directly in their daily lives. Through VR, users can immerse themselves in simulated situations that mirror the real world, offering opportunities for exploration, learning, and engagement in environments otherwise beyond their reach (Neo et al., 2021).

VRT enables players to coexist in the virtual environment and benefit from it before practice. It also creates an interactive training atmosphere that attracts the player's attention to deal with the training material more naturally and effectively (Xie et al., 2021). This facilitates this by providing players with voice instructions or animations that enable integration in this environment. The researchers reviewed many scientific studies related to the virtual learning environment using VR glasses, which confirmed the effectiveness of the training program prepared using VR glasses, as it was better than the traditional method in developing the performance level of basic skills and focusing attention (Sabry et al., 2022). Due to the nature of wrestling, which requires a lot of physical capabilities and sensory perceptions, the two researchers will study the use of VR in sports training and determine how this technology can relate to the development of the physical abilities of wrestlers. The research aims to develop the physical abilities of wrestlers using VR.

Bedir and Erhan (2021) conducted a study in which participants in the research were randomly selected athletes from some sports, such as bowling (n=13) and archery (n=7). The results showed statistically significant differences between the groups regarding shot performance and shooting skills. In another study, the researcher used the experimental approach due to its suitability to the nature of this study and used one of the experimental designs for two groups, using pre- and post-measurement. Their ages ranged between 6 and 9 years, and their ages ranged from 9 to 12 years. Each group consisted of 10 students. The researcher concluded that the three-dimensional augmented reality video technology program positively affected the experimental group learners in improving the selected skills (Daga, 2020). Farley et al. (2019) conducted a study on skill acquisition and training. Specifically, it describes VR, examines its benefits in sports, and the applicability of methodological approaches. It is used together with the outcomes, limitations, and implications for the training and exercise of athletes. In addition, the uses of VR in skill acquisition/teaching-learning outline how technology can be applied to hone specific hard-to-obtain skills and encourage new thinking for coaches.

This research presents an investigation into the application of VRT on the physical capabilities of junior wrestlers. The study involves a controlled experiment with pre and post-tests to assess the impact of an 8-week VRT program.

The research aims to explore the effects of VRT on developing specific physical abilities in junior wrestlers. Through an 8-week training program, the study assesses how VRT impacts the athletes' performance compared to traditional training methods. The purpose is to understand VRT's potential as an innovative tool for enhancing the physical capabilities crucial for wrestling, thereby offering insights into integrating technology into sports training effectively. There are three main hypotheses in this research as follows. 1) Significant improvements in the physical abilities of wrestlers in the experimental group between the pre-test and post-test, 2) Significant differences between the pre-test and post-test of the control group in wrestlers' physical abilities, favoring the post-test, and 3) Significant differences between the post-tests of the experimental and control groups in the physical abilities of the wrestling juniors, with the experimental group showing more improvement.

2. Methodology

This study will employ an experimental design, creating two groups (an experimental group and a control group) and conducting pre-tests and post-tests. This approach is chosen for its relevance to the study's objectives.

Research community: The study focuses on wrestlers aged 15-17 from the Ghazl El-Mahalla Club in Gharbia Governorate. These young athletes are registered with the Egyptian Wrestling Federation and have been actively participating in training during the 2022/2023 sports season.

Research sample: The study's sample consists of 19 wrestlers selected randomly. These participants are then divided into two groups: one experimental and one control group. The division is such that each group has seven players, with an additional 5 for survey-based studies.

Sample distribution normality: To ensure the sample's distribution is statistically normal, the study uses a skewness coefficient. This method helps in verifying that the sample's distribution in various measurements and tests aligns with a normal distribution across all variables of the study. The findings and the distribution's normality are detailed in Tables 1 and 2.

It is clear from Table 1 that the values of the torsion coefficient in the essential variables are limited to (-3: +3), indicating the moderation of the crucial variables under study.

Table 1: Characterization of the research sample in the essential variables (n=14)

Variables	Mean	Median	Standard deviation	Skewness
Age	16	16.14	0.5	0.155
Height	158.53	159.5	5.31	-0.088
Weight	60.43	59.5	5.78	0.622
Training age	3.29	3.00	0.37	0.965

Table 2: Characteristics of the research sample in the tests of physical abilities (n=14)

Physical capabilities	Tests	Mean	Median	Standard deviation	Skewness
Back muscle strength	Static strength of the muscles of the back with a dynamometer	129.24	128.45	2.64	0.384
Leg muscle strength	The constant force of the muscles of the two legs with a dynamometer	155.82	157.4	3.22	-0.914
The muscular capacity of the two legs	Broad jump from stability	2.33	2.34	0.04	-0.483
The muscular power of the arms	Throwing a medicine ball with two hands in front of the body 3 kg	5.614	5,500	0.328	-0.056
Distinctive strength with speed	The time of performing the bridge skill three times	10.53	11.11	0.64	0.444
Flexibility	Dome (flexibility of the spine and shoulders)	53.35	53	1.01	0.183
Agility	Prone from standing and crawling around a circle	8.34	8.24	0.48	0.599

Table 2 shows that the values of the torsion coefficient for the variables of physical abilities are limited to (-3: +3), indicating the moderation of the search values in the tests of physical skills.

2.1. Research measurements and tests

These measurements and tests were determined through the reference survey of many Arabic and foreign reference studies and references 2, 6, and 11. The researchers concluded that the most appropriate tests and measurements that achieve the goal of ace is:

1. Basic measurements: Chronological age (age to the nearest half year), Total length (to the nearest centimeter), Weight (to the nearest kilogram), Training age.
2. Physical measurements used in the research (Physical abilities | Test description):

- Back muscle strength: Measuring the static strength of back muscles using a dynamometer.
- Leg muscle strength: Measuring the constant force produced by the muscles in both legs with a dynamometer.
- Leg muscle capacity: Assessing leg muscle power through a standing long jump.
- Arm muscle capacity: Evaluating the power of arm muscles by throwing a 3 kg medicine ball with both hands from in front of the body.
- Strength and speed: Timing how quickly the bridge position can be performed three times.
- Flexibility: Assessing the flexibility of the spine and shoulders through the Dome test.
- Agility: Testing agility by moving from a standing position to lying prone and crawling in a circle.

To ensure both the experimental and control groups of players were comparable across all variables being studied, the researchers used the Mann-Whitney test to analyze the differences in the pre-test scores between the two groups. This statistical test helped confirm that the players in both groups were on equal footing in terms of the research variables. The outcomes of this analysis are presented in Tables 3 and 4, illustrating the groups' equivalence.

Table 3 indicates that there aren't significant differences in the key variables between the pre-tests of the experimental group and the control group. This is based on the results of the Mann-Whitney test, where the test's calculated value exceeded the critical threshold. Furthermore, the z-value was below the critical threshold at the 0.05 level, supporting the conclusion that the two groups were similar in the key variables before the study began. Table 4 reveals that there are no significant differences in the physical measurements' pre-tests between the experimental group and the control group. This conclusion is drawn from the results of the Mann-Whitney test, where the calculated value was above the critical value. Additionally, the z-value was below the critical value at the 0.05 significance level, indicating no significant differences between the two groups before the intervention.

Table 3: The equivalence of the two study groups in the essential variables (n1=n2=7)

Tests	Experimental group		The control group		Mann-Whitney U	Z value
	Rank means	Total ranks	Rank means	Total ranks		
Age	8	56	7	49	21	-0.45
Height	7	49	8	56	21	-0.45
Weight	7.85	55	7.14	50	22	-0.32
Training age	7.5	52.5	7.5	52	24	0

Mann-Whitney value at 0.05=11; Z value at 0.05=1.96

Table 4: The equivalence of the two study groups in Physical measurements (n1=n2=7)

Tests	Experimental group		The control group		Mann-Whitney U	Z value
	Rank means	Total ranks	Rank means	Total ranks		
Static strength of the muscles of the back with a dynamometer	7.35	51.5	7.64	53.5	23.5	-0.12
The constant force of the muscles of the two legs with a dynamometer	7.57	53	7.42	52	24	-0.06
Broad jump from Althaiat	7.78	54.5	7.21	50.5	22.5	-0.25
Throwing a medicine ball with two hands in front of the body 3 kg	7.28	51	7.71	54	23	-0.19
The time of performing the bridge skill three times	7.21	50.5	7.78	54	22.5	-0.28
Dome (flexibility of the spine and shoulders)	7.21	50.5	7.78	54	22.5	-0.26
Prone from standing and crawling around a circle	8	56	7	49	21	-0.53

Mann-Whitney value at 0.05=11; Z value at 0.05=1.96

2.2. Scientific transactions for physical tests

2.2.1. Validity

The researchers employed a method known as differentiation validity to assess the accuracy of the tests being studied. This involved conducting the tests with two distinct groups of wrestlers: one group consisted of wrestlers under 17 years old without notable achievements, and the other group included accomplished wrestlers under 15 years old. The researchers then analyzed the significant differences in test outcomes between these two groups to confirm the reliability of the tests. The findings, which highlight the differences between the two groups, are presented in Table 5.

Table 5 shows significant differences between the advanced group and the basic group, with the advanced group performing better. This conclusion comes from the Mann-Whitney test results, where the calculated value for these variables was below the critical value at the 0.05 level. Additionally, the z-value was above its critical value at the 0.05 level, indicating that the tests were effective in measuring their intended variables.

2.2.2. Reliability coefficient

The researchers used the test and then re-applied it to calculate the reliability of the tests in question on an exploratory sample. The tests were re-applied on the same experimental sample a week after the first application, considering the standardization of the measurement conditions. The differences between the first and second applications of the exploratory sample were calculated to calculate the reliability coefficient of the tests under consideration. The research and the results showed the stability of the tests, as shown in Table 6.

Table 5: The significance of the differences between the privileged group and the non-discriminatory group in the physical abilities under study (n=5)

Tests	Special group		Non-special group		Mann-Whitney U	Z value
	Rank means	Total ranks	Rank means	Total ranks		
Static strength of the muscles of the back with a dynamometer	8	40	3	15	.00*	2.61*
The constant force of the muscles of the two legs with a dynamometer	8	40	3	15	.00*	2.61*
Broad jump from stability	8	40	3	15	.00*	2.61*
Throwing a medicine ball with two hands in front of the body 3 kg	8	40	3	15	.00*	2.13*
The time of performing the bridge skill three times	8	40	3	15	.00*	2.68*
Dome (flexibility of the spine and shoulders)	8	40	3	15	.00*	2.62*
Prone from standing and crawling around a circle	3	15	8	40	.00*	2.61*

Mann-Whitney value at 0.05=2; *: Statistically significant at 0.05 level of significance; Z value at 0.05=1.96

Table 6: Significance of the differences between the first application and the second application in the physical abilities under study (n=5)

Tests	Negative ranks		Positive ranks		Z value	Error coefficient
	Rank means	Total ranks	Rank means	Total ranks		
Static strength of the muscles of the back with a dynamometer	3.5	7	2.67	8	0.14	0.89
The constant force of the muscles of the two legs with a dynamometer	5	5	2.5	10	0.68	0.5
Broad jump from stability	1.5	1.5	2.83	8.5	1.3	194
Throwing a medicine ball with two hands in front of the body 3 kg	3	6	3	9	40	68
The time of performing the bridge skill three times	4	4	2	6	36	71
Dome (flexibility of the spine and shoulders)	4	4	2	6	1.41	0.16
Prone from standing and crawling around a circle	1.5	3	3.5	7	1.52	0.32

Z value at 0.05=1.96

Table 6 shows that there are no significant changes between the before and after tests. This is because the value calculated for the error coefficient was above 0.05, and the z value was below the critical value at the 0.05 level. This suggests that the tests remained consistent over time.

- The first survey: The two researchers conducted the first survey in the period from 3/2/2023 to 10/2/2023 on the survey sample to ensure that:

- The validity of the devices and tools used.
- Safety, implementation, and application of measurements, tests, and related procedures following the conditions set for them and conducting scientific transactions for the tests under discussion.
- The suitability of the tests under discussion for the dental stage.
- Identifying the difficulties that the researcher may encounter while conducting the primary study.
- The program is suitable for the basic research sample.
- Determine the intensity of the performance, the number of repetitions, and rest periods.

- The second survey: The two researchers conducted the second exploratory study from 10/2/2023 A.D. to 12/2/2023 A.D. on the experimental sample, and the aim was to design the training content for the physical abilities under study using VRT. The results of the second survey study revealed the following:

- Preparing and supplying (VR BOOX) glasses.
- Designing the training content for the young players in the training program and preparing using (VR BOOX) glasses for the physical abilities under study.

Pre-test measurements: Pre-test measurements were taken for the members of the research sample for the two groups (experimental and control) from 14-13/2/2023 at Ghazl Al-Mahalla Club in Gharbia Governorate.

- The first day: Measuring growth rates (height-Weight - training age).
- The second day: Measuring physical capabilities.

2.3. Basic study

The two groups (experimental-control) underwent a unified program in all its contents during the period of special preparation, except for (VR exercises for physical abilities) proposed by the researcher on the players of the experimental group only, with the same program implementation time for the two research groups (experimental-control). For eight weeks, from 2/16/2023 A.D. to 4/10/2023 A.D.

After reviewing the reference studies and scientific references, the researcher reached some points through which the training program can be developed:

- The duration of the training program is eight weeks, and the time of the training unit is 90 minutes.
- At the rate of 24 training units, at the rate of 3 training units per week. The corrugated method was used in the application of the program (1: 2), where the intensity of the performance of the exercises was graduated during the first month, as it began in the first week with an intensity ranging from 55 to 65%, with an increase Weekly from 3-5% of the maximum of what the junior can bear, as the intensity at the end of the program reached 90%.
- The principle of load and rest was used as a base for training.

1. Preparation and design of the training program: The researchers filmed the players registered in the Egyptian Wrestling Federation while they were performing the physical abilities training under study to use the video clips in preparing the training program as follows (Filming videos for the physical abilities training under investigation):

- VR VIDEO Converter and VR Player is one of the best VR players for VR and 3D videos, giving complete control and supporting all modes. This application plays videos from the phone's memory so that you can watch all recorded videos in VR mode.
- The training content was displayed through the use of smartphones. The training content that contains physical abilities training is sent to the players during the training unit and uploaded to the VR VIDEO Converter and VR Player program. The phone is placed inside the VR glasses to view the training content.

2. Application Phase: It is the stage in which the actual implementation of the training unit takes place using VRT by presenting the content Training for the players through smartphones and VR glasses, where glasses are equipped for each player and an internet network inside the training hall. The researcher sends how to implement the physical capabilities training for the players at the beginning of the training unit to each player's phone and uploads it to the VR VIDEO Converter and VR Player program. The phone is placed inside the VR glasses to display the training content in a 360-degree panoramic and stereoscopic view. After the viewing, the players put the glasses in the designated place and then performed the exercises as they watched them correctly. This stage aims to train Players on the activities in research. This stage includes "the application period, the exercises used, and the training methods used."

Post-test measurements: Post-test measurements were made for the two groups (experimental-control) in the variables used in the research under the same conditions as previous measurements during the period 11,12 /4//2023.

3. Results and discussion

3.1. Results presentation

The results of the first hypothesis stated that there are statistically significant differences between the Pre-test and the Post-test of the experimental group in the physical abilities of the wrestlers in favor of the Post-test.

Table 7 proves that there are statistically significant differences between the pre and post-tests of the experimental group in the physical abilities in favor of the post-test, where the calculated error coefficient value was less than 0.05, as confirmed by the calculated z value, which was higher than its tabular value at 0.05.

The findings for the second hypothesis revealed that there was a noticeable improvement in the physical abilities of the wrestlers in the control group from before to after the test, with the later test showing better results. This improvement was statistically significant, as shown in Table 8, where the error coefficient's calculated value fell below 0.05. This was further supported by the z value, which exceeded the critical threshold at the 0.05 level, indicating a genuine difference in physical abilities before and after the intervention within the control group.

Additionally, the results for the third hypothesis indicated that when comparing the post-test results of both the experimental and control groups, the experimental group showed superior physical abilities. This difference between the groups' post-test performances was statistically significant, favoring the experimental group's post-test outcomes. This suggests that the intervention had a positive effect on the experimental group's physical capabilities compared to the control group.

Table 7: The significance of the differences between the pre and Post-tests of the experimental group in the physical capabilities of the study sample under study (n=7)

Tests	Negative ranks		Positive ranks		Z value	Error factor	Average change
	Rank means	Ranks total	Rank means	Ranks total			
Static strength of the muscles of the back with a dynamometer	0	0	4	28	-2.36	0.01*	11.27
The constant force of the muscles of the two legs with a dynamometer	0	0	4	28	-2.36	0.01*	5.31
Broad jump from Althaiat	0	0	4	28	-2.38	0.01*	4.71
Throwing a medicine ball with two hands in front of the body 3 kg	0	0	4	28	-2.37	0.01*	32.66
The time of performing the bridge skill three times	4	28	0	0	-2.53	0.01*	10.8
Dome (flexibility of the spine and shoulders)	0	0	4	28	-2.42	0.01*	9.84
Prone from standing and crawling around a circle	3.5	21	0	0	-2.44	0.01*	10.18

*: Statistically significant at a significant level of 0.05; Z value at 0.05 = 1.96

Table 8: The significance of the differences between the pre and post-tests of the control group in the physical capabilities of the study sample under study (n=7)

Tests	Negative ranks		Positive ranks		Z value	Error factor	Average change
	Rank means	Total ranks	Rank means	Total ranks			
Static strength of the muscles of the back with a dynamometer	0	0	4	28	-2.38	0.01*	3.75
The constant force of the muscles of the two legs with a dynamometer	0	0	4	28	-2.38	0.01*	2.2
Broad jump from Althaiat	0	0	4	28	-2.4	0.01*	1.66
Throwing a medicine ball with two hands in front of the body 3 kg	0	0	4	28	-2.37	0.01*	10.83
The time of performing the bridge skill three times	3.5	21	0	0	-0.244	0.01*	0.8
Dome flexibility of the spine and shoulders	0	0	4	28	-2.41	0.01*	4.09
Prone from standing and crawling around a circle	4	28	0	0	-2.4	0.01*	1.73

*: Statistically significant at a significant level of 0.05; Z value at 0.05=1.96

Table 9 indicates significant improvements in the physical abilities of the experimental group compared to the control group, as seen in their respective post-tests. This is evidenced by the Mann-Whitney test's calculated value being below the critical threshold and the z-value exceeding the critical threshold at the 0.05 level, suggesting the experimental group's post-test performance was notably better.

Table 9: The significance of the differences between the two Post-tests of the experimental and control groups in abilities and Physical fitness of the study sample under study (n1=n2=7)

Tests	Experimental group		The control group		Mann-Whitney U	Z value
	Rank means	Total ranks	Rank means	Total ranks		
Static strength of the muscles of the back with a dynamometer	11	77	4	28	0	-3.15*
The constant force of the muscles of the two legs with a dynamometer	9.71	68	5.29	37	9	-1.98*
Broad jump from Althaiat	10.36	72.5	4.64	32.5	4.5	-2.56*
Throwing a medicine ball with two hands in front of the body 3 kg	11	77	4	28	0	-3.15*
The time of performing the bridge skill three times	11.00	77.00	4.00	28.00	0.00	-2.64*
Dome flexibility of the spine and shoulders	10.93	76	4.07	28.5	0.5	-3.10 *
Prone from standing and crawling around a circle	11.00	77.00	4.00	28.00	0.00	-2.62*

Mann-Whitney value at 0.05=11; Z value at 0.05=1.96

3.2. Discussion and interpretation of the results

3.2.1. Discussing the results of the first hypothesis

It is clear from Table 7 that there are statistically significant differences between the pre and post-tests of the experimental group in the physical abilities in favor of the post-tests, where the calculated error coefficient value was less than 0.05, as confirmed by the calculated z value, as it was higher than its tabular value at 0.05. It was also limited. The percentage change was between (4.71% and 32.66%), where the most significant change was in the muscular ability test of the arms, while the lowest was in the muscular ability test of the two legs (broad jump from standing). These results agree with the results of a study that indicated that traditional training methods have become fixed and do not help ease learning skills, which has been eliminated by using VRT. Also, the program supported by VR contributed positively to improving performance outcomes (Zhang and Liu, 2012). The importance of VR is that it is like actual reality, as it is a way to simulate reality, whatever its circumstances and difficulties, through which it is possible to create different environments that simulate reality that the individual cannot access or coexist with. Also, these results are consistent with the study, which indicated that VR is more effective

in the training process. It is a traditional method for improving performance in various activities.

The researchers attribute these favorable results to the new virtual learning environment to create a three-dimensional imaginary atmosphere through continuous training during the training program, and the three-dimensional visual stimulus (VR BOX) from various angles affects the masterful performance of the player. When he performs the training, he retrieves the three-dimensional mental image. That was presented, and he gives internal feedback, which helps correct his mistakes, if any, which achieves the highest performance rate for the player. The previous presentation of the results and their discussion makes it clear that the first hypothesis is correct: There are statistically significant differences between the Pre-test and the Post-test of the experimental group in the physical abilities of the wrestling youths in favor of the Post-test.

3.2.2. Discussing the results of the second hypothesis

It is clear from Table 8 that there are statistically significant differences between the pre and post-tests of the control group in physical abilities in favor of the post-tests, where the calculated error coefficient value was less than 0.05, as confirmed by the computed z value, as it was higher than its tabular value at 0.05. The percentage was limited to the change between (0.8% and 10.83%). The researchers attribute these results to the traditional program of the control group, as well as the efficiency of the control group members, as the regularity and continuity of training, in addition to the ongoing competition to provide the best physical and skill performance, had a significant impact on raising the level of physical capabilities (Shaikh and Mondal, 2012; Sheerin et al., 2012). Through the previous presentation of the results and their discussion, the validity of the second hypothesis becomes clear: There are statistically significant differences between the Pre-test and the Post-test of the control group in the physical abilities of the wrestling youths in favor of the Post-test.

3.2.3. Discussing the results of the third hypothesis

It is clear from Table 9 that there are statistically significant differences between the two post-tests of the experimental group and the control group in physical abilities in favor of the post-tests of the experimental group, where the value of the Mann-Whitney test calculated was less than its tabular value, as confirmed by the z-value, as it was higher than its tabular value at 0.05. Traditional methods usually neglect the development of higher legal and cognitive skills, which negatively affects students' motivation so that their actual performance is at the level of their legal abilities and capabilities (Hargrove and Nietfeld, 2015). The researchers also attribute the superiority of the experimental group in the level of physical skills to the effectiveness of the training program using VR glasses (VR BOX), as VR in training is considered one of the technological innovations that have a remarkable imprint on the training process. This results in the use of modern technological methods in education and training work to provide the learner with the opportunity to witness the optimal performance of the movements to be learned, which in turn helps to give the learners better feedback than using traditional methods. Through the previous presentation and discussion of the results, it becomes clear that the third hypothesis is valid, which states: There are statistically significant differences between the two post-tests of the experimental and control groups in the physical abilities of the wrestling youths in favor of the post-tests of the group A. for experimental.

4. Conclusions

The study concludes that VRT exercises significantly enhanced the physical abilities of the experimental group, notably outperforming the control group in all assessed physical tests. The application of a specifically designed VRT program resulted in substantial improvements in the experimental group's pre-test and post-test comparisons, demonstrating the effectiveness of VRT in physical training.

Based on these findings, the study recommends the integration of VRT in wrestling training programs to effectively improve junior wrestlers' physical capabilities. It suggests the use of VRT applications compatible with Android technology on smartphones to address the logistical challenges of computer labs. Furthermore, the study advocates for conducting similar VRT studies across different age groups in wrestling, emphasizing the potential widespread benefits of VRT. Training courses for coaches on modern technological methods, including VRT, are also recommended to update training approaches. Finally, the study encourages the use of VRT programs to develop essential wrestling skills in junior wrestlers, highlighting the technology's role in advancing sports training methodologies.

Acknowledgment

The authors gratefully acknowledge the approval and the support of this research study by grant no. EAAA-2022-11-1754 from the Deanship of Scientific Research at Northern Border University, Arar, K.S.A.

Compliance with ethical standards

Ethical considerations

The study was conducted following the Declaration of Helsinki and was approved by the Faculty of Physical Education Ethics Committee at Tanta University in 2023.

Conflict of interest

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

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