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Designing an innovative electronic system for hip stability and its impact on certain attacking skills for seated volleyball players

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Abstract

The goal of the research is to analyze the effect of this design on the accuracy of specific attacking skills and to build a novel electrical system for hip stability for seated volleyball players. Under the direction of the Iraqi Paralympic Committee/ Diyala Branch, the research sample was chosen from physically impaired seated volleyball players for the 2023–2024 season. The twelve players were split into two groups at random, one for the experimental group and the other for the control group, with six players in each group. They were divided into two more groups to complete the necessary experiments. The study concluded that the unique hip stability design and associated exercises had a positive impact on the accuracy with which seated volleyball players perform certain attacking skills. Considering these findings, coaches are advised to use this electronic system as a teaching tool to improve player performance and decrease hip lifting infractions during games considering these findings. The use of modern technologies in training sessions should also be prioritized, keeping in mind the unique characteristics and ages of seated volleyball players. These suggestions highlight how crucial it is to use technology to enhance the sitting volleyball performance of athletes with physical disabilities and to create training regimens that adequately suit their requirements.

Keywords: Electronic system, attacking skills, seated volleyball

Introduction and Research Importance:

The advancement of scientific research has become a crucial component in the development of society. Its goal is to attain the greatest standards in all domains, including sports, to maximize the potential benefits of contemporary scientific ideas in the sports sector. Sports and physical education are two areas that, according to science, have a significant impact on people and are essential to their whole development. A person's capacity to work hard is determined by several elements, the most important of which are legal considerations, particularly while executing any kind of fundamental talent. Coaches are always looking for new and creative ways to improve athletes' performance and give them an advantage over their competitors(1).

Because of the unique nature of seated volleyball, players must possess certain skills and abilities to execute a variety of techniques with success. The physically impaired player and the ground are in constant contact during the game, whether they are playing offensively or defensively. Although defensive abilities and technical skills can occasionally take precedence, they both take a lot of work to perfect because of how tough it is to deal with movement mechanics during performance. As a result, attaining lofty standards and guaranteeing successful performance necessitate organized training. Ground-based seated volleyball rules forbid players from raising their hips off the floor or briefly leaping to play the ball; instead, player motions must be performed using their hands. Furthermore, the legal explanation for the ball's velocity and its erratic direction of movement, particularly in response to unique touches, requires instability or carrying the ball in addition to abstaining from hip-lifting or movement. This means that trying to make up for the loss of foot mobility requires complete awareness(2).

To train and develop attacking skills like spiking, offensive blocking, and serving to the point where they can help seated volleyball players become exceptional performers despite their ground-based seating arrangement, hip stability exercises are essential. Exercises coordinated with the usage of an electronic system are therefore a crucial component of performance achievement.

This study is important because it shows how to use a novel electronic system and exercises to adjust to hip stability during training sessions for seated volleyball players. It also reflects the impact of hip stability during gameplay and competition and shows how this impacts the accuracy of specific attacking skills in seated volleyball players.

Research Problem:

Researchers found that players frequently experienced hip elevation when performing attacking abilities like serving, offensive blocking, and spiking because sitting volleyball demands players to perform quickly while maintaining hip contact with the ground during every skill. This is seen as a legal violation committed by the opposition, which might cost them a point or a serve. As a result, the researchers set out to create an electronic system that would improve the player's capacity to maintain hip contact with the floor during sitting volleyball attacks.

Research Objectives:

1. Designing an innovative electronic system for hip stability for seated volleyball players.

2. Investigating the impact of the innovative electronic system design for hip stability on the accuracy of certain attacking skills for seated volleyball players.

Research Hypotheses:

1. There are statistically significant differences between the pre-test and post-test results of the experimental and control groups in some attacking skills for seated volleyball players.

2. There are statistically significant differences between the post-test results of the experimental and control groups in some attacking skills for seated volleyball players, favoring the post-test results of the experimental group.

Research Fields:

- Human domain: The research sample was deliberately chosen from physically disabled players in seated volleyball under the umbrella of the Paralympic Sub-Committee in Diyala, totaling sixteen players.

- Temporal domain: From September 2, 2023, to November 25, 2023.

- Spatial domain: The sports hall of the Katoun Youth Forum in Baqubah, Diyala Governorate.

Definition of Terms:

Exercises with an inventive electronic system: This is a reference to an electronic system worn by seated volleyball players to guarantee hip stability and sustain ground contact during practice or competition, fulfilling the principle of adaptation in certain attacking maneuvers performed by seated volleyball players.

Research Methodology and Field Procedures:

Research Method:

The approach a researcher takes to carry out their investigation and produce the greatest findings is known as their research method. Thus, to achieve their goals and test their hypotheses, the researchers decided on the experimental approach because it was best suited to the nature of the study challenge. To address the study topic, an experimental approach was chosen, and two matched groups with pre- and post-tests were designed.

Research Sample:

The sixteen physically impaired seated volleyball players competing in Diyala under the auspices of the National Paralympic Committee in 2023–2024 comprised the research sample, which was purposefully chosen.

Four players who were chosen at random to represent the pilot study were disqualified. As a result, the sample size was twelve participants, who were split into two groups at random—the experimental group and the control group, each with six players. Seventy-five percent of the entire research sample was comprised of the research sample. One of the most important steps the researcher takes is choosing a sample that fairly and correctly reflects the community. Thus, the sample was accurately determined to provide more accurate and reliable results. "When the researcher collects data and information, they resort to collecting them either from the original community or from a sample representative of this community(3).

Equivalence of the research groups.

To be able to attribute the differences to the experimental factor, "the two groups (experimental and control) must be completely equivalent in all conditions and variables except for the experimental variable that affects the experimental group without the control group(4). Furthermore, "It is necessary to form at least equivalent groups regarding variables related to the research(5). Therefore, the equivalence between the two research groups in the skills under investigation, which were determined by experts and specialists (Appendix 1), was ensured through a process of equating. This process involved using the (T) test for independent means with two equal samples. The results showed no significant differences between them, confirming the equivalence between the two groups, as illustrated in Table (1).

Data Collection Methods and Tools:

- Internet Information Network (Internet).

- Previous studies.

- Arabic and foreign sources.

- Information retrieval form.

- Observation and experimentation.

- Tests and measurements: A/Skill and physical tests under research.

- Survey form for expert opinions and specialists (Appendix).

Table (1) presents the arithmetic means, standard deviations, and calculated (T) values for some offensive skills between the experimental and control groups. Additionally, it indicates the significance of the differences between the two groups.

Variable	Measurement Unit	Experimental Group		Control Group		Calculated (T) Value	Probability	Sig
		M	±SD	M	±SD			
Forehand Top Spin Serve	Degree	11.32	0.59	11.45	0.85	1.13	0.330	NS
Offensive Blocking Wall	Degree	9.98	0.42	10.12	0.63	1.00	0.198	NS
Quasi-Central Overhead Spike (Position 4)	Degree	10.66	0.16	10.34	0.98	1.81	0.286	NS

Devices and Tools Used:

- Innovative electronic system for stabilizing the hips of seated volleyball players (6 units).

- Legal volleyball court for seated volleyball.

- Volleyball (15 balls).

- Colored adhesive tape.

- Whistle

- Paper measuring tape with a length of (2) m.

Identifying Research Indicators and Testing:

The idea of designing the innovative electronic system:

The idea of building the electronic system came about because of the investment in technology in the field of training for impaired players, which is not surprising given the rapid growth of technology in our day and age. After being given to a group of programmers and experts in information technology and civil engineering (*) to assess the viability of utilizing the developed system, the idea for designing the electronic system was born. After modifications were made, they confirmed the readiness to use the designed system in training disabled players on hip stability when hitting the ball. This process continued from Saturday, 2/9/2023, until it was finalized on Monday, 2/10/2023. A group of available electronic sensors was selected and tested in the laboratory, and the results were recorded to choose the best among them, focusing on several criteria, including the response speed of the sensor, small size, light weight, as well as attention to the method of installation to ensure it is comfortable for the player without any side effects. During the testing and selection phase of the sensors, visits were made between the University of Kirkuk and specialists in the city of Mosul to gather ideas and obtain the best performance for the electronic system and its programming.

The main components of the project are as follows:

-Two microcontroller units (Nodemcu esp8266), one attached to the player's clothing and the other placed outside the court, both connected via Wi-Fi.

- Two shock sensors, one attached to the right wrist and the other to the left wrist.

- Two mass sensors, each covered with synthetic leather on the bottom and sponge on the top, placed under the right and left seat centers.

- Two batteries.

- External speaker.

- Fine connecting wires.

- Microcontroller program.

- Power source.

Microcontroller Unit:

This is the primary and most vital component of the gadget. We employed two microcontroller units, one serving as the slave and the other as the master. The master unit is fastened to the player's body, and it uses incredibly thin connecting wires to link to the other parts and sensors. It transmits signals to the primary microcontroller from the sensors on the shorts at the hip-to-ground contact area and the sensors on the left and right hands. The master microcontroller is connected to the secondary microcontroller via Wi-Fi technology supplied by the makers once it has been configured using a computer running a specific program.

The secondary unit is placed at an appropriate distance or outside the training area. It is programmed to activate the external speaker if the player makes a mistake.

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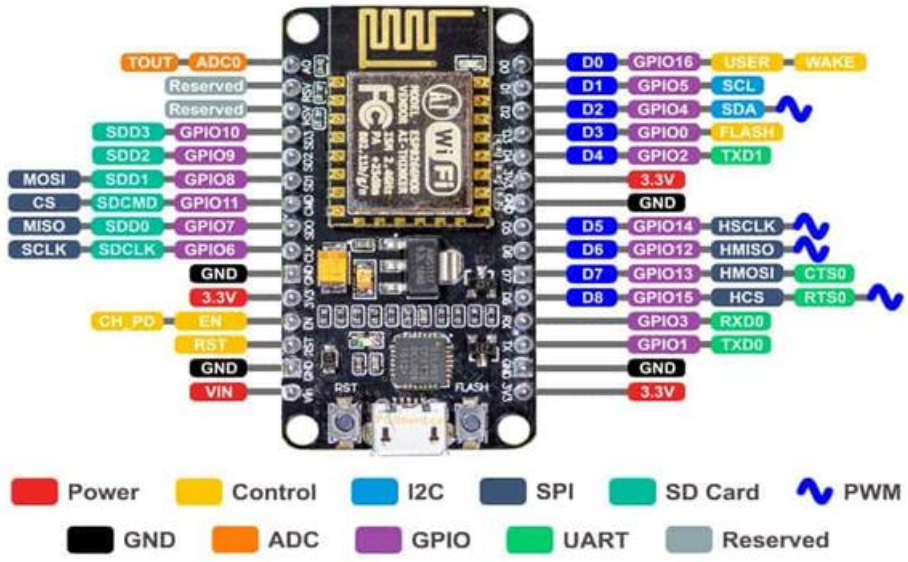
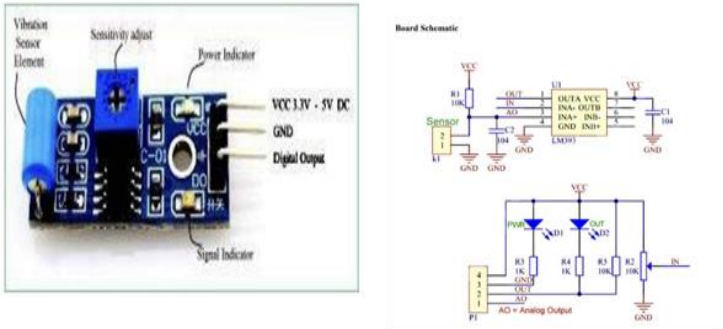


Figure (1) illustrates the microcontroller unit.

Microcontroller	**ESP-8266 32bit**
Model	Clone LoLin
Dimensions	(32 x 58) mm
Speed	80 MHz
Voltage	4.5V - 10V
Memory	4 MB
Wi-Fi Built-In	802.11 b/g/n
Temperature	40°C - 125°C

The shock sensor is an electrical device that gets its 3.3-to-5-volt electrical supply through wires from the microprocessor. The hand-mounted shock sensor detects shocks by producing a signal that it transmits to the microcontroller via the digital output port. The sensitivity adjustment can be used to change the sensor's sensitivity. Below is an illustration of this in Figure (2).



The mass sensor is a component that is wired to the microcontroller and senses pressure from the player's body mass. The microcontroller receives this signal. After that, this signal is handled programmatically. The player's seat and the ground are separated by the mass sensor, which is fixed to the shorts. This sensor was employed in two parts, one on the left and one on the right. This is seen in Figure (3).

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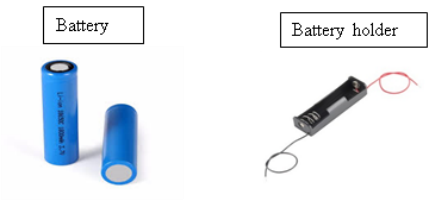
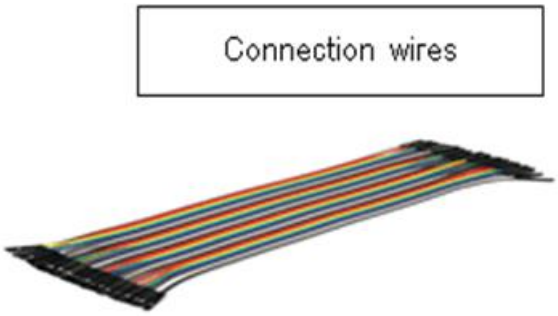
The microcontroller unit receives its electricity from the power source. It has a 5-volt rechargeable battery as its power source. It can run for more than ten hours on a single battery. As seen in pictures (4, 5) below, the battery is inserted into a thin plastic holder.

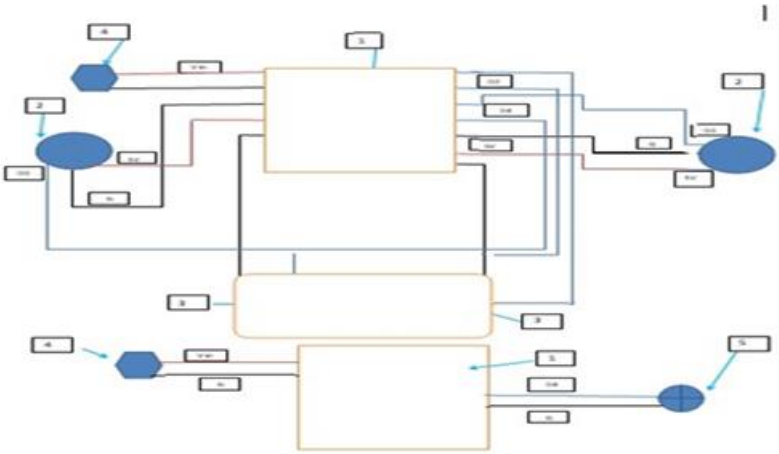


As seen in figure (6), the external speaker is connected to the secondary microcontroller unit (slave) and, if the player makes a mistake, the microcontroller will direct the speaker to make an alert sound.

As illustrated in figure (7) below, I connected the sensors and power supply to the microcontroller using 0.7mm connecting cables.



The computer was used to install the program for the microcontroller (Nodemcu esp8266), and the microcontroller received the program when it was finished and tested on the computer. The figure (8) shows this.



1. Microcontroller

2. Shock sensor

3. Mass sensor

4. 5-volt power source

5. External speaker

The principle of operation of the electronic system relies on the signals emitted from the sensors attached to the shorts in the hip area, as well as the signals from the vibration or shock sensors installed on the hands. Here is a detailed description of how it works:

When a player raises their hip off the ground, sensors on either side of their hips send out a signal. In this instance, a signal is produced by the sensor as soon as it is freed from the player's body weight pressure. The microcontroller (Nodemcu), an electronic card that is implanted on the player's belly and is pre-programmed, receives this signal. Like this, when the ball strikes the right or left hand, the shock or vibration sensor sends a signal to the microcontroller.

The program that is embedded in the microcontroller's conditions states that when the right and left hips are raised off the ground and one of the hands strikes the ball, the program will send out a signal to turn on an external speaker. Lifting the hip off the ground now of hitting the ball is a legal error that the player has made when the external speaker sounds. It is important to note that the microcontroller on the player's abdomen is linked to the external speaker using Wi-Fi technology. This microcontroller is located outside the field or training area.

This system aims to determine and test some offensive skills for seated volleyball players, and it was presented to several specialized experts for evaluation(6). Here are the final tests representing some of the offensive skills under study:

- Test Name: Frontal Spike from Above.

- Test Name: Blocking Wall.

- Test Name: Cross-Court Spike Center Position (4).

Prior to doing the actual research, the researcher did a small-scale experimental study on a pilot survey for the electronic system in use. Its goal is to choose the instruments and research methodologies. On Tuesday, March 10, 2023, the coach, and researchers performed a pilot experiment on four players who were not part of the main research sample before putting the electronic system on the sitting volleyball players. The following were the objectives of the pilot project:

1- Validity of the electronic system for final application.

2- Ability of the coach and assisting team to monitor the application of the electronic system.

3- Smoothness of the workflow and organization of players in the hall.

4- Validity of the devices and tools used and ensuring safety conditions for the players.

5- Ability of sample individuals to wear and apply the electronic system.

6- Overcoming errors that may occur during the main experiment execution.

7- Forming a clear picture of the nature of work and application method .

This experiment was carried out in the same setting and with the same parameters that the researchers expect when the electronic system is applied to the research sample in the primary experiment, but prior to the actual implementation phase of the training curriculum created by the coach(7).

Field Research Procedures:

Preliminary Tests:

On Saturday, October 7, 2023, at 9:00 AM, seated volleyball players took part in preliminary testing for certain offensive skills at the Al-Katoon Youth Forum sports hall in Baqubah, Diyala Governorate. To improve their availability and guarantee the same settings for the tests that followed, the researchers tried to guarantee the test-related conditions, including the time, place, tools utilized, execution strategy, and supporting team.

Main Research Experiment:

The procedures of the main experiment included the following points:

- Implementation of the training curriculum prepared by the coach for both experimental and control groups from Sunday, October 8, 2023, to Thursday, November 23, 2023.

- The training unit divisions (preparatory section lasting 15 minutes, main section lasting 70 minutes, and concluding section lasting 5 minutes) were the same for both experimental and control groups, except for the main section where the experimental group wore the innovative electronic system during exercises conducted by the coach, while the control group did not.

- The duration of the complete training curriculum was one and a half months.

- The curriculum duration in weeks: 6 weeks.

- Total number of training units: eighteen training units.

- Number of training units per week: three training units.

- Weekly training days: Sunday, Tuesday, Thursday.

- Duration of each training unit: 90 minutes.

Post-Training Tests:

On Saturday, November 25, 2023, at 9:00 AM, in the sports hall of the Al-Katoon Youth Forum in Baqubah, Diyala Governorate, the researchers applied the post-training test for the accuracy of performing some attacking skills of sitting volleyball players after the coach had finished implementing the training curriculum. The location, time, devices, tools, execution strategy, and work environment were all guaranteed to be the same by the researchers as they had been for the preliminary test.

Statistical Methods:

The Statistical Package for the Social Sciences (SPSS) version 20 was used to process the research data(8).

Presentation and Discussion of Results:

- Presentation of the differences (t) between the preliminary and post-training tests for the experimental group in some attacking skills of sitting volleyball players.

Variables	Unit	Experimental group				Calculated (T) value	Probability	Sig
		Pre		Post				
		M	±SD	M	±SD			
Frontal High Volley	Degree	11.32	0.59	14.83	0.97	5.481	0.000	*
Offensive Wall Block	Degree	9.98	0.42	15.66	0.53	4.118	0.003	*
Quasi-Central Overhead Spike (Position 4)	Degree	10.66	0.16	13.66	0.36	4.583	0.001	*

(*) Significant if the value of (sig) < 0.01

Table (4) Arithmetic means, standard deviations, computed values (t), and statistical significance levels between pre-test and post-test results in some offensive skills for sitting volleyball players in the control group.

Variables	Unit	Control Group				Calculated (T) value	Probability	Sig
		Pre		Post				
		M	±SD	M	±SD			
Frontal High Volley	Degree	11.45	0.85	11.98	0.97	4.583	0.201	NS
Offensive Wall Block	Degree	10.12	0.63	10.76	0.53	9.165	0.062	NS
Quasi-Central Overhead Spike (Position 4)	Degree	10.34	0.98	10.86	0.36	5.481	0.130	NS

Table (5) Arithmetic means, standard deviations, computed values (t), and statistical significance levels between post-test results in some offensive skills for sitting volleyball players in both the experimental and control groups.

Variables	Unit	Control Group				Calculated (T) value	Probability	SIG
		Pre		Post				
		M	±SD	M	±SD			
Frontal High Volley	Degree	14.83	0.97	11.98	0.97	12.875	0.000	*
Offensive Wall Block	Degree	15.66	0.53	10.76	0.53	8.490	0.000	*

Quasi-Central Overhead Spike (Position 4)	Degree	13.66	0.36	10.86	0.36	10.939	0.000	*

(*) Significant if the value of (sig) < 0.01

shows a discussion of the findings from the post-tests conducted on sitting volleyball players in various offensive skills between the experimental and control groups. The experimental group's improvements in some offensive skills were positively impacted by the novel electronic system for hip stability, as seen by the statistically significant differences that favored them. These outcomes are attributed by researchers to the experimental group's workout regimen and the beneficial impact of the novel electronic system on hip stability. This approach helped players achieve these outcomes by highlighting how muscle activity and skill performance should be coordinated.

Researchers stress the significance of matching muscle activity to skill performance as well as the technological warning function of the electronic system. It steered players' attention toward hip stability and attaining spatial accuracy when executing multiple offensive skill types at once. Because elevating the hip off the ground during ball play is illegal, players first struggled to regulate their hip stability. The working muscles were strained as a result. But to increase players' reliance on hip stability and control trunk movement in compliance with the game's legal restrictions, the novel electronic system for hip stability proved to have a beneficial role. It is asserted that achieving spatial accuracy and consistent balance requires an increase in neuromuscular control, enabling players to control muscular contractions appropriately to deliver the required force for skill execution, neither less nor more, but exactly what the skill demands(9). "Furthermore, motor performance in sports activities requires a high degree of motor coordination, meaning the ability to exhibit appropriate motor actions under specific conditions based on previous motor experiences or mastered skills. In other words, the athlete's ability to engage in motor behavior in response to varying conditions during performance (10).

Similar to this, seated volleyball players' ability to perform some offensive skills better resulted from their ability to link and coordinate motions that provide spatial accuracy. Before they started these workouts linked to wearing the electronic system, they had trouble losing the ball and using the skill legally. The electronic system helped engage the brain to solve this issue. The interpretation of the electronic system's function in attaining hip stability and accomplishing many objectives in a single action is reinforced by these results. This is consistent with what Hoffmann (2020) mentioned that "exercise sequence strengthens the relationship between the brain and muscles and repetitive practice helps to ignore external stimuli in movement performance. This sequence serves in subjecting the body to change in improvement in strength and athletic skill in the end(11).

ethods used by the researchers, and the presentation and discussion of the results, the researchers reached the following conclusions:

Conclusions and Recommendations:

Conclusions:

Based on the research procedures, the appropriate statistical methods used by the researchers, and the presentation and discussion of the results, the researchers reached the following conclusions:

1. The innovative electronic system positively influenced hip stability during the skill performance of some attacking skills for seated volleyball players.

2. The innovative electronic system for hip stability, coupled with exercises provided by the coach, positively affected the accuracy of performing the skill of frontal high attacks for seated volleyball players.

3. The innovative electronic system for hip stability, coupled with exercises provided by the coach, positively affected the accuracy of performing the skill of offensive wall blocking for seated volleyball players.

4. The innovative electronic system for hip stability, coupled with exercises provided by the coach, positively affected the accuracy of performing the skill of diagonal spiking at position number (4) for seated volleyball players.

Recommendations:

Based on the conclusions reached, the researchers propose the following recommendations:

1. Coaches are advised to incorporate the innovative electronic system for hip stability and accompanying exercises as an assisting tool in training seated volleyball players to reduce hip elevation violations during matches.

2. Emphasis should be placed on utilizing modern technology and its advancements in training methods and effectively integrating them into specific exercises, considering the age group and individual differences among seated volleyball players.

3. It is recommended to clarify the steps and mechanism of operation of the innovative electronic system for hip stability for volleyball coaches when using it for their players.

4. Other researchers are encouraged to conduct similar studies on other skills for seated volleyball or with various levels of disabled players.

5. There is a necessity to conduct similar studies on different age groups and samples of females instead of males in seated volleyball.

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