International Journal of Physiology, Sports and Physical Education

ISSN Print: 2664-7710
ISSN Online: 2664-7729
Impact Factor: RJIF 8.00
IJPSPE 2025; 7(2): 283-288
www.physicaleducationjournal.net
Received: 12-07-2025
Accepted: 17-08-2025

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The effect of specific exercises using the A.M.R.A.P method in improving the concentration ratio of partial pressure of blood gases (PO_2, PCO_2) and the performance of some movement phrases on the floor mat in men's artistic gymnastics

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DOI: https://www.doi.org/10.33545/26647710.2025.v7.i2d.166

Abstract
The purpose of this paper is to identify the effect of exercises specific to the (A.M.R.A.P) method in developing the concentration ratio of the partial pressure of blood gases (PO2, PCO2) and performing some movement phrases on the floor mat in artistic gymnastics for men, as well as identifying the superiority in the effect between exercises specific to the (A.M.R.A.P) method and trainer exercises in developing the concentration ratio of the partial pressure of blood gases (PO2, PCO2) and performing some movement phrases on the floor mat in artistic gymnastics for men. Because the experimental approach was compatible with the nature of the study challenge, it was necessary to employ it. Pre-tests and post-tests were used in a two-group (experimental and control) design. The Al-Kut Club junior artistic gymnastics players for the 2024-2025 season, totaling ten players, were designated as the research population. Using a random drawing technique, the researchers divided them equally into two groups after choosing all of them for the experiment. After that, the experimental group performed certain exercises utilizing the A.M.R.A.P. method, while the control group kept up with the coach's standard training regimen. One of the most significant conclusions the researcher came to was that: The particular exercises carried out utilizing the AMRAP approach contributed to the development of the partial pressure of carbon dioxide (PCO2) and oxygen (PO2) following exertion. Among the researchers' most crucial suggestions is the following: The researchers advise concentrating on employing particular workouts in accordance with scientific training and the AMRAP approach principles to enhance the efficiency of artistic gymnasts in training and competitions.

Keywords: A.M.R.A.P. method, blood gases (PO2, PCO2), floor movements in artistic gymnastics

Introduction
The recent development of men's artistic gymnastics did not come randomly. Rather, it was, is, and continues to be the unavoidable outcome of using scientific research methodologies and strategies along with careful planning, utilizing the foundations and principles of modern science ((Saleem Radhy, *et al.* 2025: Madloul, *et al.*, 2025) [10, 5 (a)]. Accordingly, scientific sports research has focused on studying the various applications of science, including training science and physiology, in artistic gymnastics, in order to utilize them in the sports training process. Physiologists have explained and clarified the composition of the human body and its vital functional systems, each of which performs a specific or multiple function. They have also analyzed the function of these systems, explored their mechanisms, and the factors that influence the activities of these systems. Gymnastics is one of the sports that has received widespread attention worldwide. This sport, with all its activities, requires high physical fitness to perform its rapid, powerful, and regular movements (Radi *et al.*, 2020: Naser, *et al.*, 2025) [9, 8]. Upon closer examination of the nature of performance, we find that it requires a harmonious muscular, neurological, functional, and skillful coordination. Gymnastics also requires research and study using various modern training methods and techniques to achieve good performance (Fadhil, *et al.*, 2025: Al Edhary, *et al.*, 2024) [5, 2]. Floor movements are among its most important activities, influenced by every component of

physiological and physical fitness, by the growth of bodily systems and muscular function, and by their influence on the competition's physical component.

The nature of the achievements indicates that the performance of some movement phrases on the floor mat in men's artistic gymnastics falls within the scope of the anaerobic system. Therefore, Training preparation requires careful planning. focused on enhancing functional and physical efficiency to elevate athletes' performance and keep pace with international achievements.

A recently developed training method is the A.M.R.A.P. approach, which uses high-intensity training over a predetermined amount of time and is regarded as one of the most contemporary training techniques. This is in line with the event's nature and features to produce a functioning adaption state, thus improving performance under high-stress conditions and raising the functional, physical, and skill levels of gymnasts. The A.M.R.A.P. method contributes to raising functional and physical capacity. Moreover, the artistic gymnast, especially the performance of some movement phrases on the floor mat in men's artistic gymnastics, requires a high degree of skillful and coordinated physical performance. Consequently, the significance of research in creating particular tasks using the A.M.R.A.P. method is evident. The researchers believe that it will have an impact on the concentration ratio of the partial pressure of blood gases (PO2, PCO2) and the performance of some movement sequences on the floor mat in men's artistic gymnastics.

Research problem

The research problem became clear through the researchers' field observations and their monitoring of most of the world records and the development in competition. The researchers attribute this to the coaches' use of modern training methods, and that the repetitive movement sequences on the floor mat are directly linked to the lactic energy system, as it is considered the dominant system for these movement sequences. The researchers observed a disparity in performance levels based on their expertise, and this is directly reflected in their achievement and competition for advanced positions. In addition, the researchers rarely use the A.M.R.A.P. approach, which is regarded as one of the techniques that maximizes the body's potential, as its training focuses on functional, physical, and skill variables to some extent. It constitutes a challenge to the lactic energy system, as the researchers believe it will contribute to improving Physiological aspects represented by the concentration ratio of partial pressure of blood gases (PO2, PCO2) and the performance of some movement sentences on the floor mat in artistic gymnastics for men, Thus, the researchers were interested in exploring this experiment.

Research objective

The research aimed to: identify the effect of exercises specific to the (A.M.R.A.P) method in developing the concentration ratio of the partial pressure of blood gases (PO2, PCO2) and performing some movement phrases on the floor mat in artistic gymnastics for men, as well as identifying the superiority in the effect between exercises specific to the (A.M.R.A.P) method and trainer exercises in developing the concentration ratio of the partial pressure of blood gases (PO2, PCO2) and performing some movement phrases on the floor mat in artistic gymnastics for men.

Research hypotheses

The researchers believed that the particular workouts had an impact to the (A.M.R.A.P.) method in developing the concentration ratio of the partial pressure of blood gases (PO2, PCO2) and performing some movement sentences on the floor mat in artistic gymnastics for men. There is also a preference in the effect between the exercises specific to the (A.M.R.A.P.) method and the trainer's exercises in developing the concentration ratio of the partial pressure of blood gases (PO2, PCO2) and performing some movement sentences on the floor mat in men's artistic gymnastics, and a preference in the post-test results for the experimental group members.

Research fields

- **Human field:** During the 2024-2025 season, the Al-Kut Sports Club artistic gymnastics players represented the human field.
- **Time field:** (13/12/2024) to (20/4/2025)
- **Spatial field:** The indoor gymnastics hall of Al-Kut Club, Wasit Governorate.

Fieldwork techniques and research methodology

Methods of Research

Because the experimental approach was compatible with the nature of the study challenge, it was necessary to employ it. Pre-tests and post-tests were used in a two-group (experimental and control) design.

Research on communities and samples

The Al-Kut Club junior artistic gymnastics players for the 2024-2025 season, totaling ten players, were designated as the research population. Using a random drawing technique, the researchers divided them equally into two groups after choosing all of them for the experiment. After that, the experimental group performed certain exercises utilizing the A.M.R.A.P. method, while the control group kept up with the coach's standard training regimen. The researchers then employed the skewness coefficient before performing the primary experiment on the two research groups (control and experimental), as indicated in Table (1).

Table 1: The research sample's homogeneity is displayed

Factors	Measuring unit	Mean	Median	Std. Deviations	Skewness	Result
Height	Cm	151.75	151.5	1.879	0.399	Homogeneous
Mass	Kg	65.812	65.63	2.286	0.238	Homogeneous
Chronological age	Year	13.5	13.6	0.516	0.581	Homogeneous
Training age	Year	4	4.1	0.564	0.531	Homogeneous

Table (1)'s findings demonstrate that the coefficient of torsion values are smaller than (±1), demonstrating the uniformity of the study community across all variables.

Devices, Tools, and Methods Used in the Research

Data Collection Methods

- Arabic and international references and sources.

- Measurements and tests.
- Forms specifically designed to record players' test results.

Tools and Equipment Used

- Rubber ropes of different resistances (yellow, red, black, green, silver, blue).
- Wooden boxes (50) cm high (three), and (40) cm high (three).
- (Weighting blocks weighing 0.692 kg, etc.) Weights with a mass of (0.629 kg), (0.78625 kg), and (0.8325 kg) for each leg (six).
- (3) medicine balls weighing (3) kg.
- (5) barriers with a height of (40) cm.
- handheld calculator (CASIO), made in Japan.
- electronic device for measuring height and weight, made in China.
- American-made BLOOD Gass device for measuring the following:
- Determining the oxygen partial pressure (PO2).
- Determining the carbon dioxide partial pressure (PCO2).

Field research procedures

First: Carbon dioxide (PCO2) and oxygen (PO2) partial pressure measurements.

Measurement Method: Measurements were made of the partial pressures of carbon dioxide (PCO2) and oxygen (PO2) using a BLOOD GASS device, in the research community, immediately after exertion (some movement sentences on the floor mat in men's artistic gymnastics). After (5) seconds, the subject sits on a chair and the arm is tied with a tourniquet to facilitate the process of withdrawing (200 micro) of venous blood by the chemist. After being deposited in medical tubes, the blood is sent straight to the specialist laboratory and inserted in a cassette that measures the blood's partial pressure of carbon dioxide and oxygen. After a few seconds, the cassette is inserted into the BLOOD GASS device, and a strip that displays the percentage of carbon dioxide partial pressure and oxygen partial pressure simultaneously is used to read the results.

Second: Testing some movement sequences on the floor mat in men's artistic gymnastics.

In order to determine how to assess the research sample's performance level in a manner consistent with the lactic energy system, the researchers developed a movement sequence on the floor mat with multiple, repetitive, and complex motor skills, with a tight motor connection. It also enabled the phosphagen threshold to be exceeded, making it an effective factor in improving the concentration of the partial pressure of blood gases. It is worth noting that these movement sequences were evaluated by three experienced and specialized judges to determine the appropriate score based on the skill performance of the research sample members. According to the following skills were identified: Forward roll (3 repetitions) - Diving (2 repetitions) - Twisting - Back roll (2 repetitions) - Forward handspring. (These skills are performed sequentially, and the sequence is repeated twice without a time interval for each sample member.)

Investigative Test

On Sunday, December 29, 2024, at 11:00 AM, the researchers carried out their exploratory experiment on a sample of three athletes in the Al-Kut Sports Club gymnastics facility. The following was the exploratory experiment's goal:

- To ascertain whether the tests are appropriate for the study sample.
- To calculate the amount of time needed to carry out and execute the tests.
- To ascertain whether the exercises are appropriate for the research sample, whether using them is feasible, and whether the training load components of the A.M.R.A.P. approach are taken into account.
- To determine the challenges the researchers would encounter during the primary experiment.
- To ascertain how prepared the exploratory sample is to conduct the tests.
- Findings:
- The players' capacity to complete the tests, the amount of time required, and the test's appropriateness were taken into consideration while determining whether they could be conducted.

Main Experiment

Pre-test: With the support staff's help, the researchers, conducted a pretest to measure the partial pressure of blood gas concentrations (PO2, PCO2) and the performance of a series of motor skills on the floor mat in men's artistic gymnastics on Sunday's two study groups (control and experimental), January 12, 2025, at 12:00 PM, in the gymnastics hall of Al-Kut Sports Club. This was after preparing the players, giving them a 10-15-minute warm-up period, and providing them with a sufficient explanation of the test. The values of the variables were extracted in accordance with what was previously mentioned.

The two research groups are equivalent

In order to ensure that the starting point is the same for both groups (control, experimental) in terms of the research variables, and to avoid bias by the researchers toward the experimental group, equivalence was achieved for the two groups using the t-test for independent samples with respect to the research variables equal in number, after comparing the sig value with the significance level of 0.05. Table (2) illustrates this.

Table 2: The control and experimental groups' equivalency with respect to the variables being studied is displayed

Factors	Measuring unit	Experimental group		Control group		T value computed.	Sig Level	Type-Sig
		Arithmetic mean	Standard deviation	Arithmetic mean	Standard deviation			
Post-effort PO2 ratio	mm/Hg	18	1.581	17.6	1.816	0.371	0.72	Non sig
Post-effort PO2 ratio	mmHg	61.8	0.836	61.6	1.341	0.283	0.784	Non sig
Floor gymnastics movement patterns	degree	6.28	1.254	6.34	1.163	0.362	0.845	Non sig

Preparing and Implementing Exercises for the A.M.R.A.P. Method

The researchers developed the A.M.R.A.P. exercises after discussing the priorities for their implementation and their suitability for the sample level. Scientifically standardized training units were prepared to develop the concentration ratio of the partial pressure of blood gases (PO2, PCO2) and perform some movement phrases on the floor mat in men's artistic gymnastics, fulfilling the training process's goals and objectives.

The A.M.R.A.P. exercises' specifics were as follows

- The A.M.R.A.P. exercises consist of twenty-four training units in total.
- For eight weeks, there are three weekly training units that are part of the A.M.R.A.P. activities.
- The A.M.R.A.P. exercises' training unit lasted between 27 and 33.5 minutes (main section only).
- The goal of the A.M.R.A.P. exercises was to develop the partial pressure of the blood gas concentration ratio (PO2, PCO2) and to perform some movement sequences on the floor mat in men's artistic gymnastics.
- The maximum intensity (100%) for each exercise was extracted to plot the intensity for the training units.
- The researchers used a 1:2 undulation pattern between the daily and weekly training units when implementing the A.M.R.A.P. exercises.

Post-test

The researchers conducted the post-test on March 12, 2024, at 12:00 PM, in the gymnasium of the Sports Club. The method used for the pre-tests was the same as for the pre-tests.

3-5 Methods of Statistics

The right approach was selected for the study, and the Statistical Package for the Social Sciences (SPSS) was utilized.

Results Presentation and Discussion

Results of the Biokinematic Variables for the Blocking Skill Pre- and Post-tests are presented and discussed:

The significance of the variations between the experimental group's pre- and post-test results on the variables being examined is displayed in Table (3).

Table 3: Shows experimental group's pre- and post-test differences.

Factors	Measuring unit	Prior to the test		After the test		T value computed.	Sig Level	Type-Sig
		arithmetic average	Typical deviation	arithmetic average	Typical deviation			
Post-effort PO2 ratio	mm/Hg	18	1.581	22.2	1.303	3.628	0.022	Sig
Post-effort PO2 ratio	mmHg	61.8	0.836	60	0.707	3.674	0.021	Sig
Floor gymnastics movement patterns	degree	6.28	1.254	8.26	0.8.42	3.658	0.003	Sig

Table 4: The significance of the variations between the control group's pre- and post-test results for the variables being examined is displayed

Factors	Measuring unit	Prior to the test		After the test		T value computed.	Sig Level	Type-Sig
		arithmetic average	Typical deviation	arithmetic average	Typical deviation			
Post-effort PO2 ratio	mm/Hg	17.6	1.816	24.2	1.095	7.117	0.002	Sig
Post-effort PO2 ratio	mmHg	61.6	1.341	57	1.732	5.662	0.005	Sig
Floor gymnastics movement patterns	degree	6.34	1.163	7.19	1.032	2.369	0.006	Sig

Table 5: The significance of the variations between the experimental and control groups' post-test results in the variables being examined is displayed

Factors	Measuring unit	Experimental group		Control group		T value computed.	Sig Level	Type-Sig
		arithmetic average	Typical deviation	arithmetic average	Typical deviation			
Post-effort PO2 ratio	mm/Hg	22.2	1.303	24.2	1.095	2.626	0.03	Sig
Post-effort PO2 ratio	mmHg	60	0.707	57	1.732	3.586	0.007	Sig
Floor gymnastics movement patterns	degree	8.26	0.8.42	7.19	1.032	3.025	0.005	Sig

Discussion of the Results

According to the data extracted in Tables 3 and 4 for the experimental and control sample, significant differences were found in the values of PO2 after exertion and POC2 after exertion, as well as in the movement scores on the floor mat in artistic gymnastics, in the post-tests for both groups. The researchers believe this is due to the nature of the training units organized for the control group, which were characterized by high intensity and included varied exercises aimed at developing these variables. As for the experimental group, the significant difference was due to the use of specific exercises implemented using the AMRAP method. This was characterized by repeated high intensity without specific rest periods, which led to a rapid state of hypoxia and stimulated physiological adaptations in the working muscle cells as a result of repeated work in an environment suffering from a relative lack of oxygen availability. Montero & Lundby (2017) [7] indicate that high and repeated doses of exercise are sufficient to generate physiological responses in all individuals, even those classified as "non-responders" under less intense training conditions. The results presented in the two tables above

indicate that the adopted protocols helped stimulate the circulatory and respiratory systems to a profound physiological response, whether by enhancing oxygen consumption during recovery or by increasing the muscles' efficiency in handling anaerobic loads. This is consistent with what (Abu Al-Ala Ahmed Abdel Fattah. 2003) [1] indicated, that regular training induces fundamental adaptations in the body's functional systems, especially the heart and circulatory system, which improves the ability to endure high effort and respond to it efficiently.

The results also showed a significant improvement in their physiological responses during the recovery phase, as a result of the nature of this method, which combines high-intensity performance with regular repetitions, followed by a relative recovery time based on the speed of work. The results also revealed a significant improvement in the partial pressure of oxygen and carbon dioxide, which is attributed to the nature of the work of this method, which imposes high-repetition performance during a fixed period of time without a structured rest. The study (Silveira, J. V., *et al.* 2024) [11] showed:

This type of training leads to a significant accumulation of oxygen deficiency and increases muscle glycogen utilization rates, which requires a broader intervention from the aerobic system after performance to compensate for the energy lost. Research such as (Montero, D., & Lundby, C. 2017) [7] has confirmed that continuous effort-based activities, such as AMRAP, stimulate the production of oxidative enzymes such as citrate synthase, and enhance mitochondrial proliferation, which prolongs the body's stay in the EPOC state, while simultaneously improving the muscles' ability to withstand low oxygen conditions for longer periods. In practical terms, the researchers attribute this to the type of high-intensity exercises that help speed up blood flow between the working muscles, the heart, the lungs, and the veins inside and outside the muscles in order to increase the amount of blood returning to the heart and lungs to expel CO2 and replace it with O2 and transport that saturated blood to the working muscles. The CO2 level in the research sample decreased to a better degree, and this was reflected in the adaptation to lower CO2 pressure within the working muscles and blood and raise O2 pressure. The exercises that were used The experimental group also helped create a kind of adaptation to the functional systems involved in the process of gas exchange between the atmosphere and the blood, eliminating CO2 resulting from energy waste by exhaling it, and obtaining larger quantities of O2 in the inhaled air, distributing it throughout the body's tissues. As for the difference achieved in the movement sets on the floor mat in artistic gymnastics, the researchers believe it is due to the special exercises prepared, which specifically targeted these movement sets, were meticulously designed, and were scientifically studied. The researchers also used a combination of physical and skill workouts in the exercises they developed, as these were crucial in quickening motions on the floor mat and producing more strength for the working muscles. This is what (Essam Abdel Khaleq. 1999) [4] pointed out: A skill's motor performance is dependent on certain physical capabilities.

Following the exertion, we observe that the experimental group was significantly outperformed by the control group in the post-tests of the partial pressure ratio of carbon dioxide and oxygen. The researchers ascribe this to the particular workouts used in the procedures and approach of the training load's components for the high-intensity AMRAP method, which helps speed up blood flow between the working muscles, heart, lungs, and veins inside and outside the muscles, in order to increase the amount of blood returning to the heart and lungs to expel CO2 and replace it with O2 gas, and transport this saturated blood to the working muscles. The CO2 ratio decreased in the research sample individuals to a better degree, and this was reflected in the adaptation to lower the CO2 pressure inside the working muscles and blood and raise the O2 pressure. The gradual increase in training loads is matched by another increase in the ability of the body's internal organs and systems to function, thus ensuring development and improving the results for the athlete. In addition, the use of the time period and number of training units throughout the weeks used during the implementation of the training curriculum for special exercises increased the athlete's capabilities for the research sample individuals and helped them to continue performing (Edigron D.W and Edyet on R.. 1976) [3]. The significant difference in the kinematics of the floor exercise mat is attributed to the level of skill proficiency achieved by the players. This was achieved through the use of specific exercises, such as the AMRAP method, which combined physical and skill exercises and had a significant impact on the development of The group involved in the experiment.

The researchers think that the post-test improvement is directly related to related to the high cumulative effort imposed by the nature of AMRAP training, which prompts the neuromuscular system to adapt by increasing the speed of nerve conduction and enhancing the effectiveness of fast-twitch (Type II) muscle fibers, which are responsible for performance in speed sports. The AMRAP method is based on the principle of performing the most repetitions in a predetermined amount of time time (usually 10-25 minutes), which imposes an increasing and continuous training stress on the muscular and nervous systems. This type of continuous load forces muscle fibers to adapt to rapid and continuous performance and enhances the endurance of working muscles to relatively long-term anaerobic effort. These results are consistent with what was indicated by (Maté-Muñoz *et al.* 2021) [6],2 who explained that AMRAP training is one of the most effective models for raising physical and functional efficiency and its reflection on the skill aspect and improving resistance to muscle fatigue resulting from high repetitions under continuous time pressure, which are conditions that mimic what the athlete is exposed to during short, high-intensity races.

Conclusions and Recommendations

Conclusions

- Following exertion, the particular exercises carried out utilizing the AMRAP approach assisted in developing the partial pressure of carbon dioxide (PCO2) and oxygen (PO2).
- The specific exercises helped develop the motor skills on the floor mat in artistic gymnastics for the experimental group.
- The growth of partial pressures of carbon dioxide (PCO2) and oxygen (PO2) had a beneficial effect on artistic gymnastics' floor mat motor skills.
- Recommendations
- To increase the effectiveness of artistic gymnasts in training and competition, the researchers advise

concentrating on the application of particular exercises in accordance with the AMRAP technique and scientific training principles.
- Conducting periodic evaluations of training results using biochemical indicators, as these are important indicators for assessing the training status of players.
- Performing comparable research on other individual and group activities, as well as across age groups.

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Appendix (1)

- Shows a sample of exercises for the A.M.R.A.P. method.
- **Exercise 1:** From the curled position, perform continuous forward rolls.
- **Exercise 2:** From the curled position, perform continuous backward rolls.
- **Exercise 3:** Repeated dives.
- **Exercise 4:** Combining the rolling and diving skills by turning.
- **Exercise 5:** Repeatedly performing the forward handspring skill with a change of direction.
- **Exercise 6:** Performing movement sequences that include the previous skills in a different format.

Appendix (2)

- Shows the training units for the A.M.R.A.P. exercises.
- Intensity of training unit: 90%. Exercise time: (17:5) minutes.
- Training objective:
- To develop some movement sequences on the floor mat in men's artistic gymnastics.
- To develop the concentration ratio of partial pressure of blood gases (PO2, PCO2).

No.	Exercise Number	Exercise time	Rest between exercises	Total operating time for the A.M.R.A.P. circuit	Total rest time between exercises for the A.M.R.A.P circuit	Rest time between circuits	Total circuit time
1	First	47 seconds	10 seconds	260 seconds	50 seconds	60 seconds	370 seconds
2	Fourth	36 seconds	10 seconds				
3	Second	48 seconds	10 seconds				
4	Third	32 seconds	10 seconds				
5	Fifth	40 seconds	10 seconds				
6	Sixth	57 seconds	---				
The circuit was repeated three times during the training unit.							