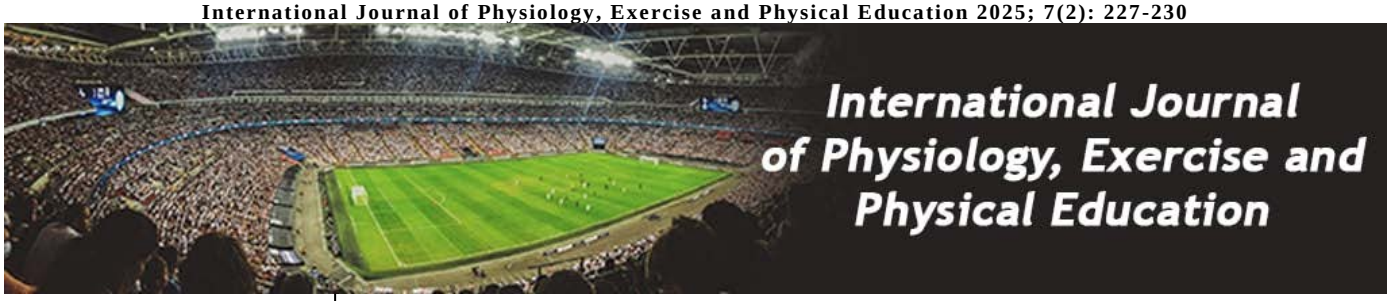

ISSN Print: 2664-7249
ISSN Online: 2664-7257
Impact Factor (RJIF): 8.3
IJPEPE 2025; 7(2): 227-230
www.physicaleducationjournals.com
Received: 06-07-2025
Accepted: 08-08-2025

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The effect of CrossFit training on developing some cardiorespiratory and endurance indicators for students of the college of Physical Education and Sports Sciences

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DOI: https://doi.org/10.33545/26647249..v.i.218

Abstract
This research aims to identify the effect of CrossFit training on developing some cardiorespiratory and endurance indicators among students in the College of Physical Education and Sports Sciences. The researcher used an experimental approach with a single-group design, including pre- and post-tests. The research sample included (10) students from the fourth year, who were intentionally selected and underwent a CrossFit training program for (6) weeks, with (3) training sessions per week. A number of cardiorespiratory indicators were measured, in addition to general and specific endurance tests, before and after the training program. The results showed a significant improvement in all cardiorespiratory and endurance indicators for the sample members between the pre- and post-tests, confirming that CrossFit training contributed effectively to developing the efficiency of the cardiorespiratory system and increasing levels of physical endurance. The researcher recommends the inclusion of CrossFit training in training programs for students in the Colleges of Physical Education and Sports Sciences, given its positive impact on enhancing physical and physiological capabilities.

Keywords: CrossFit, cardiorespiratory indicators, endurance

Introduction
Cardiorespiratory fitness and endurance are among the most important components of physical fitness, upon which athletic performance and overall health depend. They form the foundation for the effectiveness of the circulatory and respiratory systems in supplying working muscles with oxygen and eliminating metabolic waste during physical exertion. These components are of particular importance to students in faculties of physical education and sports science, as they represent the future nucleus of sports and educational work and require high levels of physical efficiency to meet the demands of practical study and training.
Cardiorespiratory endurance is directly related to an individual's ability to sustain effort for extended periods without feeling premature fatigue. It reflects the integrated functioning of the heart, blood vessels, lungs, and muscles. Recent studies have indicated that developing this aspect not only benefits athletic performance but also contributes to the prevention of many chronic diseases such as cardiovascular disease, diabetes, and obesity.[1]
CrossFit training is a modern training trend that relies on diverse, high-intensity exercises that combine strength, speed, flexibility, and endurance in a single training session. This method is expected to contribute to significant physiological adaptations in the cardiorespiratory system and improve students' overall endurance, making it an ideal choice for developing their physical fitness.[2]
Accordingly, this research examines the effect of CrossFit training on developing some cardiorespiratory and endurance indicators for students in the College of Physical Education and Sports Sciences. The goal is to determine the effectiveness of this training method in improving students' functional efficiency and physical performance.

Research Problem:
Despite the adoption of traditional programs to develop students' physical fitness, observations from practical experience indicate a deficiency in achieving an advanced level of cardiorespiratory efficiency and physical endurance, which negatively impacts their

athletic and training performance. Hence, the research problem arises in the following question:
Does CrossFit training have a positive effect on developing some cardiorespiratory and endurance indicators for students in the College of Physical Education and Sports Sciences?

Research Objectives
1. Develop a training program using the CrossFit method suitable for students in the College of Physical Education and Sports Sciences.
2. To identify the level of some cardiorespiratory and endurance indicators among the research sample before implementing the program.
3. To identify the effect of the training program on developing some cardiorespiratory and endurance indicators after its implementation.

Research Hypotheses
1. There are statistically significant differences between the pre- and post-tests of the experimental group in the cardiorespiratory indicators under investigation, in favor of the post-test.
2. There are statistically significant differences between the pre- and post-tests of the experimental group in the endurance tests, in favor of the post-test.

Research Areas
- Human Area: Fourth-year students in the College of Physical Education and Sports Sciences (number10)
- Temporal Area: The period from March 10, 2025, to April 27, 2025, for a total of (6) training weeks.
- Spatial Area: The indoor hall in the College of Physical Education and Sports Sciences.
-

Research Methodology
"The researcher used a single-group experimental method with pre- and post-tests, as it suited the nature of the research procedures."

Research Community and Sample
"The research community represents all the components of the phenomenon being studied by the researcher"[3]. This is one of the fundamental and important points in the scientific field. Based on this, the researcher defined his research community, which consisted of (10) fourth-year students in the College of Physical Education and Sports Sciences. These students were intentionally selected from within the community itself, meeting the criteria (freedom of injury, regular attendance, and physical fitness for training). All students were placed within a single experimental group.

Tools and equipment used in the research
- The Internet.
- Testing and measurement.
- Physical tests.
- Data recording questionnaire.
- Sponge mat.
- Canon camera (number one).
- Canon camera stand (number one).
- Heart rate monitor.
- Pull-up bar.
- 20 kg weight bar.
- Weight plates.

Heart rate and breath counts using the watch[3]
- Wearing the watch correctly
- Place the watch on your wrist so that it is close to your skin without applying too much pressure.
- It is best to wear it two fingers above your wrist bone for the most accurate reading.

Activating the pulse sensor
- Turn on the heart rate measurement feature from Settings or the Workout app.
- Waiting for a reading
- Wait a few seconds for the sensor to capture your pulse and display the rate in bpm (beats per minute).

Recording or Syncing
- Results are automatically saved to your phone's dedicated app (Apple Health, Garmin Connect, Polar Flow, Fitbit App) for graphing and long-term data analysis.

Pilot study
"The pilot was conducted on a sample of (2) students on Tuesday, January 28, 2025, to verify the validity of the tools and equipment used in the research, the suitability of the tests for the sample, and to clarify the testing mechanism for the support team."

Pre-tests
"Pre-tests were conducted on the research sample on Sunday March 2, 2025, at 10:00 AM, in the gymnasium of the College of Physical Education and Sports Sciences at the University of Babylon."

Training program design
- (**Warm-up:** 8 minutes (light jogging + dynamic stretching).
- (**Main part (challenge):** Perform all exercises in a specific order only once (one round).
- (**Cool-down:** 5 minutes (stretching exercises + deep breathing)).

Table 1: shows the distribution of training program exercises

Exercises	Required performance	Notes
Push-ups	20 reps	At maximum speed while maintaining proper technique.
Sit-ups	20 reps	Chin up, touching knees with hands.
Pull-ups	10 reps	Using body weight.
Squats	20 reps	Bar weight: 15 kg.
Walking	30 meters	10 kg weights in each hand.

Post-tests

"The post-tests were conducted on the research sample on Monday, May 5, 2025, at 10:00 AM, in the gymnasium of the College of Physical Education and Sports Sciences at the University of Babylon."

Statistical methods

The statistical package (SPSS) was used to process the research results and extract the results.

Results and discussion

Table 2: Presentation and discussion of statistics for research variables (heart rate)

Research variables		Mean	N	SD	T value	Sig. value	Significance of differences
Heart rate	Pretest	167.7	10	5.54	13.98	0.000	Sig.
	Posttest	144.1	10	7.13			

The results showed a significant decrease in heart rate from 167.7 before the program to 144.1 afterward, with high statistical significance (Sig = 0.000, T = 13.98).

This indicates that CrossFit training improved the efficiency of the cardiovascular system, as a lower heart rate during exertion indicates increased strength and efficiency of the heart muscle, and its ability to pump a greater volume of blood with each beat, reducing the need for a high number of beats.[4]

Interpretation of Differences

- **Decrease in mean:** There is a significant decrease in heart rate from pre-test to post-test, indicating a clear improvement in cardiorespiratory efficiency as a result of the applied training (such as CrossFit).[5]
- **High T-value:** A large T-value (13.98) indicates that the differences between the two means are not random, but rather reflect a true effect of the experiment.[6]
- **Statistical Significance ($p < 0.05$):** A p-value of 0.000 confirms that the differences are strongly statistically significant, meaning that the improvement is not due to chance.

Physiological Interpretation

This decrease in heart rate is attributed to:[7]

- **Increased cardiac efficiency:** High-intensity training, such as CrossFit, improves the contractile force of the heart muscle, which increases stroke volume and leads to a reduction in the number of beats required to supply oxygen to the body during exercise.
- **Improved circulatory efficiency:** Increasing the number of capillaries and improving blood distribution to working muscles reduces the burden on the heart during activity.
- **Increased maximum oxygen consumption (VO_2max):** Compound endurance training increases aerobic capacity, which is reflected in a lower heart rate at the same level of effort.

Table 3: Presentation and discussion of statistics for research variables (performance time)

Research variables		Mean	N	SD	T value	Sig. value	Significance of differences
Performance time	Pretest	2.843	10	0.615	8.79	0.001	Sig.
	Posttest	1.947	10	0.572			

Performance time improved from 2.843 minutes before training to 1.947 minutes after, with statistical significance (Sig = 0.001, T = 8.79).

This reflects increased physical endurance and the ability to complete movements in a shorter time, as a result of the physiological adaptations resulting from CrossFit (such as increased aerobic capacity and increased muscle efficiency in oxygen consumption).[8]

Physiological and Performance Explanation[9]

The significant decrease in performance time can be explained by the following:

- **Improved cardiorespiratory efficiency:** Increasing the heart and lungs' ability to deliver oxygen to working muscles reduces fatigue and accelerates performance.
- **Increased strength and muscular endurance:** CrossFit training relies on high-intensity, varied activities, which improves both strength and muscular endurance, thereby reducing the time required to complete exercises or tests.
- **Improved motor economy:** Increasing the efficiency of the neuromuscular system leads to reduced redundant movements and improved coordination, contributing to faster task completion.

Table 4: Presentation and discussion of statistics for research variables (number of breaths)

Research variables		Mean	N	SD	T value	Sig. value	Significance of differences
Number of breaths	Pretest	41.9	10	3.316	6.56	0.001	Sig.
	Posttest	35.1	10	2.923			

The number of breaths decreased from 41.9 before training to 35.1 after, with statistical significance (Sig = 0.001, T = 6.56).

This decrease indicates improved respiratory efficiency, as the lungs are now able to exchange gases more effectively, reducing the need for rapid breathing during exercise.[10]

Physiological Explanation

This improvement can be explained by several physiological mechanisms:[11]

- Increased gas exchange efficiency: CrossFit training increases the lungs' ability to efficiently exchange oxygen and carbon dioxide, reducing the need to increase breathing rate during exercise.
- Improved respiratory muscle strength: High-intensity training strengthens the diaphragm and intercostal

muscles, enabling more efficient inhalation and exhalation with fewer breaths.
- Increased vital capacity: Increasing the volume of air inhaled per breath (tidal volume) allows for better gas exchange without increasing breathing rate.

Conclusion

1. CrossFit training proved effective in developing upper limb muscle strength, as significant differences appeared in favor of post-test measurements compared to pre-test measurements, confirming the validity of the first hypothesis of the study.
2. CrossFit training significantly improved upper limb muscle endurance, which positively impacted students' ability to perform exercises for longer periods and with greater efficiency.
3. The results showed that these exercises helped students improve their neuromuscular coordination, which was reflected in their motor accuracy and physical response speed.
4. The study showed that students who practiced CrossFit training became more capable of withstanding high physical effort and less prone to rapid fatigue during practical activities.

Recommendations

1. Adopt CrossFit training as an essential component of the practical curricula in colleges of physical education and sports sciences, given its direct impact on developing muscle strength and endurance.
2. The necessity of including CrossFit training in the training plans of fourth-year students to prepare them physically and academically for the requirements of graduation and practical work.
3. Expanding the testing of this type of training across different academic levels (first, second, and third) to compare results and identify differences in physical response.
4. Emphasizing consideration of individual differences and gradual increase in intensity when implementing CrossFit training to reduce the risk of injury and ensure achievement of goals.

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