Kurdish Studies
Feb 2024
Volume: 12, No: 2, pp.5127-5142
ISSN: 2051-4883 (Print) | ISSN 2051-4891 (Online)
www.KurdishStudies.net

Received: December 2023 Accepted: January 2024
DOI: https://doi.org/10.58262/ks.v12i2.379

The Effect of Aerobic Exercise on the Development of Some Physiological Variables among First-Year Students in the College of Sports Sciences at the Arab American University

Islam Mohammas Abbas[1], Oday Adel Daraghmeh[2]

Abstract

The study aimed to investigate the impact of aerobic exercises on the development of certain physiological variables (resting heart rate, systolic blood pressure, diastolic blood pressure, stroke volume, and maximal oxygen consumption) among first-year students at the College of Sports Sciences at the Arab American University. The researchers employed an experimental method for a single group through pre-post measurements, deemed suitable for the study's nature. The study population comprised all first-year students enrolled in the College of Sports Sciences at the Arab American University during the first semester of the academic year 2023-2024, totaling 45 students. The study sample was purposively selected and consisted of 33 students, representing 73.3% of the original study population. Following statistical analysis using the Statistical Package for the Social Sciences (SPSS), the researchers found that aerobic exercise programs had a positive effect on physiological variables (systolic blood pressure, stroke volume, maximal oxygen consumption) in the post-intervention measurements. Additionally, statistically significant differences were observed in the post-intervention measurement of maximal oxygen consumption, favoring male students. The researchers recommended the utilization of aerobic exercise programs for their positive impact on developing respiratory endurance.

Keywords: *Aerobic Exercises, Maximal Oxygen Consumption, Resting Heart Rate, Stroke Volume*

Introduction

Scientific research plays a pivotal role in fostering advancement and excellence across all spheres. Its significance lies in the establishment of foundations, methodologies, tools, and resources essential for addressing diverse challenges encountered in various fields. Thus, for any society aspiring for development and seeking a renaissance in any domain, reliance on scientific research as a primary source of knowledge is imperative. Advanced nations demonstrate a profound commitment to scientific research, allocating substantial funds and dedicating efforts to the enhancement of research infrastructure, methodologies, tools, and resources.

The field of sports training delves into the intricate processes and fundamental requisites necessary for optimizing athletic performance and accomplishments. Given the multifaceted and varied nature of these requirements, attaining training objectives organically or intuitively proves challenging without the organized and scientifically sound implementation of training methodologies. It is imperative to structure and execute these training processes in a manner

[1] Sport Science Department /Arab American University Palestine /. Email: Islam.abbas@aaup.edu, Orcid Id: https://orcid.org/0000-0002-6421-3879
[2] Sport Science Department /Arab American University Palestine / Email: oday.daraghmeh@aaup.edu

conducive to the advancement and enhancement of individual or team athletic performance across various sports or athletic endeavors.

Endurance stands as a cornerstone of physical fitness, particularly in sports disciplines necessitating prolonged physical conditioning. Various researchers offer differing interpretations of endurance. Charles Bush characterizes it as the capacity to sustain continuous and extended muscle contractions across diverse muscle groups with adequate force and duration, inducing fatigue and stress on cardiovascular and respiratory systems. Kharabuji defines it as the ability to sustain high-intensity work for prolonged durations, while Ozlin conceptualizes it as the capacity to execute a specific motor task uninterrupted over an extended period (Bsiouni & Ash-Shati, 1992, p. 181).

Given the array of training methodologies and techniques within sports training science, this study presents an empirical effort by the researcher to elucidate the impact of aerobic exercises on augmenting physiological efficiency through key physiological variables such as maximum oxygen consumption, body mass index, and systolic and diastolic blood pressure.

The maximum oxygen consumption (VO2 max) is defined as the highest amount of oxygen consumed during muscular work using more than 50% of the body's muscles per minute (Saeed, 2003: p. 22). There are other definitions for VO2 max, as described by Hazaa (2009), who defined it as "the body's maximum capacity to take in oxygen through the respiratory system, then transport it through the cardiovascular system, and finally extract it by the working muscles." Additionally, he adds that VO2 max is equal to the product of maximal cardiac output and maximal arteriovenous oxygen difference (Maximal a-v O2 diff), which is a good indicator of cardiac, pulmonary, and muscular efficiency. It is positively correlated with physical performance, and VO2 max is attained by performing maximal physical effort until exhaustion using a large muscle mass, such as running.

Running is considered one of the most important training methods used to improve cardiovascular and respiratory fitness. Any athlete in any sport must rely on running as an essential part of their training program due to its continuous oxidative energy production through aerobic pathways, thereby increasing oxygen consumption. In fact, running accounts for approximately 11% of the total distance covered in a match. Hence, studying the concept of maximum oxygen consumption becomes crucial due to the involvement of most voluntary muscles during running. As noted by Ishtaya (2012, pp. 14-15), individual running promotes health, benefits the heart, and is suitable for all ages and genders. Moreover, during running, individuals sometimes compete with their own capabilities and other times compete with others to achieve a specific time or win a particular championship. In addition to what Abadi (2023), citing Ashley Merson, pointed out, aerobic activities that utilize oxygen and glucose for energy, commonly known as cardiovascular exercises, work to increase heart rate during exercise. Several types of exercises aim to enhance heart activity, such as walking, jogging, and running at various speeds. Aerobic exercises can be performed in various environments, including outdoors or in water, as confirmed by Nahar (2019), who stated that engaging in activities like long-distance running for varying durations enhances the heart's ability to pump blood to the body. Abdel Fattah and Sayed (2003) noted that aerobic training is characterized by not requiring maximum speed or strength for performance but rather continuous performance over a longer period. This implies a decrease in physical load intensity, making it one of the most important physical attributes that can be developed for both athletes and

non-athletes. Aerobic exercises have become the primary focus of all fitness programs for health due to their association with preventive measures against cardiovascular and respiratory diseases. They also aid in weight loss and obesity prevention and are linked to physiological and biochemical fitness, helping to improve key indicators such as blood pressure and plasma lipid concentrations.

Research Issue

The success of the educational process relies on preparing students comprehensively, as the lack of necessary physical fitness aspects affects their response to the general life requirements, which demand a significant level of physical fitness. For organs to function efficiently, they must possess a certain level of fitness to enable students to endure the activities they engage in.

Based on the researcher's experience in teaching practical courses for sports science students, a decline in physiological efficiency was observed among many students during practical lessons. This manifested in early fatigue, increased respiratory rate, and an inability to sustain effort for a prolonged period.

One of the primary goals of scientific research in the field of sports is to investigate how to enhance physical fitness and understand its impact on various physiological variables, providing accurate and objective information for improving physical fitness. Physical preparation based on sound scientific principles represents the best and most efficient ways to enhance the functional level of different body systems. As noted by Abdel Fattah and Sayed (2003), improving aerobic endurance has a positive impact on general health by enhancing the functional efficiency of essential body systems. Therefore, the researcher decided to conduct this study to assess the effect of aerobic training on some physiological variables among students of the Faculty of Sports Sciences at the Arab American University

Research Goals

This study aims to investigate the following:

1 .The impact of aerobic exercises on some physiological variables (resting heart rate, systolic blood pressure, diastolic blood pressure, stroke volume, maximal oxygen consumption) among first-year students in the College of Sports Sciences at the Arab University.
2. The differences between individuals in the sample (male students, female students) regarding some physiological variables (resting heart rate, systolic blood pressure, diastolic blood pressure, stroke volume, maximal oxygen consumption) under investigation.

Research Questions

- Are there statistically significant differences at a significance level ($\alpha \leq 0.05$) between the means of pre-test and post-test physiological variables (resting heart rate, systolic blood pressure, diastolic blood pressure, stroke volume, maximal oxygen consumption) among first-year students in the College of Sports Sciences at the Arab University?
- Are there statistically significant differences at a significance level ($\alpha \leq 0.05$) in the post-test measurements of physiological variables (resting heart rate, systolic blood pressure, diastolic blood pressure, stroke volume, maximal oxygen consumption) among first-year students in the College of Sports Sciences at the Arab University attributed to gender

Research Determinants

- Human Determinants: First-year students enrolled in the College of Sports Sciences at the Arab University who are registered for the Physical Fitness Preparation course, typically offered during the first semester for students accepted into the Sports Sciences major.
- Location: College of Sports Sciences / Arab University.
- Time Determinants: The first semester of the academic year 2023/2024.

Research Terminology

- **Aerobic Exercises:** These are activities that last for more than two minutes and rely on aerobic energy production, which occurs in the presence of oxygen. They are characterized by low to moderate intensity with a moderate or regular rhythm. (Osman, 2002)
- **VO2 Max (Maximum Oxygen Consumption):** It is the maximum volume of oxygen consumed per liter or milliliter per minute relative to body weight in kilograms. (Aliwi, 2014)
- **Systolic Blood Pressure (SBP):** It is the maximum blood pressure on the arterial wall during ventricular contraction.
- **Diastolic Blood Pressure (DBP):** It is the minimum blood pressure on the arterial wall during ventricular relaxation. (Namroud et al., 2019)
- **Stroke Volume**: It is the volume of blood ejected from the left ventricle during one heartbeat. (Saad and Meloud, 2021)

Previous Studies

Through reviewing educational literature and previous studies in this field, the researcher found numerous scientific studies related to the subject of the study, which examine the importance of physiological characteristics and their correlation with physical activity and sports performance. To achieve the objectives of this study, the researcher presents some of these studies.

Yass (2023) conducted a study with the aim of designing a training program using aquatic aerobic exercises and determining their effect on physical fitness and body mass index. The researcher used an experimental method with pre-test and post-test measurements on a single experimental group. The research community consisted of women practicing swimming at Aswan Sports Club, aged between (30-40) years, with a total of (20) participants. The sample was purposively selected from women practicing swimming at Aswan Sports Club. The most important findings indicated statistically significant differences between the mean scores of pre-test and post-test measurements in physical fitness in favor of the post-test. Within the scope of the research community and the selected sample, and in light of the research objectives and hypotheses, the researcher recommends the following:Implementing aquatic aerobic exercises improves the level of physical fitness among women practicing swimming.Continuous variation and diversification of performance rhythm, as well as the collective performance during training sessions in the aquatic environment, provide a positive relaxation and motivation for training, enabling the completion of training units with the same intensity and motivation.The use of aquatic exercises led to an improvement in the mood state of the research sample.

Abadi (2023) conducted a study aiming to investigate the effect of an aerobic exercise program on some biochemical variables (serum lipids, liver enzymes) and anthropometric indices (arm circumference, chest circumference, waist circumference, thigh circumference), and body mass index for individuals aged (35-40) years who underwent gallbladder removal surgery. The researcher used an experimental method through a pre-test and post-test experimental design for a single group, considering the appropriateness and nature of the study. The study population consisted of obese individuals resulting from gallbladder removal surgery, attending some fitness centers in Qena Governorate, and seeking weight loss, aged between (35-40) years for the period (2021-2022). The researcher purposively selected the sample. The most important findings indicated a significant improvement in body mass index among obese individuals resulting from gallbladder removal surgery by an improvement rate of (19.10%). Additionally, the program led to an enhancement in some biochemical variables, with an improvement rate of (23.26%) for cholesterol, (56.69%) for triglycerides, (16.57%) for HDL cholesterol, and a decrease rate of (20.65%) for LDL cholesterol. The improvement ranged for liver enzymes, SGPT (52.78%), and SGOT (64.32%). Moreover, the aerobic exercise program led to a significant improvement in arm circumference, chest circumference, waist circumference, and thigh circumference.

Namboonlue et al. (2023) conducted a study aiming to compare the effects of an aerobic training program and a resistance training program on body mass index, muscle strength, and maximum oxygen consumption in obese individuals. The researcher used an experimental method due to its suitability and the nature of the study. The study sample consisted of 24 college students with an average age ranging from (19-22) years, selected randomly and divided into 3 groups: the first group underwent a resistance training program, the second group trained using aerobic training, and the third group trained with a combined approach of resistance and aerobic training. The results indicated statistically significant differences between pre-test and post-test measurements of waist circumference in favor of the post-test measurements in all three groups. There were also statistically significant differences in the percentage of fat-free mass and muscle mass in favor of the first and second groups. Additionally, there were statistically significant differences between pre-test and post-test measurements of maximum oxygen consumption in favor of the post-test measurements in all three groups.

Gentile, P et al. (2023) conducted a study aimed at comparing the effects of three protocols of aerobic training on cardiovascular function and metabolism in type 2 diabetes patients. The researchers employed an experimental method due to its suitability and the nature of the study. The study sample consisted of 52 patients aged over forty years who were randomly selected and divided into three groups, each undergoing a different training program (L-HIIT, S-HIIT, or MICT). The results showed statistically significant differences in maximum oxygen consumption among the three groups, favoring the L-HIIT group compared to the MICT group, with no significant differences between the L-HIIT and S-HIIT groups. Additionally, there were statistically significant differences in the reduction of triglyceride levels and HbA1c levels in favor of the L-HIIT group. Furthermore, there were differences in the reduction of systolic blood pressure, favoring the L-HIIT group, while there were no significant differences between pre-test and post-test measurements in resting heart rate (RHR) and diastolic blood pressure.

Saeed (2023) conducted a study with the aim of investigating the effect of aerobic exercises on the development of some physical, motor, and functional abilities in non-athletic individuals aged between 45 and 50 years. The researcher utilized the experimental method due to its

suitability and the nature of the study, employing a pre-test post-test single-group design. The study sample consisted of 10 non-athletic individuals aged between 45 and 55 years. After data collection and statistical analysis, the most important results indicated that aerobic exercises positively contributed to the development of some physical, motor, and functional abilities among the participants in the experimental group. The researcher recommended the necessity of using the tests employed in the study in the training process.

Fu, Y et al. (2022) conducted a study aiming to investigate the effect of aerobic training on blood pressure (systolic blood pressure, diastolic blood pressure) in patients with hypertension. The researchers employed an analytical approach to several studies and scientific articles from the English database PubMed. This study included 14 other studies addressing the subject, involving a total of 1027 patients. These patients were divided into two groups: a control group consisting of 409 patients and an experimental group consisting of 681 patients who followed aerobic training programs. The key findings indicated a decrease in systolic blood pressure (SBP) in the experimental group compared to the control group, as well as a decrease in diastolic blood pressure (DBP) in the group that underwent aerobic training. Additionally, the results suggested that the duration of training (less than 12 weeks and more than 12 weeks) could reduce blood pressure in patients with hypertension.

Study Zoubi (2022) aimed to determine the effects of aerobic training, water intake, and aerobic training alone before meals on the weight and some physical and body characteristics of beginner athletes in endurance running for the Athletics National Team at Yarmouk University for the academic year (2017-2018). The study sample consisted of 12 players divided into two groups: the experimental group consisting of 6 players and the control group consisting of 6 players. The researcher used the experimental method due to its suitability and the nature of the study. The experimental group applied the aerobic training program with water intake before meals, while the control group applied the aerobic training program without water intake. The results showed statistically significant differences between pre- and post-measurements, favoring post-measurements for weight loss and some physical and body characteristics in the experimental group, with no statistically significant differences found in the control group. The researcher recommended the necessity of using aerobic training and water intake before meals due to their positive effects on weight loss.

Abdel-Moaty (2021) conducted a study aiming to investigate the effect of aerobic exercises on patients with hypothyroidism. The researcher employed the experimental method due to its suitability and the nature of the study. The study population consisted of patients suffering from hypothyroidism at Aswan University Hospital. The study sample comprised 20 patients selected randomly and divided into two groups: an experimental group consisting of 10 patients and a control group consisting of 10 patients, aged between 30 and 40 years old. The key findings of this study indicated statistically significant differences between the pre-test and post-test means for the experimental group, favoring the post-test for variables such as TSH, T4, T3, and body weight. Additionally, there were statistically significant differences between the pre-test and post-test means for the control group in biological variables (TSH, T4, T3) and body weight, favoring the post-test. The study's recommendations underscored the importance of paying attention to this type of program and developing rehabilitation programs for other types of diseases.

Sayyed (2021) conducted a study aiming to investigate the effect of regulated aerobic training

program on some immune variables among 1500m race athletes. The study sample consisted of 15 athletes from the 1500m race category at the Jazeera Sports Center under 18 years old and registered in the Egyptian Athletics Federation during the season (2018 – 2019). The researcher used the experimental method with pre-test and post-test measurements due to its suitability and the nature of the study. The key findings indicated statistically significant differences between the pre-test and post-test ranks for the experimental group, which applied the aerobic training program, in favor of the post-test for blood variables under study (red blood cells, hematocrit, white blood cells, lymphocytes, neutrophils). There were no statistically significant differences between the pre-test and post-test ranks for platelets, eosinophils, basophils. Additionally, there were statistically significant differences between the pre-test and post-test ranks for the experimental group in immune globulins (IgE, IgA, IgG) in favor of the post-test. The researcher recommended the necessity of conducting more physiological studies related to physical performance and the type of activity practiced.

Comment on Previous Studies

- Most of the studies focused on building and designing aerobic training programs, such as the study by YS (2023), Namboonlue et al. (2023), and Al-Zu'bi.(2022)
- The majority of the studies followed the experimental method.
- The samples in the previous studies varied; some studies focused on athletes like YS (2023), Al-Zu'bi (2022), and Mr. (2021), while other studies examined diabetic patients like Gentile, P et.al (2023), patients with thyroid gland disorders like Abdul-Moaty (2021), and patients with high blood pressure like Fu, Y et.al.(2022)
- Previous studies were utilized in building the training program, formulating the problem statement, as well as discussing and interpreting the results.

Research Method

This section includes the presentation of the study's methodology and procedures in terms of its approach, population, sample, tools used, scientific parameters for physiological tests, study variables, and statistical analyses.

Research Methodology

The researcher employed an experimental approach using a within-subject experimental design through pretest-posttest measurements, which was deemed suitable for the nature of the study.

Research Sample

The study population consisted of all first-year students enrolled in the College of Sports Sciences at the Arab American University during the first semester of the academic year (2023-2024), totaling 45 male and female students. The study sample was selected purposively and comprised 33 male and female students as the main sample, representing 73.3% of the original study population, along with 5 additional students for the survey. Seven students were excluded due to frequent absences and one student's injury. Table 1 illustrates the characteristics of the study sample (age, height, weight, body mass index), while Table 2 presents the physiological

characteristics of the variables under study.

Table (1): Means, Standard Deviations, and Skewness Coefficients for the Characteristics of the Study Sample (n=33).

Variable	Characteristics	Male (n=13)	Female (n=20)	Skewness Coefficient
Age (years)	Mean	18.46	18.30	1.188
	Std. Dev	0.519	0.571	
Height (m)	Mean	1.81	1.63	0.462
	Std. Dev	0.070	0.051	
Weight (kg)	Mean	77.38	58.30	0.851
	Std. Dev	12.37	7.644	
Body Mass Index (kg/m2)	Mean	23.46	21.77	0.750
	Std. Dev	3.21	2.42	

The results of Table (1) regarding the homogeneity of the study sample data in the primary basic measurements indicate that the skewness coefficients ranged between (0.462 – 1.188). This suggests that the derived measurements are close to symmetry, as skewness coefficients ranged between ± 3 and approached zero, confirming the homogeneity of the study sample individuals in the variables under study before conducting the study and taking measurements.

Table (2): Means, Standard Deviations, and Skewness Coefficients for the Physiological Characteristics of the Study Sample (n=33).

Variable	Characteristics	Male (n=13)	Female (n=20)	Skewness Coefficient Total (n=33)
Resting Heart Rate (beats/minute)	Mean	73.92	75.85	1.131
	Std. Dev	7.932	4.511	
Systolic Blood Pressure (mmHg)	Mean	124.75	124.33	0.023
	Std. Dev	6.235	6.022	
Diastolic Blood Pressure (mmHg)	Mean	77.92	80.20	1.086
	Std. Dev	3.523	7.564	
Stroke Volume (ml/beat)	Mean	66.26	63.24	1.276
	Std. Dev	6.580	8.833	
Maximal Oxygen Consumption (ml/kg/min)	Mean	39.80	24.41	0.477
	Std. Dev	4.90	4.054	

The results of Table (2) regarding the homogeneity of the study sample data in the primary physiological measurements indicate that the skewness coefficients ranged between (-1.086 - 1.276). This suggests that the derived measurements are close to symmetry, as skewness coefficients ranged between ± 3 and approached zero, confirming the homogeneity of the study sample individuals in the physiological variables under study before conducting the study and taking measurements

Methods of study

First: Pre-Intervention Measurements

Pre-intervention measurements were conducted between November 1st, 2023, and November 10th, 2023. Physiological measurements were taken in the gymnasium, with the assistance of three colleagues from the College of Allied Medical Sciences.

Second: Post-Intervention Measurements

After completing the intervention program, post-intervention measurements were conducted between January 28th, 2024, and January 30th, 2024, under the same conditions as the pre-intervention measurements.

Third: Pilot Study

The researcher, along with the assisting team from the College of Allied Medical Sciences, conducted a pilot study on a sample consisting of 5 students from the study population and individuals outside the study sample to assess the accuracy of the study's procedures and to address any potential obstacles. Additionally, this pilot study aimed to evaluate and test the functionality of the devices used. The pilot study was conducted on November 6th, 2023.

Forth: The Training Program

By reviewing the scientific references and relevant studies that addressed the topic of training programs, the researcher was able to reach

Table (3): Training Program Content.

Number of Units per Week	**8 weeks**
Number of Training Units During the Program	3 training units
Warm-up and Cool-down Time in Each Training Unit	24 units
Duration of Each Training Unit	10 minutes for warm-up, 5 minutes for cool-down
Program Duration	30 minutes

During the implementation of the program, the following considerations were taken into account:

- Warm-up Section: Starting with warm-up exercises to prepare all muscles of the body collectively. This section includes various physical exercises and simple games that contribute to activating the blood circulation and generating energy in the body. The duration of this section is 10 minutes.
- Main Section: This part includes aerobic exercises performed continuously and at a moderate pace, leading to an increase in heart rate. The duration of each unit is 30 minutes.
- Running from a high starting position.
- Intensity was determined according to the Karvonen method by calculating the maximum heart rate reserve (maximum heart rate during exertion - maximum heart rate during rest) using the following equation:

Target heart rate = Maximum heart rate reserve × Percentage of target heart rate + Resting heart rate

Fifth: Physiological Measurements

The following measurements were conducted:

Height: Measured using a stadiometer to determine the overall height of the body to the nearest centimeter.

Weight: Measured using a medical scale.

Heart Rate and Blood Pressure Measurement: A Sphygmomanometer (S82) device was used to measure blood pressure. Colleagues from the College of Medical Sciences assisted in taking blood pressure measurements and measuring heart rate using medical stethoscopes.

Stroke Volume Measurement: Stroke volume was estimated using the equation by Starr et al. (1954) as referenced by Abdelfattah Abu Al-Ala and Mohamed Sabry Hassanin:

Stroke Volume = 100 + (0.5 × difference in systolic blood pressure) – (0.6 × diastolic blood pressure) – (0.6 × age in years). (Sayed, 2003)

Body Mass Index (BMI): BMI is an important indicator for assessing obesity in individuals and has gained increased attention in recent years. It is calculated by dividing body mass in kilograms by the square of height in meters. (Salama, 2013)

Measurement of Relative Maximum Oxygen Consumption (VO2max): The Cooper test was used, known for its high validity and reliability. Al-Haza'a (2008, p. 496) indicated a high correlation coefficient (0.90) between the distance covered in 12 minutes and the relative maximum oxygen consumption. The Cooper test is widely used to estimate VO2max and has been utilized in various studies such as Zaid's study (2010). The test procedure is described as follows:

Cooper Test (12-Minute Run)

Test Objective: To measure the efficiency of the respiratory system to determine the VO2max.

Field and Equipment Used: Stopwatch, cones or flags to mark the running track, field, whistle, measuring tape (50 meters long). A running track is marked, with cones placed every ten meters to define the running track, and a starting point is determined.

Test Procedure: Players assume the starting position behind the starting line. Upon hearing the whistle, players run continuously around the track for 12 minutes, attempting to cover the greatest distance possible. When the time is up, the distance covered in meters is calculated.

Recording: When the designated test time ends, each player stands in place to determine the distance between them and the starting point. This is done by counting the number of laps completed multiplied by the distance of each lap, then adding the remaining meters covered after crossing the starting line for the last time. The distance is then converted from meters to kilometers.

The equation provided by Al-Haza'a (2008, p. 496) is used to calculate VO2max:

VO2max (ml/kg/min) = 22.351 × (distance covered in kilometers) - 11.289.

Study Variables

After reviewing the educational literature and previous studies such as Al-Zoubi's study (2022), Rasheed et al. (2021), and Lee.B & Oh. D (2016), the study included the following variables:

Independent Variable: Proposed Training Program

Dependent Variables: these include the following variables:

- Resting Heart Rate

- Systolic Blood Pressure
- Diastolic Blood Pressure
- Stroke Volume
- Maximum Oxygen Consumption (VO2max)

Statistical Analysis

In order to answer research questions and reach conclusions, the Statistical Package for the Social Sciences (SPSS) was utilized. This involved:

- Calculating means, standard deviations, and skewness coefficients.
- Conducting a Paired Sample T-test to determine differences between pre-test and post-test measurements.
- Employing an Independent Sample T-test to assess differences in post-test measurements.

Discussion of Results

Firstly, concerning the first research question, which inquires: Are there statistically significant differences at a significance level ($\alpha \leq 0.05$) between the mean values of pre-test and post-test measurements for the physiological variables (resting heart rate, systolic blood pressure, diastolic blood pressure, stroke volume, maximal oxygen consumption) among first-year students in the College of Sports Sciences at the Arab American University?

To answer this question, a Paired Sample T-test was employed, and Table (4) illustrates this

Table (4): Presents the Results of the Paired Sample T-test for Assessing Differences Between Pre-test and Post-test Measurements of Physiological Variables Among First-year Students in the Faculty of Sports Science at the Arab American University (n = 33).

Variable	Pre-test		Post-test		Degrees of Freedom	t-value	p-value	Improvement Percentage
	Mean	Std. Dev	Mean	Std. Dev				
Resting Heart Rate (beats/min)	75.09	6.049	73.15	8.526	32	1.274	0.212	2.5%
Systolic Blood Pressure (mmHg)	124.67	5.835	122.91	5.433	32	2.149	0.039*	1.4%
Diastolic Blood Pressure (mmHg)	79.30	6.317	78.33	6.931	32	1.582	0.124	1.2%
Stroke Volume (mm/beat)	64.43	8.050	65.81	7.369	32	2.331-	0.026*	2.1%
Maximum Oxygen Consumption (ml/kg/min)	30.47	8.781	33.52	9.655	32	20.033	0.000*	10%

(* Indicates Significance at $\alpha \leq 0.05$).

The results in Table (4) indicate statistically significant differences at the $\alpha \leq 0.05$ level between the pre-test and post-test means for systolic blood pressure, stroke volume, and maximum oxygen consumption among first-year students in the Faculty of Sports Science at the Arab American University. The significance levels were 0.039, 0.026, and 0.000, respectively, which are all below the $\alpha \leq 0.05$ threshold. However, there were no statistically significant differences

at the $\alpha \leq 0.05$ level for resting heart rate and diastolic blood pressure.

The researchers attribute the improvement in the physiological variables under study to the structured aerobic exercise program. This type of exercise relies on the aerobic energy system and helps stimulate the heart muscle's function, enhancing its performance. This, in turn, leads to an increase in the efficiency of both the cardiovascular and respiratory systems. Several studies, such as the one by Ali (2023) and Mr. Saeed (2021), have indicated similar findings. These results were confirmed by the data presented in Table (4), which showed improvements in all physiological variables studied (resting heart rate, systolic blood pressure, diastolic blood pressure, stroke volume, and maximum oxygen consumption). The improvement percentages were 2.5% for resting heart rate, 1.4% for systolic blood pressure, 1.2% for diastolic blood pressure, 2.1%, and 10% for stroke volume and maximum oxygen consumption, respectively.

These findings suggest that the structured effort undertaken by the sample positively influenced the efficiency of the cardiovascular and respiratory systems, as well as muscle function, resulting in improved post-test results compared to pre-test results. This is consistent with the study by Hawari and Ben Zidan (2019), which stated that regular physical activity leads to physiological changes in various body organs as a response to physical exertion. Additionally, as indicated by Abdel Fattah and Hassanein (1997), regular sports training induces physiological changes in all functions of the athlete's body, especially heart functions. Zaid's study (2010) also suggested that endurance exercises contribute to enhancing physiological efficiency, as evidenced by the post-test results.

Regarding the decrease in systolic blood pressure, the American College of Sports Medicine (ACSM, 2016) has confirmed a relationship between the decrease in systolic and diastolic blood pressure and increased physical activity. A decrease in blood pressure is considered an indicator of improved fitness levels for athletes. This aligns with the results of this study, where statistically significant differences were found between the pre-test and post-test averages of systolic blood pressure in favor of the post-test. This result is also consistent with the study by Abu Zeid (2017), Namboonlue et al. (2023), and Fu, Y et al. (2022), which indicated differences between pre-test and post-test measurements in systolic blood pressure in favor of the post-test for the experimental group. Regarding diastolic blood pressure, the results showed no statistically significant differences between the pre-test and post-test averages. This result can be explained, according to Widian (2016), by increased vasodilation of blood vessels during physical activity, leading to decreased peripheral resistance to blood flow during rest, thus not affecting diastolic blood pressure. The researchers also believe that this indicates the effectiveness of the proposed program, as it succeeded in reducing systolic blood pressure levels without affecting diastolic blood pressure. This result is consistent with the study by Gentile, P et al. (2023), which found no differences between pre-test and post-test measurements in diastolic blood pressure. However, it differs from the findings of Abu Zeid (2017) and Fu, Y et al. (2022), which indicated significant differences between pre-test and post-test measurements in diastolic blood pressure in favor of the post-test for the experimental group that underwent an aerobic exercise program.

Regarding the variable of maximum oxygen consumption, the results indicated statistically significant differences between the pre-test and post-test averages for maximum oxygen consumption, in favor of the post-test. The researchers attribute this to the effect of structured aerobic training on the functional efficiency of the heart, lungs, and blood vessels in delivering

inhaled oxygen from the lungs to the blood, thereby benefiting from it during aerobic work. These results are consistent with the findings of Hazaa (2009), who noted that physical activities and especially endurance training increase an individual's maximum oxygen consumption compared to pre-training levels. This is also in line with the findings of Katch & McArdle (1988), who stated that the increase in VO2Max depends primarily on participation in regular training programs, resulting in an increase ranging from 5% to 25%. This increase depends on several factors, including the intensity, duration, and frequency of training, the training method used, and the individual's training level.

Indeed, as evident from the results in Table (4), there was a decrease in resting heart rate, although this decrease, even if it did not reach the level of significance, indicates an improvement in the functional efficiency of the heart. This is considered one of the most important physiological indicators of the efficiency of the respiratory system. This finding is consistent with the study by Gentile, P et al. (2023), which indicated no statistically significant differences between the pre-test and post-test averages for resting heart rate in the group that performed aerobic exercises. The researchers attribute this to the regularity of training, which led to a decrease in heart rate due to an increase in stroke volume. This finding is supported by many studies, as the results of this study indicated statistically significant differences in stroke volume between the pre-test and post-test averages, in favor of the post-test. This makes the heart more efficient in meeting the body's needs with fewer beats.

To answer the second question regarding whether there are statistically significant differences at the $\alpha \leq 0.05$ level in the post-test measurements of physiological variables (resting heart rate, systolic blood pressure, diastolic blood pressure, stroke volume, and maximum oxygen consumption) among first-year students in the College of Sports Sciences at the Arab American University attributed to gender, a statistical analysis was conducted.

To address this question, an Independent Sample T-test was employed, and Table (5) illustrates this**.**

Table (5): Presents the Results of the Independent Sample T-test for Two Independent Groups, Indicating the Significance of Differences in the Post-measurements of Physiological Variables Among First-year Students in the College of Sports Science at the Arab American University (N = 33).

Variable	Characteristics	Males (n = 13)	Females (n = 20)	t-value	Significance Level
Resting Heart Rate (beats/min)	Mean (Std. Dev)	72.00 (8.031)	73.90 (8.955)	0.619	0.540
Systolic Blood Pressure (mmHg)	Mean (Std. Dev)	121.77 (4.729)	123.65 (5.842)	0.971	0.339
Diastolic Blood Pressure (mmHg)	Mean (Std. Dev)	76.15 (5.595)	79.75 (7.468)	1.483	0.148
Stroke Volume (mm/beat)	Mean (Std. Dev)	68.41 (3.275)	64.11 (8.776)	1.684	0.102
Maximal Oxygen Consumption (ml/kg/min)	Mean (Std. Dev)	43.78 (5.387)	26.85 (4.453)	9.825	0.001*

*Significant at the $\alpha \leq 0.05$ level

The results from Table (5) indicate statistically significant differences at the $\alpha \leq 0.05$ level in the post-measurement of the variable "Maximal Oxygen Consumption" favoring males, with a significance level of 0.001, which is less than 0.05. However, there were no statistically significant differences at the $\alpha \leq 0.05$ level in the post-measurements of the variables (Resting

Heart Rate, Systolic Blood Pressure, Diastolic Blood Pressure, Stroke Volume) among first-year students in the College of Sports Science at the Arab American University, with significance levels of 0.540, 0.339, 0.148, and 0.102, respectively.

The researchers believe that the absence of statistically significant differences among the sample indicates that the proposed aerobic exercise program improved functional capacities, especially the cardiovascular system, for all participants regardless of gender. This improvement was reflected in the functional responses of the sample after performing the prescribed physical exertion by the researchers. Furthermore, regularity in the program and uniformity in exercise type, intensity, and duration contributed to these outcomes. This aligns with the findings and assertions of Al-Qadoumi (2017), who stated that body composition improvement is associated with various factors such as the type and regularity of activity, training loads, as well as lifestyle factors and general life requirements.

Regarding the variable of Maximal Oxygen Consumption, the researchers view the overall results of the study as logical, considering that Maximal Oxygen Consumption levels vary among individuals based on factors such as age, gender, and body weight. This is consistent with the findings of Maallem (2015) in their study.

Conclusions

Statistically significant differences were observed at the $\alpha \leq 0.05$ level between pre and post-means in physiological variables, including Systolic Blood Pressure, Stroke Volume, and Maximal Oxygen Consumption, with post-measurements showing favorable outcomes. Conversely, no statistically significant differences at the $\alpha \leq 0.05$ level were detected for Resting Heart Rate and Diastolic Blood Pressure variables. Additionally, significant differences at the $\alpha \leq 0.05$ level were found in the post-measurement of Maximal Oxygen Consumption, favoring males. However, among the study sample, no statistically significant differences at the $\alpha \leq 0.05$ level were identified in the post-measurements of Resting Heart Rate, Systolic Blood Pressure, Diastolic Blood Pressure, and Stroke Volume variables. Recommendations for future research include implementing aerobic exercise programs to enhance cardiovascular endurance and conducting further studies utilizing aerobic exercises on other physiological variables

1. Abbadi, Ahmad (2023). The Effect of an Aerobic Exercise Program on Some Biochemical and Anthropometric Variables and Body Mass Index for Gallbladder Removal Cases in the Age Range of 35-40 Years. Journal of Sports Science and Physical Education Applications, 28(1), 1-19.
2. Abdel Mouti, Abbas Qasim. (2021). The Effect of an Aerobic Exercise Program on Patients with Thyroid Dysfunction. Assiut Journal of Science and Arts of Physical Education, 59(3), 766-782.
3. Abdel-Fattah, abu Ala'la., Hassanein, Mohammad Subhi. (1997). Sports Physiology and Morphology and Methods of Physical Education Evaluation. Dar Al-Fikr Al-Arabi, Cairo.
4. Abdel-Fattah, abu Ala'la., Sayed, Ahmad. (2003). Physical Fitness Physiology. 2nd edition, Dar Al-Fikr Al-Arabi, Cairo.
5. Aboud, Falah Mahdi. (2010). Studying Some Functional Variables to Determine Predictive Capacity and Relative Importance of Maximal Oxygen Consumption (Vo2max). Thi Qar

University Journal, (6) 5.
6. Abu Zeid, Mohammad (2017). The Effect of Aerobic Exercise Program on Body Composition Rate and its Reflection on Physical and Functional Status among the Staff of Al-Baha University in the Kingdom of Saudi Arabia. Journal of Applied Sports Sciences, 3(93), 84-100.
7. Al Basyouni, Mohammas., Al Shatiti, Faisal. (1992). Theories and Methods of Physical Education and Sports, 2nd edition, Diwan Al-Matbuat Al-Jamiyah, Algeria, p. 181.
8. Al Sayed, Saeid. (2021). The Effect of Aerobic Training on Some Immune Variables and Digital Level for the 1500m Running Competition. Scientific Journal of Physical Education and Sports Sciences, 27(2), 72-96.
9. Ali, Hozan Jabbar. (2023). The Impact of Continuous Aerobic Exercises Accompanied by Music on Some Skeletal Muscles and Functional Indicators. Journal of Physical Education Sciences, Volume 16, Issue 3, 239-267.
10. Aliwi, Karima. (2014). The Relationship of Some Functional Variables to the Performance Level of Some Basic Skills of Female Five-a-Side Football Players. Al-Ibtidaa Al-Riyadi, 14, 105–117. https://doi.org/10.12816/0022838.
11. Almeida, Marcos B., and Claudio Gil S. Araújo. (2003). Effects of aerobic training on heart rate. Revista Brasileira de Medicina do Esporte, 9, 113-120.
12. Al-Za'abi, Amal Suleiman. (2022). A Comparative Study of the Effect of Aerobic Training, Water Consumption, and Aerobic Training Alone Before Meals on Weight and Some Physical and Bodily Characteristics of Endurance Runners in Track and Field. Mu'tah Journal for Research and Studies - Humanities and Social Sciences Series. https://doi.org/10.35682/0062-037-003-004
13. American college of sport medicine (2016). Guideline for exercise testing and prescription (tenth ed). Philadelphia PA: Lippincott Williams & Wilkins.
14. Fu, Yanping, Qiongfang Feng, Yingna Wei, Liang Fan, Yandie Pan, Jingui Ji, and Chengxia Lin. (2022). Meta-analysis of the effect of aerobic training on blood pressure in hypertensive patients. Computational and Mathematical Methods in Medicine.
15. Gentil, Paulo, Daniela Espíndola Antunes, Luciana Barbosa Carneiro, Claudio Andre Barbosa de Lira, Gislene Batista, Jordana Campos Martins de Oliveira, John Sebastião Cardoso, Daniel CostaCosta Souza, and Ana Cristina Silva Rebelo. (2023). The effects of three different low-volume aerobic training protocols on cardiometabolic parameters of type 2 diabetes patients: A randomized clinical trial. Frontiers in Endocrinology, 14, 985404.
16. Hawari, Belqada., Ben Zidan, Hussein. (2019). The Effect of Applying Moderate Intensity Physical Load on Some Physiological Indicators in Adolescents Aged 11-14 Years. The Scientific Journal of Physical and Sports Activities, 178. https://doi.org/10.54031/2070-016-001-010
17. Hazzaa, Mohammad Al- Hazza'a. (2009). Physical Effort Physiology "Theoretical Foundations and Practical Procedures for Physiological Measurements". Riyadh: Scientific Publishing and Printing, King Saud University, (2): 582.
18. Ishtiya, Muntaha. (2012). "Maximum Oxygen Consumption, Anaerobic Capacity, and Resting Metabolism, and Body Composition among Female Football Players in the West Bank". (Master's thesis), An-Najah National University, Palestine.
19. Katch F & Mcardle W. (1988). Nutrition Weight Control And Exercise W. Brown Publishers Philadelphia.

20. Lee, Bo-Ae, and Deuk-Ja Oh (2016). The effects of long-term aerobic exercise on cardiac structure, stroke volume of the left ventricle, and cardiac output. *Journal of exercise rehabilitation*, *12*(1), 37.
21. Moallem, Abdel Malek. (2015). Maximum Oxygen Consumption for Young Athletes Aged 12-15 Engaged in Sports and Study Programs. Journal of Humanities Sciences, Volume (A), Issue 43, pp. 293 – 308.
22. Namboonlue, Chaiyawat, Sarocha Namboonlue, Palakorn Sriwiset, Jittima Jaisuk, Arunya Buttichak, Nattha Muangritdech, and Wisutthida Saengjan. (2023). Effects of Concurrent Resistance and Aerobic Training on Body Composition, Muscular Strength and Maximum Oxygen Uptake in Men with Excess Weight. Physical Education Theory and Methodology, 23(3), 389–396. https://doi.org/10.17309/tmfv.2023.3.11.
23. Namroud, Bashir., Lakhdar, Bouali., & Mohamed, Nasser. (2019). Regulating a Proposed Training Program to Reduce Blood Pressure in Seniors - An Experimental Study of Seniors with Hypertension in Khemis Miliana. Al-Ibtidaa Al-Riyadi, 10(2), 426 – 445. https://doi.org/10.47337/1787-010-002-070
24. Osman, Reem Mohamed Mohsen. (2002). The Effect of Aerobic Exercises on Some Functional Variables Reflecting Respiratory System Damage Associated with Air Pollution. Scientific Journal of Research and Studies in Physical Education, 5(5), 30-49.
25. Qudumi, Abdel Nasser. (2017). The Effect of Daily Biological Rhythm on the Timing of Physical Fitness Training for Students of Police and Military Colleges. Arab Journal for Security Studies - 32(69), 205-242.
26. Rasheed, Majid Abdul Hameed, Akram Abdul Hussein Chiyad, and Ali Mohsen Dery. (2021). The relationship of oxygen endurance and the maximum oxygen consumption to the repeated sprint ability of the Iraqi Elite Soccer League players. *Sport culture*, *12*(1).
27. Saad, Rafiq., Al-Miloud, Sholi. (2021). Comparison of the Efficiency of Some Physiological Variables and Achievement Level among 5km and 10km Runners. Al Mohtarif, 8(3), 40-56.
28. Saeed, Mahmoud Rashid. (2023). The Effect of Aerobic Exercises on the Development of Some Physical, Motor, and Functional Abilities of Non-Athletic Individuals Ages (45-50) Years Old. Wasit Journal of Sports Sciences, 13(1), 24-36.
29. Sayed, N. (2003). Sports Physiology: Theories and Applications. Dar Al-Fikr Al-Arabi for Printing and Publishing.
30. Yes, Duha Muhammad Jamal. (2023). The Effect of Aerobic Exercises on Physical Fitness in Women Practicing Swimming. The Scientific Journal of Specialized Physical Education and Sports Sciences, 14(1), 112-124**.**
31. Zayed, Ziyad. (2010). The Relationship of Body Mass Index to Some Physical Fitness Elements and Maximum Oxygen Consumption. An-Najah University Journal for Research, Volume (24), 2763-2776.