RESEARCH ARTICLE

Impact of Physical Exercise on Blood Pressure in Middle-Distance Track Athletes

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Abstract

This study aimed to investigate the blood pressure values—both systolic and diastolic—before and after performing physical exercises at an intensity of 180 beats per minute among track and field students. Given the nature of the research, the descriptive analytical method was adopted using a survey approach, as it was deemed appropriate for the study's objectives. The sample consisted of third-year undergraduate students specializing in track and field at the Institute of Science and Techniques of Physical and Sports Activities, University of Bouira. The total number of participants was 12 during the 2023/2024 academic year. Measurements were carried out at the Laboratory of Modern Sciences in Physical and Sports Activities. The findings revealed that physical exercises performed at a heart rate of 180 bpm had a significant effect on both systolic and diastolic blood pressure among track and field students. The researcher recommends regular monitoring of blood pressure and heart rate among athletes.

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1. Introduction to the Study:

The science of exercise physiology focuses on studying the physiological changes that occur during training and physical activity, aiming to explore both the immediate and long-term effects of physical exercises—or movement in general—on the functions, systems, and organs of the body, such as the respiratory system, circulatory system, muscular system, etc. The goal is to improve the body's responses to various physiological variables such as blood pressure.

It is evident that there are many essential physiological indicators for the athlete's body that significantly contribute to improving athletic performance, due to their effective role in maintaining internal balance within the athlete's body.

Therefore, it has become necessary to use modern techniques to measure and understand these important physiological indicators, in order to support progress and bring about development in enhancing the level of athletic achievements, which are based on the body's responses throughout the long years of training. Among these indicators is **blood pressure**.

Achieving high levels in sports is not coincidental, but rather a result of long-term, regular training, which impacts various responses in the body. Accordingly, examining and analyzing precise physiological and biochemical aspects—such as blood pressure—is essential. This helps us understand the extent of physiological changes in other indicators resulting from continuous training, enabling us to evaluate the harmony between these physiological adaptations and responses in the bodies of middle-distance track and field athletes.

2. Problem Statement:

The physical exertion experienced by athletes during physical exercises causes functional changes in vital systems, increasing the rates of functional activity. Through this process, these systems adapt to physical loads. Physical exercises require multiple responses from the athlete's body in order to reach high levels of performance, especially for track and field athletes. Among these responses is **blood pressure**, which plays a major role in initiating changes in the athlete's body, primarily by supplying the blood with vital components that help the body continuously generate the energy needed for active muscles—this being a key factor in achieving high-level performance.

Hence, the core problem lies in understanding the **value of blood pressure during physical exercises**, by measuring the blood pressure levels of track and field athletes at rest, and determining the physiological effect when athletes are subjected to exercises at a level of 180 beats per minute.

From this, we can raise the following general question:
Does physical exercise affect blood pressure in students majoring in track and field?

3. General Hypothesis:

Physical exercise has an effect on blood pressure in students specializing in track and field.

4. Objectives of the Study:

- To determine the value of blood pressure **before and after applying physical exercises at a level of 180 beats per minute** on students specializing in track and field.

5. Scope of the Study:

- **Human Scope:** Students majoring in track and field at the Institute of Science and Techniques of Physical and Sports Activities.
- **Temporal Scope:** From **October 5, 2023** to **February 25, 2024**.
- **Spatial Scope:** Laboratory of Modern Sciences in Physical and Sports Activities, Institute of Science and Techniques of Physical and Sports Activities, **University of Bouira, Algeria**.

6. Definition of Study Terms:

6.1. Heart Rate:

The heart is considered the most important organ in the circulatory system, functioning as a pump to push blood throughout the body. It receives both oxygenated and deoxygenated blood through alternating contraction and relaxation, which are proportional to the body's position, type of activity, its intensity and volume. These factors determine the amount of blood pumped with each beat.

In general, athletes have a slower heart rate compared to non-athletes or sedentary individuals. This is due to the larger size of the athlete's heart, which allows it to pump a greater volume of blood with each contraction. Heart rate is defined as the number of heartbeats per minute and is considered one of the most important indicators for athletes because it is easy to measure and does not require equipment.

6.2. Blood Pressure:

Blood pressure is defined as the **lateral pressure exerted on the walls of the blood vessels** due to the passage of blood through them. It is also known as the force applied by the blood on the surface of the arterial walls. Blood pressure results from two forces:

1. The **heart's pumping force** pushing blood into the arteries, and
2. The **resistance of the arteries** to the flow of blood (known as peripheral vascular resistance).

The total pressure across different points of the vascular system during both heart contraction and relaxation is referred to as **blood pressure**.

Blood pressure varies throughout the day, reaching its lowest during sleep, and rising upon waking, during emotional stress, tension, and physical exertion.

Systolic Pressure:

This pressure is generated during the contraction of the heart muscle (specifically the ventricles) and the ejection of blood through the arteries to all parts of the body. It is influenced by the resistance of the arterial walls to the passage of blood.

Diagnosis and most treatment decisions are based on systolic blood pressure, as an increase in systolic pressure is associated with increased peripheral vascular resistance, while a rise in diastolic pressure reflects an increase in cardiac output and/or the stiffness of large arteries.

The average systolic pressure in a healthy individual is **120 ±10 mmHg**, and it may vary slightly (higher or lower) depending on the following factors:

1. **Physical exertion**, as it increases with pulse rate or during physical effort. During dynamic effort, systolic pressure increases while diastolic decreases, whereas during static effort, both systolic and diastolic pressures rise, and then decline during the recovery phase.
2. **Psychological state**, such as stress and anxiety.
3. **Increased salt concentration in the blood**.
4. **Aging**, due to arterial stiffness.
5. **Increased cholesterol levels** in the blood.
6. **Use of certain drugs and substances** that affect the central nervous system (CNS).
7. **Hormones**, such as cortisol, which causes fluid retention in the body.
8. **Excessive intake of food and fluids**.

Blood pressure is defined as the driving force of blood within the circulatory system, resulting from blood flow from high-pressure areas to low-pressure areas. It includes two types:

- **Systolic pressure**: the pressure at the moment of ventricular contraction, with a normal value between **100–120 mmHg**.
- **Diastolic pressure**: the pressure in the aorta during ventricular relaxation, ranging between **60–90 mmHg**.

2. Diastolic Pressure:

Diastolic pressure results from the relaxation of the heart muscle (ventricles), the contraction of the atria, the flow of blood into the ventricles, and the closure of the aortic valve. In a healthy person, diastolic pressure ranges from **70–80 mmHg**. It is more stable and less affected by external factors like physical exertion and emotional states. However, it may rise due to several diseases such as kidney disease or renal artery abnormalities, and also due to aortic valve insufficiency.

Blood pressure is influenced by other factors such as **age, gender, weight, and body composition**. Systolic pressure tends to increase during exercise and can reach up to **175 mmHg**, while diastolic pressure increases only slightly.

6-3. Physical Exercise:

According to **Matveiev**, physical exercises are a set of motor actions directed toward achieving various physical education and sports training objectives. Physical exercise has an impact on the body, causing internal changes that manifest in psychological, physiological, and pedagogical aspects. Each type of physical exercise has a unique form that distinguishes it from others, such as the duration, body position in space, and the direction of the athlete's movements.

7. Previous and Similar Studies:

7-1. Study by Falah Mahdi Aboud

Titled: *The effect of physical effort on copper concentration and blood pressure in the blood*, the study aimed to determine the copper concentration in the blood before and after physical effort at a heart rate of 180 beats/min among middle-distance runners, as well as to measure blood pressure (systolic and diastolic) before and after the effort. The sample included **six athletes** specializing in middle-distance running (800m–1500m) at the national level. The researcher concluded that physical effort at 180 bpm affects both copper concentration and blood pressure in these athletes.

7-2. Study by Mokhtar Kacem et al.

Titled: *The effect of aerobic physical effort on some physiological and biochemical variables in the elderly – A field study of women aged 50–60 years.* The aim was to examine the effect of a proposed training program on certain physical, physiological, and biochemical variables in elderly women. The study sample included **10 women** who followed the program for **8 weeks**. The study concluded that the proposed exercise program had a positive effect on physiological and biochemical tests (heart rate, blood pressure, body mass index, blood sugar level, and hemoglobin concentration) in elderly women aged 50–60.

8. Research Methodology and Field Procedures:

8-1. Research Methodology:

The researcher used the **descriptive method** in its **survey style**.

8-2. Research Sample:

The sample was deliberately selected and consisted of **12 third-year students** majoring in athletics, representing **75%** of the total population in that specialization.

Variables	Mean	Standard Deviation	Coefficient of Variation
Heart rate (bpm)	57.63	4.37	5.6%
Height (cm)	163.7	5.13	3.22%
Weight (kg)	64.85	7.25	7.75%

Age / Years: 21.44 ± 1.35 (6.18%)
Table (01): Shows the arithmetic mean, standard deviation, and coefficient of variation for the variables: heart rate, height, weight, and age at rest.

The researcher ensured homogeneity among the study sample individuals as shown in Table (01), where it is evident that the coefficient of variation for the variables is less than 25%, indicating that the research sample is homogeneous.

8-3 Devices and Tools Used:

The following devices and tools were used:

- Treadmill device.
- Blood pressure monitor.
- Medical scale for measuring weight and height.

8-4 Anthropometric Measurements:

Height and weight of the sample individuals were measured using a medical scale, with their heights and weights recorded.

8-5 Functional Measurements:

First – Heart Rate Measurement:

Heart rate was measured in the study sample before and after physical exercise for a duration of (30 seconds × 2).

Second – Blood Pressure Measurement:

Blood pressure was measured before and after physical exercise at a rate of 180 beats/min directly on the study sample.

8-6 Pilot Study:

To ensure the functionality and validity of the devices, the researcher conducted a preliminary pilot study on 4 students from the sample. The study involved performing the following proposed physical exercises:

- First exercise: 8 km/h (speed rate: 2.22 m/s)
- Second exercise: 10 km/h (speed rate: 3.33 m/s)
- Third exercise: 12 km/h (speed rate: 3.33 m/s)

This was done to assess the compatibility of the exertion with the selected sample, evaluate the efficiency of the assisting team during the implementation of the tests, address any errors or shortcomings that may appear during the main experiment, and calculate the testing time for each selected exercise.

8-7 Study Procedures:

The researcher conducted the main experiment from **October 5, 2023 to February 25, 2024** on the study sample at rest. The participants were given ten minutes in a lying position, followed by taking the relevant measurements. Then, physical exercises were applied by having the student run on the treadmill at a constant speed of **10 km/h for 3 minutes**, after which the speed increased by **2 km/h every minute** until the heart rate reached **180 beats per minute**.

8-8 Statistical Methods:

Data was processed using the **SPSS Version 11** statistical software.
The statistical methods included:

- Arithmetic mean
- Standard deviation
- Coefficient of variation
- Paired samples t-test (T-test)

9. Presentation and Discussion of Results:

9-1 Presentation and Discussion of Heart Rate and Systolic and Diastolic Blood Pressure Before and After Physical Exercise:

Variables	Before Exercise	After Exercise	Std. Deviation of Differences	Degrees of Freedom	Calculated T	Tabulated T	Result
Heart Rate (bpm)	56.33	178.56	18.62	11	6.27	2.015	Significant
Systolic Pressure (mmHg)	113	175	12.094	11	11.95	2.015	Significant
Diastolic Pressure (mmHg)	67	78	6.515	11	3.34	2.015	Significant

Table (2): Shows the arithmetic mean, standard deviation, and both the calculated and tabulated (T) values for the variables of heart rate, systolic blood pressure, and diastolic blood pressure before and after performing physical exercises.

It is evident from Table (2) that the calculated T-value for heart rate was **6.27**, which is greater than the tabulated T-value (**2.015**) at a significance level of **0.05** and with **11 degrees of freedom**. This indicates the existence of statistically significant differences in favor of the post-exercise effort for heart rate. Similarly, for both systolic and

diastolic blood pressure, the calculated T-values were **11.95** and **3.34** respectively, which are also greater than the tabulated T-value (**2.015**) at the same significance level and degrees of freedom. This means that there are statistically significant differences in favor of the post-exercise effort for both systolic and diastolic blood pressure when the heart rate reaches 180 beats per minute.

The researcher explains these significant differences by the nature of the physical exercises at a heart rate of 180 beats/minute, which imposed a burden on the study sample by increasing blood concentration. This leads to an increase in blood viscosity that persists for a long period, reflecting an increase in resistance to blood flow through blood vessels, causing an elevation in blood pressure (both systolic and diastolic). Consequently, this increases the load and response of the heart muscle to meet the working muscles' need for oxygenated blood and to produce the necessary energy for continuing physical exertion in middle-distance runners.

This is explained by **Qais Ibrahim Al-Douri** and **Tariq Abdul-Malik** as being due to the exercise performed, competitive performance, differences in body sizes, and the amount of blood returning and ejected in one heartbeat, which is compensated for by an increase in heart rate per minute to increase the ejected blood volume. Researchers also interpret the increase in heart rate as a sign of the body's ongoing need for oxygenated blood during metabolic processes, in addition to the direct correlation between physical effort and heart rate. Likewise, the study by **Hull (1997)** confirms that engaging in physical activity increases the turbulent and dense blood flow in blood vessels, due to the overall increase in blood flow speed throughout the circulatory system.

Continuing physical exercises leads to increased blood flow and thus an increase in metabolic processes that require amounts of water to help transport it to working cells. This results in greater blood flow and, consequently, an increase in blood pressure. This is in line with the study by **Mahfouz Faleh (2003)**, which found that blood pressure increased in a sample of long-distance runners after performing effort for **10 minutes** on a treadmill. The study by **Lamb (1984)** also confirms that blood concentration is a physiologically significant factor during long-duration physical activity due to its close relationship with blood viscosity.

Physical exercises have a clear and effective impact on blood pressure, both systolic and diastolic. Scientific experiments have shown that physical exercises help reduce blood pressure in individuals suffering from hypertension. Moreover, physical training has proven to be effective based on studies that have shown it can be used as a preventive method to avoid high blood pressure before its symptoms appear in humans.

The study by **Westerterp K. and Saris W. (1992)** indicates that performing physical exercises reduces blood pressure even in people with normal blood pressure. Additionally, athletes generally have lower blood pressure at rest compared to non-athletes. Normal blood pressure and resting heart rate are physiological indicators of a good training condition. However, some suggest that differences in blood pressure between trained and untrained healthy individuals may not appear at rest, but rather during physical exertion, where slight differences in arterial pressure are found in favor of the trained individuals.

Therefore, it can be said that engaging in physical and sports activities, especially aerobic (oxygen-based) activities such as walking, jogging, swimming, and cycling, helps prevent high blood pressure in general. It also reduces blood pressure in people with mild hypertension. However, scientific studies have yet to prove the effect of physical exercise on resting blood pressure in individuals with normal blood pressure.

10. Conclusions:

- Physical exercises performed at a heart rate of 180 beats per minute had a significant impact on blood pressure (both systolic and diastolic) among students specializing in athletics.

- There were significant differences in the physiological indicators under study due to physical exercises, as reflected in cardiovascular responses including elevated heart rate and blood pressure.

11. Recommendations:

1. It is essential to regularly monitor heart rate and blood pressure among athletes.
2. Athletes should be encouraged to consume foods that help improve blood viscosity.
3. Further studies should be conducted on various vital physiological indicators for athletes, such as heart volume, blood composition, and concentrations of minerals like magnesium, iron, copper, and zinc.

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