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The Relationship Between Cardiorespiratory Fitness and Heart Rate Among Physical Education Students

[1]Ahmed Mahmood Mahdi[*]

[*]Corresponding Author, E-mail: **ahmed.mo.m@uosamarra.edu.iq**

[1]College of Physical Education and Sport Sciences, University of Samarra, Iraq

Abstract

Objectives. This study was conducted to examine the relationship between heart rate and cardiorespiratory fitness among second-year students of the College of Physical Education and Sports Sciences. Heart rate and cardiorespiratory fitness are important indicators of the functional condition of the cardiovascular and respiratory systems, and both reflect the body's physiological adaptation to physical activity. This study was considered necessary because empirical data related to these variables in the academic setting were still limited. Therefore, the research aimed to identify the pattern of association between resting heart rate, post-exercise heart rate, and cardiorespiratory fitness.

Materials and Methods. The study employed a descriptive correlational design. The population consisted of 84 second-year students, from which 40 students were selected randomly, representing 47.62% of the total population. Cardiorespiratory fitness was measured using the Cooper 12-minute run test. Heart rate was measured twice, namely before running and immediately after running, using a heart rate monitoring device. The collected data were analyzed using descriptive and inferential statistics, including arithmetic mean, standard deviation, Pearson correlation coefficient, and t-test at a significance level of 0.05**.**

Results. The findings showed that the students achieved an average running distance of 2550 meters in the Cooper test. The mean resting heart rate was 68 beats per minute, while the mean heart rate after running reached 171 beats per minute. Statistical analysis revealed a strong negative correlation between heart rate and cardiorespiratory fitness. The correlation coefficient between resting heart rate and cardiorespiratory fitness was **r = -0.71**, while the correlation between post-exercise heart rate and cardiorespiratory fitness

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was **r = -0.63**. These findings indicate that students with better cardiorespiratory fitness tended to have lower heart rates, both at rest and after physical exertion.

Conclusions. The study concludes that heart rate has a significant inverse relationship with cardiorespiratory fitness. In other words, lower heart rates are associated with higher levels of cardiorespiratory fitness. This pattern reflects physiological adaptations that occur as a result of regular physical activity and better cardiovascular efficiency. Based on these findings, heart rate can be used as a simple and practical physiological indicator for estimating cardiorespiratory fitness. It is recommended that heart rate monitoring be included in periodic student fitness evaluations and that training programs be designed to further improve cardiorespiratory fitness. Future studies are also encouraged to investigate other physiological variables related to cardiac efficiency, such as heart rate recovery and heart rate variability (HRV).

Keywords: Cardiorespiratory fitness; Heart rate; Physical education students; Cooper test; Exercise physiology

Introduction

Cardiorespiratory fitness is considered one of the most important components of health-related and performance-related physical fitness, as it reflects the efficiency of the cardiovascular and respiratory systems in providing the working muscles with oxygen during physical activity (Ahmad et al., 2023a, 2023b). Cardiorespiratory fitness is linked to the heart's ability to pump blood efficiently and the respiratory system's ability for gas exchange, which contributes to improving the ability to perform physical activities and reducing fatigue(Allen & Ross, 2013; Mariana Lolowang et al., 2025; Nopriani et al., 2023). It is also an important indicator of the body's functional state and the level of physiological adaptation resulting from regular physical training**.**

Heart rate is one of the most important physiological indicators that reflect the efficiency of the cardiac system and its response to physical effort, as it is affected by several factors, including the level of physical fitness, health status, and adaptation resulting from training. Regular physical training leads to improved cardiac efficiency, which results in a decrease in resting heart rate due to an increase in stroke volume and improved efficiency of the circulatory system(*A Systematic Review and Meta-Analysis of the Effectiveness of High-*

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Intensity Interval Training for Physical Fitness in University Students | BMC Public Health | Full Text, n.d.; Masanovic et al., 2020; Medrano-Ureña et al., 2020).

A decrease in resting heart rate is considered an indicator of a high level of cardiorespiratory fitness.

Furthermore, the relationship between cardiorespiratory fitness and heart rate is one of the important indicators reflecting the level of physiological adaptation resulting from training. Improved cardiorespiratory fitness leads to increased efficiency of the cardiac system, thereby reducing the heart rate at rest and during physical exertion. Heart rate is used as an important indicator to evaluate the level of cardiorespiratory fitness and monitor the resulting adaptations.

Students of the College of Physical Education and Sports Sciences are among the groups that require a good level of cardiorespiratory fitness due to the nature of the physical activities they engage in during practical and training sessions. Furthermore, training and education programs can contribute to or help in understanding physical fitness and physiological adaptation by studying the relationship between heart rate and cardiorespiratory fitness in this group (Abduh et al., 2024; Azlan et al., 2020; Bessa et al., 2021)**.**

The importance of this objective lies in its contribution to clarifying the relationship between cardiorespiratory fitness and heart rate. The degree of adaptation resulting from physical training and the efficiency of the cardiorespiratory system are considered vital physiological indicators. Assessing and evaluating cardiac function helps to understand this relationship and assess individuals' fitness levels, which can contribute effectively to physical rehabilitation and the development of tailored training programs.

In addition to what has been mentioned previously, this research presents several scientific findings related to the level of cardiorespiratory fitness of college students, as this contributes to knowing and understanding the extent of their physical fitness efficiency and the ability to develop modern educational programs that can be compatible with their physical and physiological capabilities (Purwanto et al., 2025; Sekulic et al., 2021).

Research Problem

Cardiorespiratory fitness is one of the fundamental indicators reflecting the efficiency of the cardiovascular and respiratory systems in meeting the demands of physical activity; it is also directly linked to an individual's ability to perform physical effort efficiently. Heart rate is one of the most significant physiological indicators reflecting the functional state of the heart and the level of adaptation resulting from physical training. Improving

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cardiorespiratory fitness leads to increased cardiac efficiency, which results in a decrease in resting heart rate and improved cardiac response during physical exertion.

Through the researcher's work in the field of physical education instruction, a variance was observed in the levels of cardiorespiratory fitness among students, as well as differences in their heart rates at rest and after physical effort, indicating the potential existence of a relationship between these two variables. However, this relationship has not been scientifically and accurately studied among students of the College of Physical Education and Sports Sciences, which prompted the researcher to investigate the relationship between cardiorespiratory fitness and heart rate in this specific group.

Research Objectives

The research aims to:

Identify the level of cardiorespiratory fitness among students of the College of Physical Education and Sports Sciences.

Identify the heart rate (at rest and post-exertion) among students of the College of Physical Education and Sports Sciences.

Reveal the nature of the relationship between cardiorespiratory fitness and heart rate among students of the College of Physical Education and Sports Sciences.

Research Hypotheses

There is a statistically significant correlation between cardiorespiratory fitness and resting heart rate among students of the College of Physical Education and Sports Sciences.

There is a statistically significant correlation between cardiorespiratory fitness and heart rate after physical exertion among students of the College of Physical Education and Sports Sciences.

Materials and Methods

Study Participants.

This study involved second-year students of the College of Physical Education and Sports Sciences. The population consisted of 84 students, and 40 students were randomly selected as the research sample, representing 47.62% of the total population. The participants were selected after meeting several requirements, namely being free from cardiovascular and respiratory diseases, having no physical injuries that could affect test performance, and regularly attending practical classes. These criteria were applied to ensure that the participants were physically capable of completing the test procedures and that the collected data reflected their actual cardiorespiratory condition. The remaining 44 students, or 52.38% of the population, were not included in the sample.

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Study organization.

The researcher employed a descriptive correlational design because the study was intended to identify the relationship between cardiorespiratory fitness and heart rate without manipulating the research variables. Before the main data collection was carried out, a pilot study was conducted to familiarize the researcher with the instruments and procedures, verify the feasibility of the test administration, and anticipate possible technical problems in the field. During the implementation stage, all measurements were conducted under the same environmental conditions and at a standardized testing time. Participants were also instructed not to perform strenuous physical activity within 24 hours before the test. All data were recorded directly into prepared data sheets to minimize recording errors.

Cardiorespiratory fitness was measured using the Cooper 12-Minute Run Test. In this test, each participant was asked to run continuously for 12 minutes and cover the greatest possible distance. The total distance achieved was then recorded in meters. The test was conducted on a track of known length, and the participants started running upon the researcher's signal. At the end of the 12-minute period, they were instructed to stop immediately, and the final running distance was calculated. This test was selected because it is widely used as a field-based measure of cardiorespiratory fitness and provides an estimate of maximal oxygen consumption (VO_2max) using the formula: VO_2max = (distance in meters – 504.9) / 44.73.

Heart rate was measured in two conditions, namely at rest and immediately after exercise. Resting heart rate was measured after the participant sat quietly for five minutes in a relaxed position without unnecessary movement. The measurement was taken using a Polar device or a certified digital heart rate monitor, and the total number of beats per minute was recorded. This measure was used to reflect cardiac efficiency under resting conditions. Post-exercise heart rate was measured immediately after the completion of the Cooper test, and the value recorded during the first minute after exertion was used as an indicator of the cardiac response to physical load. These two measurements were considered important because resting heart rate reflects cardiovascular efficiency, whereas post-exercise heart rate reflects the body's physiological response and recovery capacity after effort.

Statistical analysis.

The collected data were analyzed using both descriptive and inferential statistics. The arithmetic mean was used to determine the average score of each research variable, while the standard deviation was used to describe the spread of the data around the mean. Pearson's

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correlation coefficient was applied to examine the relationship between cardiorespiratory fitness and heart rate variables. In addition, the t-test for the significance of the correlation coefficient was used to determine whether the observed relationships were statistically significant at the 0.05 level. These statistical procedures were chosen because they were appropriate for the correlational nature of the study and allowed the researcher to describe the data clearly while testing the strength and direction of the relationships among variables.

Results

The descriptive analysis showed that the students had a mean cardiorespiratory fitness score equivalent to a running distance of **2550 m** in the Cooper 12-minute test, with a standard deviation of **210 m**. This result indicates that, in general, the participants demonstrated a fairly good level of cardiorespiratory fitness. The relatively moderate spread of scores also suggests that the participants' fitness levels were not widely dispersed. Resting heart rate had a mean of **68 bpm** with a standard deviation of **5.4**, while post-exercise heart rate had a mean of **172 bpm** with a standard deviation of **9.2**. These values indicate that the participants showed a normal cardiac response both at rest and following physical exertion.

The correlational analysis revealed a significant negative relationship between cardiorespiratory fitness and heart rate. Cardiorespiratory fitness was strongly and inversely correlated with resting heart rate (**$r = -0.71, p < 0.05$**), indicating that students with better cardiorespiratory fitness tended to have lower resting heart rates. A significant negative correlation was also found between cardiorespiratory fitness and post-exercise heart rate (**$r = -0.63, p < 0.05$**). This finding suggests that students with higher fitness levels also tended to show lower heart rates after running, reflecting a more efficient physiological response to exercise. Overall, these results confirm that heart rate, both before and after exercise, is closely associated with the level of cardiorespiratory fitness among physical education students.

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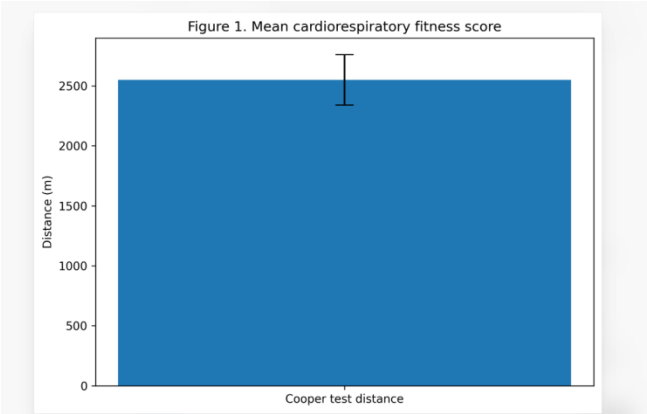

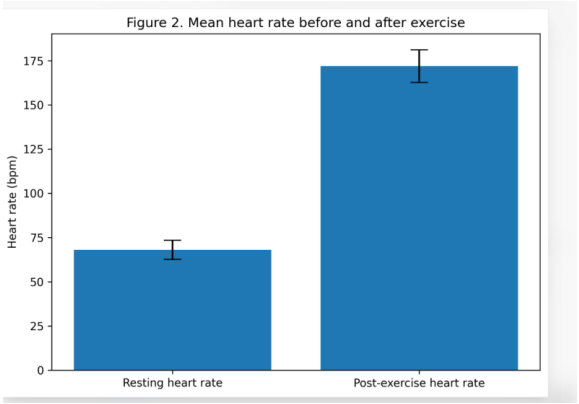

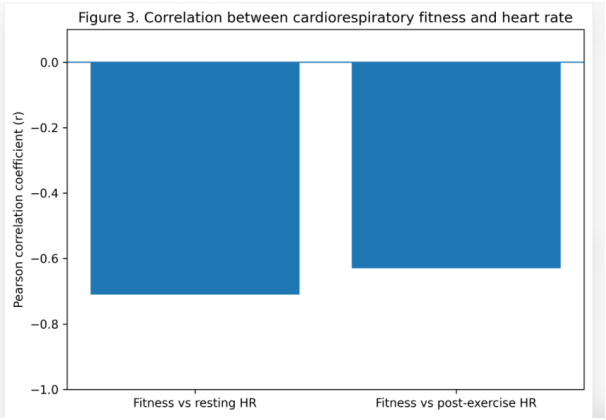

Figure 1 shows the mean cardiorespiratory fitness score of the students based on the Cooper 12-minute run test. The average distance covered by the participants was 2550 m, indicating that, in general, the students had a fairly good level of cardiorespiratory fitness. The error bar also suggests that the distribution of scores remained within a reasonable range, reflecting moderate variation among participants. Figure 2 presents the mean resting heart rate and post-exercise heart rate of the students. The average resting heart rate was 68 bpm, while the average post-exercise heart rate increased to 172 bpm. This pattern indicates a normal physiological response, as heart rate rises after physical exertion to meet the body's increased oxygen demand during activity. Figure 3 illustrates the correlation between cardiorespiratory fitness and heart rate variables. The correlation coefficient between cardiorespiratory fitness and resting heart rate was r = -0.71, while the correlation between cardiorespiratory fitness and post-exercise heart rate was r = -0.63. Both correlations were negative, indicating that higher cardiorespiratory fitness was associated with lower heart rate values, both at rest and after exercise. These findings support the view that better cardiorespiratory fitness is closely linked to greater cardiac efficiency.

Discussion

The present study found that cardiorespiratory fitness was negatively associated with both resting and post-exercise heart rate. The stronger relationship observed with resting

heart rate suggests that this variable is particularly sensitive in reflecting cardiovascular efficiency (Hanssen et al., 2023; Maron et al., 2007; Pate et al., 2006). Students who achieved better results in the Cooper test tended to have lower resting pulse rates, which can be interpreted as an indication of more efficient cardiac function. Physiologically, this pattern is reasonable because individuals with better aerobic fitness generally develop a greater stroke volume, allowing the heart to pump more blood with each contraction. As a result, the heart does not need to beat as frequently to meet the body's oxygen demands at rest. This explanation is consistent with the view that regular aerobic conditioning leads to positive cardiovascular adaptations, including improved myocardial efficiency and lower resting heart rate.

A similar pattern was found for post-exercise heart rate (@ Charles et al., 2017; Medrano-Ureña et al., 2020). The significant negative correlation indicates that students with higher cardiorespiratory fitness were better able to regulate their cardiac response following physical exertion. In practical terms, fitter students appear to tolerate exercise load more efficiently, requiring less cardiovascular strain to perform the same running task. This finding supports the assumption that improved oxygen transport, better peripheral adaptation, and more efficient recovery mechanisms are characteristic of individuals with higher aerobic capacity. In this context, post-exercise heart rate can serve not only as an indicator of exercise response but also as a practical marker of cardiovascular conditioning in student populations.

From a broader physiological perspective, the inverse relationship identified in this study may also be linked to autonomic regulation. Higher cardiorespiratory fitness is commonly associated with greater parasympathetic dominance at rest and better autonomic balance during and after exercise (Ramos-Campo et al., 2021). This condition contributes to a lower resting pulse and a more controlled increase in heart rate during physical activity. The magnitude of the correlation coefficients in this study, especially for resting heart rate, indicates that heart rate is not merely a temporary response variable but may also function as a meaningful physiological indicator of aerobic fitness in college students. Therefore, the findings of this study strengthen the practical value of heart rate monitoring in educational and sports settings, particularly where simple and accessible measures are needed for routine fitness evaluation.

Conclusions

Based on the findings of the study, it can be concluded that second-year students of the College of Physical Education and Sports Sciences demonstrated a fairly good level of cardiorespiratory fitness, as reflected in their performance on the Cooper 12-minute run test.

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Their resting heart rate values were also within a normal range, suggesting acceptable cardiovascular function. More importantly, the study confirmed that cardiorespiratory fitness had a significant inverse relationship with both resting heart rate and post-exercise heart rate. Students with better cardiorespiratory fitness tended to show lower heart rates in both conditions.

These findings indicate that heart rate can be used as a simple and practical physiological indicator for estimating cardiorespiratory fitness among physical education students. The results also suggest that physiological adaptations associated with regular physical activity contribute to improved cardiac efficiency and reduced cardiovascular workload, both at rest and after exercise. For this reason, heart rate measurement can be meaningfully incorporated into routine fitness monitoring and evaluation programs in physical education contexts.

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