



Evaluating Cardiorespiratory Fitness Level of College Students: A Comparative Analysis Between Basketball and Football Classes

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Authors' Contribution: A – Study design; B – Data collection; C – Statistical analysis; D – Manuscript Preparation; E – Funds Collection

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Accepted for Publication: June 3, 2024

Published: June 30, 2024

DOI: 10.17309/tmfv.2024.3.10

Abstract

Objectives. The study aimed to compare the cardiorespiratory fitness levels among male students majoring in football and basketball.

Materials and methods. A cross-sectional study was conducted with a sample size of 60 students, divided into two groups: 30 students from the basketball class and 30 students from the football class. The average age of students in the football class was 22.03 ± 0.81 , while in the basketball class, it was 22.07 ± 0.74 . All participants were male and active strata 1 students in semesters 4 and 6, equivalent to second and third-year students. The cardiorespiratory fitness level was assessed using the Cooper 1.5 mile or 2.4 km Run Test. The data analysis was performed using a two-tailed independent sample t-test to determine differences between the two groups at a significance level of less than 5% ($p < 0.05$). Prior to the t-test, normality was assessed using the Shapiro-Wilk test, and homogeneity was assessed using Levene's statistics, with a significance level higher than 5% ($p > 0.05$).

Results. The findings revealed that students in the football class showed a higher VO_{2max} (42.54 ± 5.40) compared to those in the basketball class (37.86 ± 5.62), demonstrating a statistically significant difference ($p = 0.002$).

Conclusions. The study found a significant disparity in cardiorespiratory fitness levels between the football and basketball student groups within the campus setting.

Keywords: college students, football, basketball, cardiorespiratory fitness.

Introduction

Physical fitness, as highlighted by Farley et al. (2020), Puchalska-Sarna et al. (2022), Xiao et al. (2021), stands out as a crucial factor influencing sports performance. This concept is commonly categorized into two distinct components: fitness pertaining to overall health and fitness specific to sports skills, as discussed by Kariyawasam et al. (2019) and Zheng et al. (2023). The foundation of health-related fitness is essential for individuals across the spectrum (Xiang et al., 2017), encompassing both the general populace and athletes, including basketball and football players. Optimal physical fitness is imperative to underpin daily activities and accomplishments. Therefore, it can be inferred that health-related physical fitness serves as the cornerstone that athletes must establish before honing skill-related physical abilities

to attain peak performance. Bompa (2012) emphasizes that physical fitness linked to health represents a fundamental biomotor element that every athlete should possess.

The fitness components associated with health encompass body composition, cardiorespiratory fitness, flexibility, muscle strength, and muscle endurance, as highlighted by Blair et al. (2001), Janssen and Leblanc (2010), and Ross et al. (2016). Among these elements, cardiorespiratory fitness assumes paramount importance due to its direct correlation with vital human systems, specifically the lungs and heart. Raghuvver et al., (2020) describe cardiorespiratory fitness as the synergy between the cardiovascular system (comprising the heart and blood vessels) and the respiratory system (involving the lungs and respiratory tract) in facilitating oxygen distribution throughout the body and eliminating carbon dioxide generated during metabolic processes.

In the realm of student demographics, the levels of cardiorespiratory fitness emerge as a significant focal point as they wield the potential to impact academic performance, overall well-being, and quality of life, as noted by Chang & Jui-Fu (2011) and Singh et al. (2012). This notion aligns with

findings from Sardinha et al. (2016), underscoring that higher levels of cardiorespiratory fitness and sustained enhancements in fitness are linked to enhanced academic outcomes. Essentially, individuals with elevated and progressively advancing cardiopulmonary fitness levels tend to exhibit improved academic achievements. Studies concerning cardiorespiratory fitness among college students often underscore the role of regular physical activity in enhancing lung and heart health. Nevertheless, within educational settings, particularly campuses, other variables such as engagement in competitive sports can also impact cardiorespiratory fitness levels.

The participants in this study consisted of students who were enrolled in basketball and football coaching programs. It was essential to note that not all students in these classes were necessarily athletes. Among the students were individuals with a keen interest in basketball or football, aiming to delve deeper into these sports, including former athletes and enthusiasts aspiring to pursue coaching roles. Thus, the primary objective of this study was to meticulously evaluate and compare the cardiorespiratory fitness levels of students engaged in basketball and football classes. Through this comparative analysis, we aimed to enhance our comprehension of how the nature of sporting activities could impact cardiorespiratory fitness levels within the college student cohort.

This research offers valuable insights not only into the significance of sports education in upholding student health but also into the specific impact of certain sports on enhancing cardiorespiratory fitness. Therefore, the objectives of this research carry significant practical implications for the advancement of health and fitness programs tailored for students within the campus setting.

Materials and Methods

Participants

This research is a cross-sectional and observational study that examines data collected from a specific population at a single time point (Capili, 2021; Kesmodel, 2018; Wang & Cheng, 2020). The sample for this study comprised 60 male students, with 30 students from the basketball sports coaching class and 30 from the football sports coaching class. These participants were active undergraduate students in their fourth and sixth semesters, corresponding to the second and third years of study. Essentially, these students possessed significant prior experience in practicing basketball or football. For further details regarding the sample characteristics in this study, please refer to Table 1.

Data Collection Technique

In this research, data collection employed tests and measurements. Participants were required to be in good health, free from injuries, and instructed to refrain from engaging in strenuous exercise for a minimum of 48 hours,

as well as abstain from consuming food prior to the test. Prior to the testing procedure, participants were recommended to engage in a 10-minute warm-up and stretching session.

The Cooper 1.5 mile or 2.4 km Run Test was the instrument utilized to evaluate cardiorespiratory fitness levels in this study. This 2.4 km running test serves as a straightforward aerobic fitness assessment, necessitating solely a running track, stopwatch, and a recording sheet to document the participant's overall score. Subsequent to the test, calculations and standards for cardiorespiratory fitness levels were analyzed utilizing the formula outlined by Wood (2008).

Statistical Analysis

The data analysis was conducted utilizing SPSS version 27.0. The data presentation format adopted was mean \pm SD. The data analysis technique employed a two-tailed independent sample t-test to assess variations in the means of the two groups, with a significance threshold set below 5% ($p < 0.05$). Prior to conducting the t-test, prerequisite tests were performed, namely: (1) normality testing using Shapiro-Wilk; and (2) homogeneity testing using Levene Statistics. The prerequisite or assumption tests utilized a significance level exceeding 5% ($p > 0.05$).

Results

Normality Test

Table 2. Normality Test Results

Variable	Class	Shapiro-Wilk		
		Statistic	df	Sig.
VO ₂ max (ml/kg/min)	Football	0.959	30	0.284
	Basketball	0.960	30	0.311

The table above displays the outcomes of the Shapiro-Wilk test. The p-value for the Shapiro-Wilk test in the football class is 0.284 (> 0.05), and in the basketball class, it is 0.311 (> 0.05). As both values are greater than 0.05, it indicates that both groups exhibit a normal distribution according to the Shapiro-Wilk test.

Homogeneity Test

Table 3. Homogeneity Test Result

Variable	Levene Statistic	df1	df2	Sig.
Based on Mean	0.328	1	58	0.569
Based on Median	0.236	1	58	0.629
VO ₂ max (ml/kg/min)	0.236	1	57.867	0.629
Based on trimmed mean	0.324	1	58	0.571

Table 1. Participant's physical characteristics (mean \pm SD)

Group	N	Age	Height (m)	Weight (kg)	BMI	HB (g/dl)
Basketball	30	22.07 \pm 0.74	1.70 \pm 0.52	60.61 \pm 8.32	20.78 \pm 2.22	15.45 \pm 1.77
Football	30	22.03 \pm 0.81	1.66 \pm 0.56	57.63 \pm 7.48	20.84 \pm 2.23	16.30 \pm 1.72

The table above presents the outcomes of the homogeneity test conducted using Levene's Test method. The Levene's value displayed in the row based on the Mean is 0.328, with a p-value (sig) of 0.569, indicating that the value is > 0.05. This result suggests that there is equal variance between the groups, signifying homogeneity.

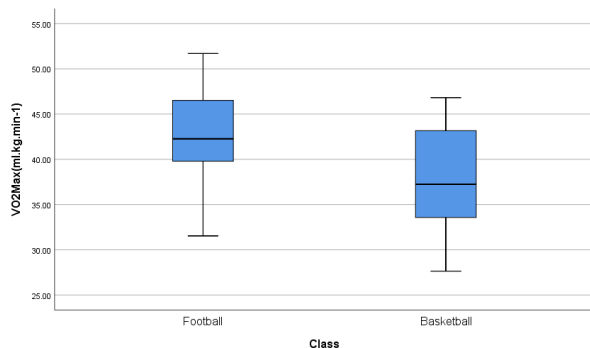


Fig. 1. Boxplot independent t-test

The box plot above reveals no outliers above or below the boxplot, indicating the absence of any outliers. With all assumptions met, we have proceeded to the next test, namely the Independent T-Test.

Hypothesis Test

Prior to testing the hypothesis, the cardiorespiratory fitness level results were classified within each class. Below is the data from this categorization:

Table 4. Data Category Results of Cardiorespiratory Fitness Level of Basketball and Football Class

Group	Category					Total
	Very Poor	Poor	Fair	Good	Excellent	
Class Football	2	3	15	5	5	30
Basketball	8	9	9	4	0	30
Total	10	12	24	9	5	60

Upon reviewing the categorized data of cardiorespiratory fitness levels for the basketball and football classes, a comparison of the analysis results conducted by the researchers is presented in Table 5. The mean ± standard deviation is greater in the football class than in basketball, with a significant p-value of 0.002 (p < 0.005), indicating a notable difference.

Table 5. Comparison Cardiorespiratory Fitness Level Basketball and Football Class

Variable	Basketball Class	Football Class	p value
Cardiorespiratory Fitness [VO ₂ max (ml/kg/min)]	37.86±5.62	42.54±5.40	0.002*

Mean±Standard deviation; *Statistically significance

Discussion

In the soccer class, the average age was 22.03 ± 0.81, while in the basketball class, it was 22.07 ± 0.74. It is important to note that the research samples in both groups included not only athletes but also former athletes, amateur players, or individuals studying the sport to pursue coaching roles.

The study uncovered notable variances in cardiorespiratory fitness levels among college students enrolled in basketball and football classes. This distinction was supported by a significance level of p = 0.002, indicating a value below 0.05. These results offer valuable insights into the factors impacting cardiorespiratory fitness levels within the student community and may have implications for designing programs in higher education.

Students enrolled in soccer classes exhibited superior levels of cardiorespiratory fitness in comparison to their counterparts in basketball classes in this study. This disparity could be attributed to variations in the intensity and nature of exercises practiced in each sport.

Drawing on research by Stojanović et al. (2018), the average VO₂max of elite male basketball athletes ranges from 50 to 61 ml/kg/min. In comparison, student athletes typically exhibit an average VO₂max of 50 to 58 ml/kg/min, engaging in approximately 21 to 57 movements per minute during gameplay. Further, the average distance covered by players in a basketball game spans from 4,400 to 7,500 meters over a 40-minute match (excluding breaks).

Basketball is classified as an intermittent sport, as highlighted by Koryahin, (2022) and Salafi et al. (2023), characterized predominantly by high-intensity activities where the average heart rate surpasses 85% of HRmax during gameplay. In contrast, elite male soccer players, as reported by Turner & Stewart (2014), typically exhibit an average VO₂max ranging from 50.3 to 65.3 ml/kg/min. Moreover, the average distance covered in a football match typically ranges between 10 to 13 kilometers per game.

Football is a high intensity intermittent sport, featuring critical events completed at high/maximal intensity which is superimposed onto an aerobic base of lower intensity activities and rest (Hulton et al., 2022). The aerobic energy system is highly taxed during a football game, with average and peak heart rates around 85% and 98% of maximal values, respectively, corresponding to average oxygen uptake of around 70% of maximum (Bangsbo, 2014). In summary, during a soccer match, the body predominantly utilizes the aerobic energy system at high intensity, leading to elevated heart rates and oxygen consumption. This underscores the crucial role of cardiorespiratory fitness in determining athletes' performance levels during soccer matches.

Based on the findings of cardiorespiratory fitness research, students in football classes exhibit a VO₂max of 42.54 ± 5.40, whereas those in basketball classes show 37.86 ± 5.62. These results suggest that the intensity and duration of training in basketball classes may not be sufficient to achieve the same level of cardiorespiratory fitness as observed in soccer classes.

Not only physical performance but also biological conditions can significantly influence performance optimization. For instance, hematological parameters are crucial for predicting optimal physical performance as hemoglobin and red blood cells are essential for oxygen transport (Schum-

acher et al., 2002). According to Table 1, the average Hemoglobin (HB) levels are 16.30 ± 1.72 for students in football classes and 15.45 ± 1.77 for those in basketball classes.

According to Walker et al. (1990), the typical Hb levels for males range from 14 to 18 g/dl, while for females, the range is 12 to 16 g/dl, indicating that the HB results for each class fall within the normal range. However, the soccer class showed the highest improvement. The levels of hemoglobin and cardiorespiratory fitness are closely linked. It is well-established that endurance training leads to adaptations in blood levels, characterized by an increase in blood volume due to heightened plasma volume and an increase in the red blood cell count (Schumacher et al., 2002). The study revealed that players residing at moderate altitudes exhibited higher hemoglobin concentrations (16.2 ± 0.2 g/dl) compared to those living at sea level locations (14.4 ± 0.7 g/dl). Additionally, the average VO_2 max value of players at medium altitude (54.1 ml/kg/min) significantly surpassed that of players at low altitude (49 ml/kg/min). A review indicates that elevated hemoglobin concentrations are linked to enhanced physical performance, with improvements ranging between 5% and 10% (Wilber, 2002).

It is essential to note that while adequate hemoglobin levels in the blood are crucial, enhancing VO_2 max remains a key consideration. Factors like lung capacity, heart efficiency, and the muscles' capacity to utilize oxygen all impact an individual's VO_2 max. Thus, although elevated hemoglobin levels can enhance VO_2 max, a holistic grasp of the various elements influencing aerobic capacity is vital for optimizing athletic performance and overall physical fitness.

Various factors, including motivation, effective rest time management, and lifestyle choices, can impact cardiorespiratory fitness outcomes (Noriega de la Colina et al., 2024; Thapa et al., 2023). Students in the football class might exhibit higher motivation levels towards enhancing their cardiorespiratory fitness. Moreover, maintaining a healthy lifestyle and efficiently managing time to strike a balance between academic responsibilities and sports engagements can further enhance cardiorespiratory fitness levels.

The level of cardiorespiratory fitness in this study can also be influenced by factors such as the content covered in the lecture, the duration of the lecture, and the frequency of meeting sessions conducted.

The findings emphasize the significance of considering the type and intensity of cardiorespiratory fitness programs developed within the campus setting. The discrepancy in results between basketball and football classes could possibly be attributed to the frequency of lectures. This aspect warrants careful consideration to optimize outcomes.

This research offers recommendations for enhancing current lecture programs, such as incorporating training techniques from other sports to enhance the cardiorespiratory fitness of students in basketball classes. Strategies may involve integrating intense cardiorespiratory training components and emphasizing targeted aerobic exercises to elevate fitness levels. Additionally, students can benefit from insights gained from lectures in other classes to inspire ongoing skill and knowledge development, thereby preventing monotony in a single sport discipline.

This study has several limitations that need to be acknowledged. Firstly, the relatively small sample size might restrict the applicability of the findings to the broader student

population. Moreover, factors like genetic predispositions and stress levels, not accounted for in this study, could impact cardiorespiratory fitness outcomes, warranting consideration in future research endeavors. Furthermore, a limitation arises from the predominant use of athlete data in related studies, highlighting the scarcity of research focused on the student demographic.

Nevertheless, this study can provide strong evidence about the differences in cardiorespiratory fitness levels between basketball and football students in a college setting.

Conclusions

The study findings revealed that students in the soccer class exhibited a higher VO_2 max (42.54 ± 5.40) in comparison to those in the basketball class (37.86 ± 5.62), indicating a statistically significant distinction ($p = 0.002$). Therefore, it can be concluded that there exists a notable variance in cardiorespiratory fitness levels between the two student groups within the campus setting.

Acknowledgments

The researcher expresses gratitude to all individuals who participated in this study and to Universitas Negeri Yogyakarta for their support, which facilitated the smooth and successful completion of this research.

Conflict of interest

The authors guarantee that no conflicts of interest exist.

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Оцінка рівня кардіореспіраторної підготовленості студентів коледжу: Порівняльний аналіз груп, які займаються баскетболом та футболом

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Авторський вклад: А – дизайн дослідження; В – збір даних; С – статаналіз; D – підготовка рукопису; E – збір коштів

Реферат. Стаття: 6 с., 5 табл., 1 рис., 29 джерел.

Мета дослідження. Метою цього дослідження було проведення порівняльного аналізу показників кардіореспіраторної підготовленості серед студентів чоловічої статі, які займаються футболом та баскетболом.

Матеріали та методи. Проведено поперечне дослідження з обсягом вибірки 60 студентів, розділених на дві групи: 30 студентів з баскетбольного класу та 30 студентів з футбольного класу. Середній вік студентів у футбольному класі становив $22,03 \pm 0,81$ роки, тоді як у баскетбольному — $22,07 \pm 0,74$. Усі учасники дослідження були чоловічої статі з категорії активного прошарку та навчалися на 4 і 6 семестрах, що еквівалентно студентам другого і третього курсів. Рівень кардіореспіраторної підготовленості оцінювали за допомогою бігового тесту Купера на 1,5 милі або 2,4 км. Аналіз даних проведено із застосуванням двостороннього критерію для незалежних вибірок з метою визначення відмінностей між двома групами на рівні значущості менше 5% ($p < 0,05$). Перед застосуванням t-критерію, було оцінено перевірку даних на нормальність (критерій нормальності) за допомогою тесту Шапіро-Вілка, а однорідність визначено із використанням статистики Левене, з рівнем значущості вище 5% ($p > 0,05$).

Результати. Результати дослідження свідчать про те, що студенти футбольного класу мали вищий показник VO_{2max} (максимальне споживання кисню) ($42,54 \pm 5,40$) порівняно зі студентами баскетбольного класу ($37,86 \pm 5,62$), демонструючи статистично значущу різницю ($p = 0,002$).

Висновки. В ході дослідження встановлено значну різницю в рівнях кардіореспіраторної підготовленості між групами студентів, які займаються футболом і баскетболом у межах студентського містечка.

Ключові слова: студенти коледжу, футбол, баскетбол, кардіореспіраторна підготовленість.

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Cite this article as: Arrum, D. N. A., Tomoliyus, Alim, A., & Miftachurochmah, Y. (2024). Evaluating Cardiorespiratory Fitness Level of College Students: A Comparative Analysis Between Basketball and Football Classes. *Physical Education Theory and Methodology*, 24(3), 420-425. <https://doi.org/10.17309/tmfv.2024.3.10>

Received: 20.05.2024. Accepted: 03.06.2024. Published: 30.06.2024

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