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Exploring cardiovascular and respiratory fitness: A comparative study of adolescents involved in extracurricular activities

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ABSTRACT

Background Problems: The critical importance of maintaining physical fitness among high school students to mitigate the potential health hazards associated with a sedentary lifestyle. **Research Objectives**: This study aims to explore the impact of futsal and hadang extracurricular activities on adolescent cardiovascular and respiratory fitness. **Methods**: This research used an experimental study with pre-post design and control group. Ninety students from Serang City high schools were divided into three groups: Futsal Extracurricular, Hadang Extracurricular, and Control. Initial assessments established baseline fitness levels, followed by an 8-weeks program and post-program evaluations. **Findings and Results**: The results showed an increase in aerobic capacity and respiratory capacity after 8-weeks extracurricular program in both groups. The futsal extracurricular group experienced a higly significant increase aerobic capacity and respiratory capacity compared to the baseline. Meanwhile, the hadang extracurricular group experienced a significant increase aerobic capacity and respiratory capacity compared to the baseline. Conversely, the control group appears to exhibit a decline in both aerobic and respiratory capacities, although it is important to note that these changes did not reach statistical significance in our study. **Conclusion**: In conclusion, this study provided valuable insights into how futsal and hadang extracurricular activities impact adolescent cardiovascular and respiratory fitness. These findings were relevant for educators and policymakers, highlighting the role of extracurricular programs in enhancing students' overall well-being. Additionally, it contributes to our understanding of how specific activities can influence the cardiovascular and respiratory health of adolescents.

Keywords: Cardiovascular; respiratory fitness; hadang; futsal

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INTRODUCTION

In the contemporary epoch, alterations in lifestyles due to societal shifts and advancements in technology have wielded considerable influence on the ways humans conduct their lives. This influence extends to

adolescents in high school as well. Within this context, a distinctive trend known as the sedentary lifestyle has emerged (Valencia-Peris et al., 2021). This sedentary lifestyle is defined by a notable reduction in physical exertion and an augmented duration of exposure to electronic screens (Ross et al., 2016). The ramifications of this phenomenon have been investigated in previous scholarly endeavors, which have underscored the potential adverse impact of sedentary behaviors on the health and physical well-being of teenagers (Damian et al., 2018; Nascimento et al., 2019).

Adolescents in high school who exhibit a propensity for extended gadget usage as opposed to active participation in physical endeavors are confronted with an elevated susceptibility to a spectrum of health concerns (Anugrah et al., 2021). These concerns encompass conditions such as obesity, type 2 diabetes, and cardiovascular afflictions (Damian et al., 2018; Umer et al., 2017). It is noteworthy that diminished levels of physical activity may exert an influence on the development of bones and muscles during pivotal stages of growth (Malina et al., 2015). Hence, upholding physical fitness among this demographic is of paramount importance to ameliorate the potential manifestation of these health hazards.

Drawing upon the insights gleaned from prior investigative studies, it becomes apparent that engagement in physical pursuits, particularly within the realm of sports, exerts a constructive influence on the health and physical well-being of adolescent individuals (Anugrah et al., 2021; Prayogo et al., 2021). It is noteworthy that the implications of sports involvement extend beyond cardiovascular and physical fitness realms, encompassing a broader spectrum of health dimensions. Among these are the enhancement of sleep quality, stress alleviation, and mood elevation (Ostrzyżek-Przeździecka et al., 2019). Moreover, sports contribute significantly to the cultivation of an enduring active way of life, which serves as a pivotal strategy for countering sedentary tendencies (Melero-Cañas et al., 2021).

Engaging in sports activities represents a significant opportunity for adolescents to enhance their social and emotional skills by interacting with peers. It also plays a pivotal role in the development of discipline and self-responsibility (Bloemen et al., 2015). School-sponsored extracurricular sports programs provide an ideal environment for high school students to discover their hidden talents, cultivate teamwork abilities, and nurture leadership qualities. These programs serve as valuable platforms for their personal and interpersonal growth.

Several prior investigations have indicated that extracurricular sports initiatives can yield advantages for adolescent students. These benefits encompass enhanced motor development and heightened cardiovascular endurance in comparison to their sedentary counterparts of the same age (Anggia, 2019; Ashari, 2019). Additionally, further research has contributed to this body of knowledge by demonstrating that engagement in extracurricular sports programs positively influences respiratory capacity and augments the aerobic endurance of participating teenagers (Ashari, 2019).

While previous studies have investigated the consequences of sedentary behaviors on adolescents' health (Valencia-Peris et al., 2021), this research takes a distinct approach by examining the role of school-sponsored extracurricular sports programs as a potential solution. What sets this study apart is its detailed exploration of the specific effects of two different extracurricular sports programs – futsal and hadang – on the dimensions of aerobic and respiratory capacity. Such a comparative analysis provides a deeper understanding of how varying sports activities influence the overall fitness and athletic abilities of high school students, thereby contributing to a more comprehensive perspective on the subject.

Several studies explained that hadang as traditional sport from Indonesia comprises two factions, denominated as the defensive cohort and the adversary cohort (Ashari, 2019; Nurdiansyah, 2018). Participants in the defensive cohort align themselves linearly, extending their upper extremities to construct a formidable obstacle impeding traversal by members of the opposing cohort (Nurdiansyah, 2018). Simultaneously, a solitary member of the defensive cohort maneuvers along the axial demarcation, maintaining a prescribed spatial offset from other cohort constituents (Ashari, 2019; Nurdiansyah, 2018). The demarcation of the play area is demarked with chalk, and throughout the course of the activity, one lower extremity of the defensive participant must consistently maintain contact with the delineation, thereby circumscribing their range of motion (Nurdiansyah, 2018). The classification of an opposing participant as defeated is contingent upon physical contact with a member of the defensive cohort. Attainment of victory by the defensive cohort is

contingent upon successful physical contact with each member of the opposing cohort (Ashari, 2019; Nurdiansyah, 2018).

In addition to its unique methodology that focuses on two specific extracurricular programs, this research advances the current understanding by emphasizing the broader health dimensions influenced by sports involvement. Beyond cardiovascular and physical fitness, the study considers factors like sleep quality, stress alleviation, and mood enhancement, contributing to a more holistic perspective on the potential benefits of sports participation (Ostrzyżek-Przeździecka et al., 2019). Furthermore, this research seeks to provide valuable insights for educational institutions, policymakers, and parents, promoting informed decisions aimed at encouraging adolescents to lead healthier, more active lives. By addressing the sedentary lifestyle trend, this study offers a pathway to tackle the health challenges faced by high school students in the contemporary digital age. Ultimately, it aims to equip teenagers with the knowledge and opportunities they need to counteract sedentary behaviors and maximize their developmental potential.

In our contemporary society, characterized by rapid societal shifts and technological advances, the primary purpose of this research is to address the pressing issue of sedentary lifestyles among high school adolescents (Hasan et al., 2020). The surge in sedentary behaviors, marked by reduced physical activity and prolonged screen time, has significant implications for the health and well-being of teenagers (Nascimento et al., 2019; Valencia-Peris et al., 2021; Zhang et al., 2021). As our initial investigations reveal, this lifestyle trend can lead to various health concerns, including obesity, type 2 diabetes, and cardiovascular ailments (Melero-Cañas et al., 2021; Zhang et al., 2021).

With these concerns in mind, our research aims to underscore the critical importance of maintaining physical fitness among high school students to mitigate the potential health hazards associated with a sedentary lifestyle. The urgency of this research stems from the growing prevalence of sedentary behaviors among adolescents, posing a substantial threat to their health. Sedentary lifestyles have become the norm, driven by extensive gadget usage and reduced physical activity. This trend demands immediate attention due to the elevated susceptibility of high school students to a range of health issues, as documented in prior research. By understanding the urgency of this issue, our research seeks to prompt timely action to address the health challenges faced by this demographic.

This manuscript holds paramount importance in the field of adolescent health and physical fitness. It illuminates the critical role of sports in promoting the well-being of high school students, extending beyond physical fitness to encompass dimensions such as sleep quality, stress reduction, and enhanced mood. This research emphasizes that sports can counter sedentary tendencies and play a pivotal role in fostering social and emotional skills, discipline, and self-responsibility. The significance of this manuscript lies in its potential to shape policies and interventions aimed at improving the health and lifestyle choices of adolescents.

Our research contributes to the existing body of knowledge by conducting a comprehensive analysis of the impact of extracurricular sports programs on the physical well-being of high school students. By focusing on aerobic and respiratory capacities, we aim to shed light on the distinct effects of futsal and hadang programs. This contribution is crucial in guiding educational institutions, policymakers, and parents in making informed decisions regarding extracurricular sports programs, thereby empowering teenagers to lead healthier and more active lives. The significance of this research lies in its potential to instigate a shift in how we perceive and address sedentary behaviors among high school students. By highlighting the profound impact of sports programs on physical fitness and overall well-being, we hope to encourage a paradigm shift in promoting active lifestyles. This research seeks to equip adolescents with the knowledge and motivation needed to combat sedentary tendencies, thereby helping them unlock their full developmental potential and steer clear of associated health risk.

METHOD

Research Design

Our research adopted a true-experimental pretest-post-test design using control group, ensuring a robust framework for our inquiry (Creswell, 2013). To mitigate potential biases and ensure the transparency of participant assignment, a meticulous randomization procedure was employed to allocate participants into three

distinct groups: the Futsal Extracurricular group (referred to as FE), the Hadang Extracurricular group (referred to as HE), and the Control Group (referred to as CO). The randomization process was conducted using a computer-generated sequence of random numbers. Each participant's name was correlated with a corresponding number, and these numbers were subsequently reorganized to generate the randomized allocation list. This approach ensured an impartial and equitable distribution of participants, thereby enhancing the credibility of our findings.

Research Subject

The study engaged a cohort of ninety dedicated students from several high schools in Serang City, who enthusiastically volunteered their participation to contribute to the study's objectives. To ensure the integrity of the participant pool, thorough assessments were conducted to verify their non-smoking history. The recruitment process adhered to strict inclusion criteria, which encompassed an adolescents in the age range of 15 to 18 years enrolled in Senior High School (SMA) will be considered as potential candidates. Specifically, we focused on students who were not currently enrolled in the Hadang Extracurricular or Futsal Extracurricular at their respective schools.

Furthermore, candidates possessing a sufficient level of physical health to actively participate in physically demanding activities, such as sports included. A key criterion for selection was the willingness of students to fully engage in the extracurricular programs and to undergo the requisite assessments throughout the course of the study. This set of inclusion criteria had been meticulously designed to ascertain that the selected participants align with the necessary prerequisites and were well-suited to participate in the comparative investigation involving the Hadang and Futsal Extracurricular activities alongside the control group..

The research methodology was granted ethical approval by the Health Research Ethics Committee of Universitas Airlangga School of Medicine (Approval No. 223/EC/KEPK/FKUA/2022). All participants who were included in the study provided their informed written consent. Before participating, potential subjects were provided with detailed explanations of the research procedures and subsequently provided their consent through written documentation.

Research Procedure

In the conducted research, various phases have been undertaken. Some of these stages encompass:

Stage	Action	Description
1	Securing Ethical Approvals and Permits	Obtaining necessary ethical approvals and permits to comply with standards and gain facility access.
2	Random Allocation of Participants	Randomly categorizing participants into Futsal Extracurricular Group (FEG), Hadang Extracurricular Group (HEG), and Control Group (COG).
3	Initial Physical Fitness Assessment	Administering baseline physical fitness assessments for all participants before engaging in extracurricular activities.
4	Training Sessions	Conducting eight weeks of structured training sessions, with FEG and HEG training twice a week on specific activities.
5	Control Group's Daily Activities	Observing regular daily activities of the Control Group (COG) as a control variable for comparison.
6	Follow-up Physical Test	Conducting a follow-up physical test for all participants to measure the impact of extracurricular activities on physical well-being.

Statistic Analysis

The data analysis process was conducted using IBM SPSS version 24 statistical software. The study results were presented as mean ± SD values. The Shapiro-Wilk test was utilized to assess the homogeneity of the data. Two-Way Repeated Measures Analysis of Variance was employed to examine differences among groups and determine the presence of significant variations. If a significant difference was found with a confidence level of $P < 0.05$, it indicated a statistically significant distinction among the groups. Paired sample t-tests were conducted to evaluate changes in respiratory capacity and aerobic capacity from pretest to post-test

among groups. Additionally, an independent sample t-test was utilized to compare post-test aerobic capacity and respiratory capacity among groups.

RESULTS AND DISCUSSION

The primary objective of this research was to compare adolescents engaged in futsal extracurricular programs and those participating in hadang extracurricular programs, focusing on the dimensions of respiratory capacity and aerobic capacity. To the best of our knowledge, this study represented the first attempt to compare the adolescents engaged in futsal extracurricular programs and those participating in hadang extracurricular programs on respiratory capacity and aerobic capacity. The key finding of this investigation indicated that futsal extracurricular programs was more effective increasing respiratory capacity and aerobic capacity in adolescents when compared to the hadang extracurricular programs.

Table 1 provides a comprehensive overview of the recorded data pertaining to the Anthropometric Characteristics of the research participants, encompassing age, weight, height, and body mass index (BMI) for all groups, represented as mean values with their respective standard deviations (SD). Following a meticulous analysis of this data, it becomes evident that no statistically significant differences in anthropometric attributes were observed among the various groups in this study. This outcome underscores the initial comparability and similarity of the participant groups in terms of their baseline characteristics.

Table 1. Anthropometric Characteristics of Research Subjects

Variable	Group			*P-value*
	FEG	HEG	COG	
Age (years)	17.5 ± 1.7	17.9 ± 2.1	17.6 ± 2.3	0.382
Weight (kg)	66.8 ± 5.1	62.2 ± 4.8	64.3 ± 4.1	0.413
Height (cm)	167.6 ± 6.7	166.4 ± 7.1	168. 6 ± 7.5	0.344
BMI (kg/cm^2)	22.6 ± 3.6	22.5± 3.1	22.7 ± 3.3	0.424

The statistical analysis in Table 2 employs the Paired Sample T-test, unveiled noteworthy disparities ($p < 0.05$) when comparing the pretest and posttest data within the Futsal Extracurricular Group (FEG) and Hadang Extracurricular Group (HEG). These differences signified an enhancement in aerobic capacity, with the most substantial improvement observed within the FEG. Conversely, the Control Group (COG) did not exhibit any significant alterations in this regard.

Table 2. Comparison of Pretest and Posttest Aerobic Capacity among Groups

Group	Pretest (ml/kg/min)	Posttest (ml/kg/min)	P Value	Significance
FEG	28.32 ± 1.92	35.65 ± 2.11	0.01	Highly Significant
HEG	27.93 ± 2.08	30.86 ± 2.43	0.05	Significant
COG	28.88 ± 2.62	28.70 ± 1.81	0.182	Not Significant

As depicted in Table 3, the mean aerobic capacity level within the Futsal Extracurricular Group (FEG) surpasses that of both the Hadang Extracurricular Group (HEG) and the Control Group (COG). Through the application of an independent t-test, a notable disparity with a p-value of 0.01 emerged, signifying a significant divergence in the enhancement of aerobic capacity.

Table 3. Comparison of Mean Posttest Aerobic Capacity among Groups

Group	Posttest (ml/kg/min)	Mean Difference	P Value	Significance
FEG	35.65 ± 2.11	6.95	0.01	Highly Significant
HEG	30.86 ± 2.43			
COG	28.70 ± 1.81			

Table 4 shows the statistical analysis, employing the Paired Sample T-test, unveiled noteworthy disparities ($p < 0.05$) when comparing the pretest and posttest data within the Futsal Extracurricular Group (FEG) and Hadang Extracurricular Group (HEG). These differences signified an enhancement in respiaratoy capacity,

with the most substantial improvement observed within the FEG. Conversely, the Control Group (COG) did not exhibit any significant alterations in this regard.

Table 4. Comparison of Pretest and Posttest Respiratory Capacity among Groups

Group	Pretest (L)	Posttest (L)	P Value	Significance
FEG	2.84 ± 0.42	3.24 ± 0.27	0.01	Highly Significant
HEG	2.89 ± 0.21	3.09 ± 0.28	0.05	Significant
COG	2.81 ± 0.64	2.79 ± 0.34	0.61	Not Significant

As illustrated in Table 5, the mean respiratory capacity level within the Futsal Extracurricular Group (FEG) notably exceeds that of both the Hadang Extracurricular Group (HEG) and the Control Group (COG). Utilizing an independent t-test for analysis, a substantial distinction with a p-value of 0.01 was identified, indicating a significant disparity in the improvement of respiratory capacity.

Table 5. Comparison of Mean Posttest Respiratory Capacity Among Groups

Group	Posttest (L)	Mean Difference	P Value	Significance
FEG	3.35 ± 0.27	5.26	0.01	Highly Significant
HEG	3.12 ± 0.28			
COG	2.79 ± 0.34			

A significant discovery arising from our study underscores the favorable impact of two distinct extracurricular programs: the futsal extracurricular program and the hadang extracurricular program, on the respiratory and aerobic capacities of the participating adolescent. Notably, our investigation revealed that the futsal extracurricular program exhibited a more substantial influence in enhancing both aerobic and respiratory capacities when contrasted with the hadang extracurricular program. In contrast, the control group in our research did not demonstrate a significant increase in either aerobic or respiratory capacity. This observation underscores the differing effects of these extracurricular programs on key physiological parameters.

The results of our investigation align with previous research, providing further confirmation that adolescents who regularly participate in sports activities tend to display significantly improved aerobic and respiratory capacities compared to their sedentary counterparts (Brown et al., 2017; Gomes-Neto et al., 2016; Hancox & Rasmussen, 2018). Additionally, it is worth highlighting that teenagers involved in soccer or futsal often exhibit notably superior aerobic and respiratory capacities in contrast to their peers who engage in other sports (Fernandez-Gonzalo et al., 2010; Juniarsyah et al., 2021; Kartal, 2016). However, a distinct body of research outcomes contends that engaging in swimming emerges as particularly impactful in fostering heightened respiratory and aerobic capacities in contrast to alternative sporting modalities like futsal and football (Adin & Pancar, 2023). These findings underscore the nuanced relationships between specific sports and their respective influences on respiratory and aerobic performance.

Our research outcomes unequivocally indicate the superior efficacy of the futsal extracurricular program in enhancing both aerobic and respiratory capacities when compared to the hadang extracurricular program. This observation prompts us to consider the distinctive attributes inherent to futsal training, including its dynamic nature characterized by rapid directional changes and high-intensity running during practice and matches (Apriantono et al., 2021; Juniarsyah et al., 2021). It is plausible that these specific elements contribute significantly to the pronounced advancements in physical fitness observed within the futsal participant cohort.

Furthermore, it is imperative to recognize that futsal, characterized by its high-intensity nature, imposes a substantial workload on the cardiovascular system (Ramos-Campo et al., 2016; Sekulic et al., 2020). Consequently, this form of physical activity elicits noteworthy cardiovascular adaptations, notably an augmentation in stroke volume, denoting the volume of blood expelled with each cardiac contraction, alongside a reduction in resting heart rate (França et al., 2023; Fyfe et al., 2022; Roh et al., 2016). These adaptations collectively serve to enhance the efficacy of the circulatory system in furnishing oxygen to actively engaged musculature. Engaging in regular futsal participation yields notable benefits for respiratory physiology. These improvements encompass lung function enhancements, characterized by amplified tidal volume (the volume of air displaced per breath) and augmented vital capacity (the maximal air volume

exhalable after a profound inhalation) (Bahri et al., 2021; Hancox & Rasmussen, 2018). These physiological enhancements contribute to a more efficient respiratory exchange of oxygen and carbon dioxide within the pulmonary system (Gomes-Neto et al., 2016).

Fundamentally, within the framework of our investigation, it becomes evident that the extracurricular hadang program, while capable of inducing improvements in both aerobic and respiratory capacities, falls short of achieving the level of effectiveness demonstrated by its futsal counterpart. Our rationale for this discrepancy is grounded in the observation that the training regimen and extracurricular matches associated with the hadang program exhibit a comparatively lower degree of intensity and optimization when juxtaposed with the rigors of the futsal extracurricular program (Nurdiansyah, 2018). It is this inherent disparity that, in essence, curtails the full potential of the hadang extracurricular program in augmenting aerobic and respiratory capacities.

In our research, it is evident that the control group exhibited a plateauing of their aerobic and respiratory capacities. While analyzing the data, it becomes apparent that there was a modest decline in both aerobic and respiratory capacities within the control group, although this decline did not reach statistical significance. It is plausible to suggest that the reduction observed in the control group may be attributed to their engagement in daily routine activities, which lack the structured physical exercise regimen followed by the other two groups throughout the study period. The observed decline in both aerobic and respiratory capacity in the control group, while not meeting the threshold for statistical significance, can potentially exacerbate with prolonged periods of physical inactivity. It is crucial to recognize that the consequences of insufficient physical activity and imbalanced nutrition can become more pronounced over extended durations of sedentary behavior. Numerous prior research studies have highlighted the inadequate levels of physical activity and the prevalence of unbalanced dietary patterns among children and adolescents. These unhealthy habits are strongly associated with the development of excess weight, obesity, and a host of related health issues, ultimately diminishing their overall quality of life (Damian et al., 2018; Nascimento et al., 2019).

The implications of our findings are particularly noteworthy, suggesting that the incorporation of regular futsal extracurricular programs should be actively promoted, especially among sedentary children and young adolescents. Such programs hold substantial promise in ameliorating health-related physical fitness parameters and thereby fostering a more active and healthier lifestyle among this demographic. Nevertheless, it is imperative to acknowledge the need for further research endeavors to explore and elucidate certain aspects that lie beyond the scope of our current study.

We acknowledges the presence of specific constraints within this study that warrant attention in forthcoming research endeavors. Firstly, this investigation did not incorporate an evaluation of the dietary and lifestyle factors of the research subjects, variables that have the potential to exert an influence on research outcomes. Secondly, enhancing the depth of analysis by encompassing additional parameters, including the intensity levels during training and competitive matches, holds the potential to furnish a more comprehensive comprehension of the subject matter and address lingering inquiries. Consequently, future research should prioritize the examination of these dimensions to elevate the collective understanding of this domain.

CONCLUSION

In conclusion, our study delving into cardiovascular and respiratory fitness among adolescents participating in Futsal and Hadang extracurricular activities has revealed valuable insights. While both activities contribute positively to the cardiovascular and respiratory capacities of adolescents, futsal appears to have a more significant impact in enhancing these fitness parameters. The adolescents engaged in futsal demonstrated notable improvements in their aerobic and respiratory capacities compared to those participating in hadang. These findings underscore the potential benefits of futsal as an extracurricular activity for promoting cardiovascular and respiratory health among adolescents. However, it is crucial to consider individual preferences and interests when promoting such activities in the school curriculum, as personal motivation and enjoyment are essential factors in sustaining long-term participation and reaping the associated health benefits. Further research can delve into the long-term effects and sustainability of these improvements and explore additional factors that may influence cardiovascular and respiratory fitness in adolescents.

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CONFLICT OF INTEREST

The authors state no conflict of interest.

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