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The Effect of a Proposed Training Approach to Developing the Physiological Fitness fo The Heart and Circulatory System and the Performance of Quick Shooting Skills in Young Basketball Players

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Abstract

The lack of emphasis on endurance-specific training in junior basketball coaching often leads to early fatigue and suboptimal skill development during competition. This study aimed to develop and evaluate a structured training program designed to enhance special endurance and improve quick shooting performance among junior basketball players. An experimental method was employed involving 20 players aged 15–16 years from the Dhi Qar Governorate team, who were purposively selected and randomly assigned to either an experimental group or a control group (n = 10 each). The experimental group underwent a six-week intervention comprising 24 training sessions focused on cardiovascular endurance, while the control group followed their regular training routine. Pre- and post-tests measured performance using the Six-Time Rapid Layup Test and the Carlson Fatigue Curve Test. The experimental group showed a statistically significant improvement in layup performance (pre-test M = 50.79s, post-test M = 45.50s; t = 18.78, $p < 0.05$) and cardiovascular endurance (pre-test M = 20.2, post-test M = 9.8; t = 26.5, $p < 0.05$). In contrast, the control group showed only modest gains. These findings highlight the effectiveness of targeted endurance training in enhancing both physiological fitness and technical skill. It is recommended that basketball coaches integrate evidence-based endurance programs into junior training curricula to build physical resilience and support sustained athletic performance.

Keywords: Physiological Fitness; Cardiovascular Endurance; Quick Shooting Skills; Junior Basketball Training

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1. INTRODUCTION

Basketball is widely recognized as one of the most popular and physically demanding team sports in the world. The dynamic nature of the game requires players to execute a variety of high-intensity actions such as sprinting, jumping, rapid directional changes, and precision shooting—in quick succession and often under physical pressure. To meet these demands, athletes must undergo well-designed training programs that integrate both physiological and technical components, ensuring optimal performance across all phases of play (Abbott & Berninger, 1993; Cronin & Allen, 2017; Gandrapu & Rakesh, 2024; Hidayat et al., 2024; Lestari & Dewi, 2022).

Among the physical capabilities essential for basketball success, special endurance plays a particularly crucial role. This type of endurance refers to an athlete's ability to sustain high-level performance throughout a match without a significant decline in execution. Maintaining this performance is especially challenging due to the sport's continuous transitions between offense and defense, which place substantial demands on the cardiovascular and muscular systems (Afifa et al., 2024; Awais et al., 2023; Donnelly et al., 2016) Therefore, training methods that enhance cardiovascular endurance should be a central focus within basketball coaching strategies (Adewale et al., 2024; Hays et al., 2009; Vealey, 2024).

From a physiological perspective, basketball primarily utilizes the phosphagen and lactic acid energy systems, which together account for approximately 85% of the energy expended during gameplay. Only about 15% of energy derives from aerobic pathways. This distribution highlights the importance of targeting both anaerobic and aerobic systems through structured training programs that enhance heart efficiency, increase stroke volume, reduce exertional heart rate, and improve respiratory capacity (Baechle, T. R., & Earle, R. W., 2008; Bellicha et al., 2021; Hartika Aulia et al., 2024; Schroeder et al., 2019).

Despite this scientific understanding, many junior-level basketball coaches continue to overlook the importance of endurance-specific training. Observational data and field experience indicate that this oversight often results in early fatigue, reduced technical execution, and impaired decision-making under pressure (Ahmad

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et al., 2023; Ding & Yu, 2024; Kuswoyo et al., 2020; Lochhead et al., 2024; Wang et al., 2024). These concerns highlight a pressing need to develop and implement scientifically grounded training programs tailored to the endurance demands of competitive basketball.

Based on these gaps, the current study proposes a structured training program specifically designed to improve cardiovascular fitness and quick shooting performance among junior basketball players. The program integrates targeted endurance exercises with skill-specific drills to evaluate their combined effect on physical and technical performance outcomes (Hakim et al., 2023; Hamann & Schiemann, 2021; Haney Aguirre-Loaiza, 2025; Riyanto & Kuswoyo, 2019).

2. METHOD

This study employed an experimental research design to examine the effect of a proposed training program on cardiovascular fitness and quick shooting skills in junior basketball players. The research involved 20 male athletes aged 15 to 16 years from the Dhi Qar Governorate team. Participants were selected using purposive sampling based on eligibility criteria, then randomly assigned to two groups—an experimental group and a control group each consisting of 10 players. Randomization was carried out using the lottery method to ensure objectivity and group equivalence.

To evaluate the impact of the training, two instruments were used. The Six-Time Rapid Layup Test measured shooting accuracy and specific endurance, requiring players to perform six consecutive fast-paced layups. The Carlson Fatigue Curve Test was used to assess cardiovascular endurance and fatigue resistance through a series of running-in-place activities followed by pulse measurements. Prior to the training intervention, data on players' physical characteristics, including height, weight, age, and training background, were collected to ensure the homogeneity of the sample. Statistical analysis confirmed that no significant differences existed between the two groups at baseline.

The experimental group underwent a structured training program over a six-week period, consisting of 24 sessions conducted four times per week. Each session lasted between 90 and 120 minutes, with 30 to 35 minutes dedicated specifically to endurance-based activities using submaximal and high-intensity interval methods aimed at developing speed and strength endurance. Pre-tests were conducted on April 2, 2025, and post-tests on May 16, 2025, using identical procedures to maintain measurement consistency.

The validity of the instruments was ensured through expert review, while reliability was tested using the test-retest method with a seven-day interval, resulting in high correlation coefficients. Objectivity was maintained through standardized testing procedures and impartial administration by trained evaluators. Data were analyzed using SPSS version 22, applying descriptive statistics (mean, standard deviation, and skewness) and inferential statistics (paired and independent sample t-tests) to determine the significance of differences within and between groups at a 0.05 level of significance.

3. RESULTS AND DISCUSSION

The findings of this study revealed significant improvements in both physiological and skill performance among participants in the experimental group following the implementation of the proposed training program. In the Six-Time Rapid Layup Test, designed to assess specific endurance and shooting accuracy, the experimental group demonstrated a notable reduction in completion time from a pre-test mean of 50.79 seconds (±0.90) to a post-test mean of 45.5 seconds (±0.91). The calculated t-value of 18.78 exceeded the tabulated value at the 0.05 level of significance, confirming a statistically significant improvement in performance. In contrast, the control group showed a less substantial improvement, with pre- and post-test means of 50.71 seconds and 48.59 seconds respectively, and a calculated t-value of 10.25. Although the control group did improve, the gains were considerably smaller, suggesting that their regular training routine was less effective in enhancing specific endurance and shooting skills compared to the targeted training provided to the experimental group.

The results from the Carlson Fatigue Curve Test, which measured cardiovascular endurance and recovery efficiency, further supported the effectiveness of the proposed program. The experimental group's performance improved significantly, with a reduction in fatigue scores from a pre-test mean of 20.2 (±0.42) to a post-test mean of 9.8 (±0.41), and a t-value of 26.5, indicating high statistical significance. The control group also showed improvement—from 20.1 (±0.56) to 13 (±0.66)—but to a lesser extent, as reflected by a t-value of 12.6. These

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results suggest that the proposed training program led to superior adaptations in cardiovascular function, enhancing the players' ability to sustain high-intensity efforts and recover effectively.

The discussion of these findings highlights the role of structured, scientifically designed training programs in improving specific performance components in basketball. The significant improvements observed in the experimental group can be attributed to the use of varied, targeted endurance exercises within the training curriculum (Bellicha et al., 2021; Van Assen, 2021). According to (Gipit et al., 2017; Luo et al., 2022; Vealey, 2024) skill performance is intrinsically linked to physical and motor capabilities, and developing these capacities enhances the execution of complex skills such as rapid layups. The improvement in cardiovascular fitness is consistent with earlier findings by (Schroeder et al., 2019) who noted that repeated endurance training can lead to beneficial functional changes such as heart dilation, increased stroke volume, and reduced resting heart rate—all of which contribute to improved athletic performance (Bergeron et al., 2015).

Moreover, the structured application of progressive overload, combined with high-intensity interval training and attention to recovery, likely contributed to the development of both aerobic and anaerobic energy systems (Setiawan et al., 2024). This supports assertion that effective basketball training must address both the phosphagen and lactic acid systems to meet the physiological demands of the game. The results also validate the importance of integrating endurance-focused training into junior-level programs, especially for skills that require repeated efforts under fatigue.

In conclusion, the proposed training program significantly enhanced both cardiovascular efficiency and rapid shooting ability among junior basketball players. These outcomes underscore the need for basketball coaches to incorporate endurance development systematically into training sessions to improve performance and delay fatigue-related declines during competition.

In light of the study's findings, several practical recommendations can be proposed to enhance the training and development of junior basketball players. First, coaches and trainers are strongly encouraged to incorporate structured endurance training programs that target cardiovascular efficiency and physical resilience. Given the significant improvements observed in the experimental group, such training should be designed with progressive intensity and include both aerobic and anaerobic components tailored to basketball-specific movements.

Second, training programs should prioritize the development of special endurance, particularly in young athletes, as it directly influences their ability to perform high-intensity tasks repeatedly during competition without a decline in skill execution. This includes integrating exercises that simulate game conditions, such as repeated sprints, rapid transitions, and fatigue-based skill drills like the rapid layup

Third, coaches should apply scientifically grounded principles in designing training loads, taking into consideration players' age, developmental stage, and current fitness level. The use of high-intensity interval training (HIIT), in combination with recovery strategies, can optimize functional adaptations without increasing the risk of overtraining or injury.

Fourth, it is essential to monitor players' physiological responses to training using valid and reliable tests, such as the Carlson Fatigue Curve Test. Regular testing allows coaches to track progress, adjust training loads, and ensure that players are achieving the intended adaptations.

Finally, sports institutions and youth training centers should adopt and support training programs like the one proposed in this study, as it offers a practical and evidence-based model for improving both physiological and skill-related aspects of basketball performance. Investing in scientifically designed programs at the junior level can lead to the development of more competitive, physically prepared athletes capable of sustaining high performance throughout games. These results affirm the importance of integrating structured and scientifically designed endurance training into basketball programs, particularly at the junior level where foundational physical development is critical. The use of high-intensity interval training, progressive overload, and skill-specific conditioning was instrumental in achieving these improvements. Compared to the control group, whose performance gains were modest, the experimental group benefitted from a training model that addressed both the physical demands of the sport and the physiological adaptations necessary for sustained performance.

4. CONCLUSION

Based on the findings of this study, it can be concluded that the proposed training program had a

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significant and positive effect on both the physiological fitness of the cardiovascular system and the performance of quick shooting skills in junior basketball players. The experimental group, which followed the targeted endurance-based training regimen, showed statistically significant improvements in cardiovascular endurance, as evidenced by the results of the Carlson Fatigue Curve Test. Additionally, the same group demonstrated enhanced performance in rapid layup shooting, indicating that the program not only improved physiological capacity but also translated into better skill execution under conditions of fatigue. Therefore, it is recommended that basketball coaches prioritize the development of special endurance through evidence-based training approaches. Doing so not only enhances the physiological resilience of young athletes but also improves their technical execution during gameplay. The proposed program provides a practical and effective model that can be adapted and implemented widely to support long-term athlete development and performance sustainability in competitive basketball.

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