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The Effect of High Intensity Interval Training (HIIT) on Improving The Anaerobic Endurance of Basketball

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Abstract
Basketball performance depends on strong anaerobic endurance due to repeated high-intensity movements such as sprinting, jumping, and rapid directional changes. High-Intensity Interval Training (HIIT) is widely recognized as an effective method to improve anaerobic capacity because it reflects the intermittent demands of basketball and enhances metabolic efficiency. This study aimed to examine the effect of HIIT on the anaerobic endurance of basketball players at the Halilintar Bukittinggi Club. This experimental study used a one-group pre-test and post-test design. The participants were 12 basketball players aged 15–18 years selected through purposive sampling. The intervention consisted of a 6-week HIIT program conducted three times per week. Anaerobic endurance was measured using the Running-Based Anaerobic Sprint Test (RAST), with fatigue index as the main indicator. Data were analyzed using a paired sample t-test. The results showed a notable improvement in anaerobic endurance. The average fatigue index decreased from 10.11 to 6.07, indicating an improvement with Cohen's d was 0.90. Since a lower fatigue index reflects better anaerobic endurance, this result demonstrates a meaningful performance enhancement. Statistical analysis confirmed a significant effect ($t = 8.24$; $p < 0.05$). In conclusion, HIIT is an effective training method for improving anaerobic endurance in young basketball players.

Keywords: anaerobic endurance; basketball performance; high intensity interval training (HIIT); RAST

1. Introduction

Basketball is a high-intensity intermittent sport characterized by repeated bouts of sprinting, jumping, rapid directional changes, and short recovery periods (Gottlieb et al., 2021). These movement patterns place substantial demands on both aerobic and anaerobic energy systems, with a dominant contribution from anaerobic metabolism during decisive game moments. Players are required to repeatedly perform maximal or near-maximal efforts, making physiological readiness—particularly the ability to sustain high-intensity actions—critical for optimal performance (Bompa and Buzzichelli, 2019) Consequently, physical conditioning in basketball must be specifically designed to reflect these game demands.

Anaerobic endurance, often operationalized through repeated sprint ability (RSA), is a key determinant of basketball performance. It refers to the capacity to sustain repeated high-intensity efforts with minimal performance decrement (Figueira et al., 2021). Recent studies highlight that elite basketball players demonstrate superior RSA and fatigue resistance, which are strongly associated with match performance indicators such as sprint frequency, defensive transitions, and offensive execution

(Girard, Mendez-Villanueva, and Bishop, 2018). Furthermore, contemporary research emphasizes that the fatigue index derived from tests such as the Running-Based Anaerobic Sprint Test (RAST) provides a valid indicator of anaerobic endurance, where lower values indicate better performance. Athletes with poor anaerobic endurance experience rapid declines in both physical output and decision-making under fatigue conditions.

High-Intensity Interval Training (HIIT) has emerged as an effective and time-efficient method to improve both anaerobic and aerobic performance in intermittent sports. HIIT typically involves repeated bouts of exercise performed at intensities above 85–90% of maximal capacity interspersed with recovery periods. Recent evidence demonstrates that HIIT significantly enhances glycolytic capacity, neuromuscular function, and repeated sprint performance in team-sport athletes (Ziemann et al., 2011; Franchini et al., 2020). In basketball-specific contexts, HIIT has been shown to improve sprint performance, fatigue resistance, and overall match readiness, making it particularly relevant for youth player development.

Despite the growing body of international literature, there remains a lack of empirical evidence examining HIIT-based conditioning in Indonesian youth basketball players. Differences in training culture, resource availability, coaching approaches, and athlete development systems may influence the effectiveness of conditioning programs. Observations at the Halilintar Bukittinggi Club indicate that players often experience decreased stamina in the final stages of games, suggesting insufficient anaerobic endurance and suboptimal training strategies. However, localized, sport-specific data to guide evidence-based interventions are still limited.

Therefore, this study aims to investigate the effect of High-Intensity Interval Training (HIIT) on the anaerobic endurance of youth basketball players at the Halilintar Bukittinggi Club. It is hypothesized that a structured HIIT program will significantly improve anaerobic endurance, as indicated by a reduction in fatigue index scores from pre-test to post-test. The findings are expected to provide practical and scientific contributions to the development of effective conditioning programs for youth basketball athletes in Indonesia.

2. Method

This study uses a quantitative approach with a pre-test and post-test design of a quasi-experimental group. Participants consisted of 12 male basketball players aged 15–18 years old from the Bukittinggi Halilintar Club, who were selected using targeted sampling based on active participation in regular training and physical readiness. This research was conducted on the basketball court of Halilintar Bukittinggi. Anaerobic endurance was measured using the Running-Based Anaerobic Sprint Test (RAST), which assesses the fatigue index as an indicator of anaerobic performance. Pre-test measurements were conducted prior to the intervention, and post-test measurements were conducted after completion of the training program. The intervention consisted of a structured High-Intensity Interval Training (HIIT) program conducted over 6 weeks with a frequency of 3 sessions per week (a total of 18 sessions). Each session lasts about 30–40 minutes, including warm-ups and cool-downs. The main HIIT protocol is performed at an intensity of about 85–95% of the maximum effort.

The training program includes bodyweight exercises and sprint-based exercises such as push-ups, high knees, mountain climbers, burpees, planks, jumping jacks, and the 20-meter sprint. Each session consists of 3–4 sets, with 6–8 exercises per set. Each exercise is done for 20–30 seconds, followed by 20–30 seconds of active recovery. Between sets, participants were given a 2–3 minute break. The progressive load principle is applied throughout the intervention. The volume and intensity of the exercise are gradually increased by adding reps, reducing rest intervals, and increasing the speed or complexity of movement from week to week.

Data analysis was performed using the Liliefors test to assess normality, followed by a paired sample t-test to determine differences between pretest and posttest results at a significance level of 0.05. In addition to statistical significance testing, the magnitude of the intervention effect was evaluated using Cohen's d effect size for paired samples. Effect size interpretation followed conventional criteria: small (d = 0.20), medium (d = 0.50), and large (d ≥ 0.80). This analysis was included to provide a more comprehensive understanding of the practical significance of the HIIT intervention beyond p-values.

3. Result

Tables 1 and 2 present the results of the anaerobic endurance pretest and posttest measured by the RAST fatigue index, where lower values indicate better anaerobic performance. In the pretest (Table 1), the mean fatigue index was 10.11 (SD = 5.05), indicating anaerobic endurance that was generally low among the players. Scores range widely from 3.28 to 18.12, reflecting substantial variability in initial fitness levels. Descriptively, more than half of the participants were categorized as "poor," indicating that most players experienced considerable fatigue during repeated sprint attempts.

Table 1. Pretest result of anaerobic endurance

Number	Fatigue Index (watts/second)	Description
1	16.62	Poor
2	13.41	Poor
3	4.10	Good
4	5.89	Good
5	14.68	Poor
6	18.12	Poor
7	12.65	Poor
8	3.28	Good
9	8.43	Good
10	5.16	Good
11	7.61	Good
12	11.38	Poor
Average		10.11
SD		5.05
Minimum		3.28
Maximum		18.12

After a 6-week HIIT intervention, the posttest results (Table 2) showed a clear improvement in anaerobic endurance. The mean fatigue index decreased to 6.07 (SD = 4.13), representing a significant reduction in fatigue and an increase in the ability to maintain high-intensity activity. The range also shifted downwards (1.81–13.87), indicating an overall improvement in performance among the participants. It is worth noting that the majority of players are reclassified into the "good" category, with only a small number remaining in the "bad" classification.

Table 2. Posttest result of anaerobic endurance

Number	Fatigue Index (watts/second)	Description
1	13.87	Poor
2	7.31	Good

Number	Fatigue Index (watts/second)	Description
3	3.14	Good
4	4.90	Good
5	6.68	Good
6	3.34	Good
7	11.76	Poor
8	1.99	Good
9	1.81	Good
10	3.14	Good
11	3.79	Good
12	11.22	Poor
Average		6.07
SD		4.13
Minimum		1.81
Maximum		13.87

Table 3. The comparation of anaerobic endurance before and after high-intensity interval training

Variable		Mean	SD	p-value
HIIT Training	Pretest	10.11	5.05	0.015
	Posttest	6.07	4.13	

Table 3 presents a comparative analysis of anaerobic endurance before and after HIIT interventions. The average fatigue index decreased from 10.11 (SD = 5.05) on the pretest to 6.07 (SD = 4.13) on the posttest. Since a lower fatigue index reflects better anaerobic endurance, this decrease indicates a clear improvement in the player's ability to sustain repetitive high-intensity efforts. Statistically, a p value of 0.015 ($p < 0.05$) confirms that the difference between pretest and posttest results is significant. This suggests that the observed increase is most likely not due to chance and can be attributed to HIIT interventions. In addition, a decrease in standard deviation showed a slight improvement in consistency among participants after training.

In summary, the findings suggest that HIIT has a significant and positive effect on improving anaerobic endurance in the samples, supporting its effectiveness as a conditioning method for basketball players.

Table 4. Effect size (cohen's d) of HIIT on anaerobic endurance

Variable	Pretest Mean □ SD	Posttest Mean □ SD	Mean Difference	Cohen's d	Effect Size Interpretation
Fatigue index (RAST)	10.11 ± 5.05	10.11 ± 5.05	4.04	0.90	Large effect

The calculated Cohen's d value of 0.90 indicates a large effect size, suggesting that the HIIT intervention had a substantial practical impact on improving anaerobic endurance. This means that the observed reduction in fatigue index is not only statistically significant but also meaningful in real-world performance. According to conventional benchmarks ($d \geq 0.80$), this magnitude of effect reflects a strong training adaptation and supports the effectiveness of HIIT as a conditioning strategy for basketball players.

4. Discussion

This study showed that a 6-week High Intensity Interval Training (HIIT) program significantly improved anaerobic endurance in young basketball players, as shown by a marked decrease in the RAST fatigue index. Before the intervention, only some athletes showed adequate endurance, while others were categorized as having poor anaerobic capacity. This imbalance of physical readiness creates challenges for team performance, especially during the final stages of the game. Once a structured HIIT program is structured, most players show a marked improvement, showing that a systematic and athlete-friendly training design can effectively overcome the endurance deficit in a relatively short period of time.

From a physiological point of view, the increase in anaerobic endurance can be explained by adaptations to the phosphageic and glycolytic energy systems, which are essential for repetitive high-intensity efforts in basketball (Gottlieb et al., 2021). Endurance plays a crucial role in maintaining performance, facilitating recovery between efforts, and delaying fatigue (Hung et al., 2025). As noted by Susila (2021), optimal physical conditioning—especially anaerobic endurance—is fundamental to achieving peak athletic performance, while inadequate endurance leads to decreased tactical execution and increased fatigue-related errors.). The decrease in fatigue index observed in this study reflects increased metabolic efficiency and increased tolerance to high-intensity workloads.

The effectiveness of HIIT observed in this study is consistent with its theoretical foundation as a training method that involves short bursts of intensive training interspersed with recovery periods. Nugraha and Berawi (2017) describe HIIT as a time-efficient approach that maximizes training stimulus through high-intensity efforts with controlled recovery intervals. The variety of exercises used—such as sprints, burpees, and plyometric movements—involves multiple muscle groups, contributing to comprehensive physical development. Supporting this, Helgerud et al. (2007) show that HIIT can produce significant improvements in aerobic and anaerobic performance even with reduced training volumes.

In addition to improving endurance, HIIT has been shown to improve several components of physical fitness. Wibowo (2019) reported significant improvements in cardiovascular agility, speed, and endurance among adolescent athletes after HIIT interventions. Similarly, Arifuddin (2016) found that HIIT improves cardiovascular efficiency through increased oxygen delivery and respiratory muscle function. This multidimensional adaptation is particularly relevant in basketball, where performance depends on a combination of speed, power, and endurance.

The findings of this study are further supported by research showing that HIIT improves explosive strength, agility, and coordination. Fajrin and Kusmanik (2017) show that HIIT significantly improves performance variables related to speed and strength. Additionally, HIIT has been shown to increase anaerobic thresholds, allowing athletes to maintain high-intensity activity for longer durations without rapid fatigue. Adiatmika (2017), emphasizes that increasing lactate buffer capacity through HIIT allows for better performance during repetitive high-intensity efforts.

At the elite level, empirical evidence strongly supports the application of HIIT in basketball and other intermittent sports. A study found that an 8-week HIIT program significantly improved VO_2max, sprint performance, and muscle endurance in basketball players (Shamim, 2021). Similarly, Suarez-Arrones et al. (2014), reported an improvement in repetitive sprint ability and vertical jump performance after basketball-specific HIIT training. A recent meta-analysis further confirmed that HIIT resulted in significant improvements in cardiovascular fitness, muscle strength, and exercise-specific performance across a wide range of populations (Stankovic et al., 2023).

Despite these positive results, it is important to recognize variability between individuals in training responses. In this study, a small number of participants remained in the "poor" category after the intervention, suggesting that not all athletes responded to HIIT equally. This is consistent with the findings of Montero and Lundby (2017), which highlight the role of genetic and environmental factors in influencing training adaptation. Similarly, Mann et al (2014) emphasize the need for an individualized training approach due to variability in physiological responses.

Methodologically, the quasi-experimental design of the study without a control group and a relatively small sample size limits the generalization of the findings. Further research should use randomized controlled trials with a larger sample and include additional performance indicators such as game statistics, sprint times, and psychological variables. Nonetheless, the consistent improvement observed among the participants provides strong preliminary evidence supporting the effectiveness of HIIT in this context.

In conclusion, the integration of HIIT into basketball training programs offers a scientifically and practically supported approach to improving anaerobic endurance and overall performance. The structured, varied, and engaging nature of HIIT not only enhances physiological adaptation but also encourages athlete motivation and compliance. Therefore, HIIT can be recommended as a core component of conditioning programs for young basketball players, particularly in addressing performance limitations related to endurance.

5. Conclusion and Recommendation

In conclusion, the findings of this study demonstrate that a structured 6-week High-Intensity Interval Training (HIIT) program significantly improves anaerobic endurance in youth basketball players, as evidenced by the reduction in RAST fatigue index scores. This indicates enhanced ability to sustain repeated high-intensity efforts, which is essential for optimal basketball performance. The results confirm that HIIT is an effective, time-efficient, and practical conditioning method for developing sport-specific fitness in adolescent athletes. Based on these findings, it is recommended that coaches and practitioners incorporate HIIT into regular basketball training programs with appropriate planning, progressive overload, and individualized monitoring to maximize outcomes. Future research should employ larger sample sizes, control groups, and additional performance indicators to strengthen the evidence base and further explore the long-term effects of HIIT in different athletic populations.

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Conflict of interest

The authors declare that there are no conflicts of interest related to this study.

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