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EFFECTS OF TRAINING FREQUENCIES ON MUSCULAR FITNESS AMONG AMATEUR TRACK EVENT ATHLETES IN A NIGERIAN UNIVERSITY

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Abstract

This study investigated the effects of different training frequencies on muscular strength and endurance among track event athletes at Adekunle Ajasin University (AAUA), Akungba-Akoko, Nigeria. A quasi-experimental design was employed with 24 participants (19 males, 5 females) randomly assigned to one of three groups: a control group, a three training sessions per week group, and a five training sessions per week group. Over an 8-week period, participants engaged in resistance training for strength and high-intensity interval training (HIIT) for endurance. Pretest and posttest measurements of muscular strength (via the push-up test) and endurance (via the Running-Based Anaerobic Sprint Test) were collected. Data were analyzed using Analysis of Covariance (ANCOVA), with pretest scores as a covariate. The results revealed a significant improvement in muscular strength for both experimental groups compared to the control group. Specifically, the five sessions per week group showed the greatest strength gains ($F(2, 20) = 12.869$, $p = <0.001$, $\eta^2 = 0.563$). However, there was no significant difference in muscular endurance between the groups ($F(2, 20) = 0.001$, $p = 0.974$, $\eta^2 = 0.000$), suggesting that while training frequency had a strong impact on strength, it did not significantly affect endurance within the 8-week period. The study concludes that training three to five times per week can lead to notable strength gains, with higher frequencies yielding the best results. However, endurance improvements may require longer interventions. Future research should consider longer training durations (e.g., 12–16 weeks) and explore mixed training modalities, combining both aerobic conditioning and resistance training, to optimize both strength and endurance outcomes in athletes.

Keywords: Training frequency, Muscular strength, Endurance, Track events, Athletes.

Introduction

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Athletic performance remains a central focus for sports scientists, trainers, athletes, psychologists, and fitness enthusiasts, with various factors influencing an athlete's progress. One of the most critical determinants of improved performance is training frequency. The belief that the frequency of an athlete's training is directly related to their physical development is well-established. Training irregularities or infrequent training sessions can diminish performance, while appropriate rest periods between training days foster the body's adaptation and growth (Haff, 2015). Crafting an effective resistance training (RT) program involves a balance of key components, including sets, repetitions, and recovery times, all of which profoundly influence the outcome of the training (Gentil et al., 2017a). Recently, training frequency has gained increasing attention, with some researchers asserting that it is one of the most effective variables in enhancing RT programs (Dankel et al., 2017). This importance is amplified by the fact that time constraints often limit the ability of athletes to follow consistent training routines (Trost et al., 2002).

One potential solution to overcome time limitations is to reduce the number of training days, while still maintaining the total training volume. This approach can save time while ensuring continued progress. However, while more frequent training may lead to sustained adaptation, it may not work for everyone. Research shows that even training just once a week can result in strength and muscle gains in untrained individuals (Gentil et al., 2015), although the effects on trained athletes are still under investigation. According to the American College of Sports Medicine (ACSM, 2009), experienced athletes should train four to five times a week to maximize strength and muscle growth. However, it remains ambiguous whether this recommendation pertains to the number of times each muscle group should be trained, or simply the total number of sessions. Studies have shown that training a muscle group multiple times per week could yield greater benefits for trained athletes, as highlighted by Schoenfeld et al. (2016) and Grgic et al. (2018).

In the context of Adekunle Ajasin University, Akungba-Akoko (AAUA), student-athletes engage in various competitions, including local, national, and international events. Despite the university's strong athletic support, track event athletes have struggled to meet expectations in major competitions such as the Nigerian University Games Association (NUGA). This performance gap has raised concerns, with one likely contributing factor being the training frequency. Research by Esho (2012) at the University of Ibadan identified inconsistent training, poor training modalities, and late preparation as key reasons for underperformance among athletes. Although the influence of training frequency on performance is well-documented, its specific effects on muscle strength, endurance, and power among AAUA track athletes remain unclear. It is possible that the current training schedule does not sufficiently meet the needs of these athletes, leading to suboptimal performance outcomes.

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This study, therefore, aims to investigate how different training frequencies, specifically three versus five training sessions per week affect muscular strength and endurance in AAUA's track athletes, with the goal of improving their performance in intercollegiate competitions. Despite the limited local studies focusing on the Nigerian context, there is a critical need to understand how varying training frequencies might influence athletic performance in this region. Research in similar contexts can provide valuable insights into addressing performance gaps at AAUA.

The decision to compare three and five training sessions per week is based on several critical factors. First, the ACSM guidelines (2009) recommend that experienced individuals train at least four to five times a week for optimal strength and muscle growth. This recommendation informed the selection of the five sessions per week frequency for the study. Secondly, previous studies, including those by Grgic et al. (2018) and Schoenfeld (2015), have shown that training three times per week can still result in significant muscular strength and endurance gains. Therefore, three sessions per week was chosen as a valid frequency for comparison in this study.

Additionally, practical considerations for the AAUA athletes were taken into account. While five training sessions per week may result in optimal strength development, three sessions per week is often a more feasible option for athletes who have time constraints or face difficulties adhering to a more demanding training schedule. For AAUA athletes, who also have academic responsibilities, three sessions per week offer a more sustainable approach to maintaining regular training. Thus, both frequencies were selected to explore their effects on athletic performance while considering the realities of the athletes' schedules.

Furthermore, studies support the idea that training frequency can significantly impact athletic performance. Ogunleye (2016) found that consistent training at a higher frequency yielded better results in terms of strength and endurance among Nigerian athletes, while Akinwale (2018) emphasized the need for well-structured training schedules to optimize performance in track athletes. Similarly, Ojo (2017) in his study of university athletes highlighted the need for a structured approach to training frequency to prevent overtraining or undertraining. This study seeks to build on these findings, applying them specifically to the context of AAUA's track athletes.

In conclusion, the present study will assess the effects of three and five training sessions per week on muscle strength and endurance, based on established guidelines and research. By examining the relationship between training frequency and athletic performance, this study aims to provide valuable recommendations for improving training practices at AAUA and other Nigerian universities.

Conceptual Model or Framework

The conceptual framework for this study in **Figure 1** illustrates the expected relationship between training frequency, strength, and endurance outcomes:

i. Training Frequency (Independent Variable): The number of training sessions per week (three vs. five).
ii. Muscular Strength (Dependent Variable 1): Assessed through the Push-up Test, reflecting upper body strength improvements.
iii. Muscular Endurance (Dependent Variable 2): Measured using the Running-Based Anaerobic Sprint Test (RAST), indicating endurance progress.

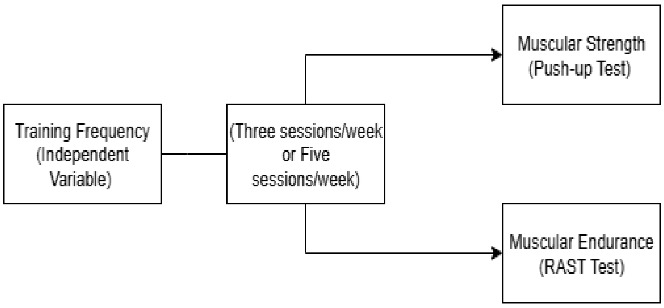

Figure 1: Conceptual framework

The model hypothesizes that higher training frequency (five sessions per week) will lead to greater improvements in both muscular strength and endurance, while lower frequency (three sessions per week) will result in moderate improvements. However, it is also anticipated that training frequency may have a more pronounced effect on strength than on endurance, as suggested by the findings of Schoenfeld et al. (2016) and Hunter (2013).

Objectives of the study

The primary objective of this study is to investigate the impact of training frequencies on the muscular strength and endurance of track event athletes at Adekunle Ajasin University, Akungba-Akoko. Therefore, the specific objectives of this study are to;

1. To determine the effect of 3 vs 5 training sessions/week on muscular strength and endurance among AAUA track athletes.
2. To compare pretest and posttest measurements of muscular strength and endurance after 8 weeks of training with 3 and 5 sessions per week.

Research Hypotheses

The study tested the following hypotheses.

1. There is no significant difference in the pretest and posttest scores of muscular strength after 8 weeks of training with 3 vs 5 sessions per week.
   H0:μ3= μ5H
   H1:μ3$\neq$ μ5H
2. There is no significant difference in the pretest and posttest scores of muscular endurance after 8 weeks of training with 3 vs 5 sessions per week.
   H0:μ3= μ5H

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H1:µ3≠ µ5H

Methodology

This study employed a control group and a pretest-posttest design, utilizing a quasi-experimental research approach. Quasi-experimental studies evaluate the association between an intervention and an outcome using experiments in which the intervention is not randomly assigned (Schweizer et al., 2016). This method is suitable for this study because the researcher does not have absolute control over the participants. The track event athletes who participated were divided into three groups: two experimental groups and one control group. The two experimental groups consist of three athletes with a training frequency of three times per week, five athletes with a training frequency of three times per week, and a control group. All three groups received pretests; experimental groups received treatment after the first week; and measures and posttests were conducted at the eighth week of the experimental period for all three groups, as shown below;

Groups	Pre-test	Treatment M T W TH F S S	Posttest in the fourth week	Posttest at the eighth week
Group 1	√	X X X X X X X	√	√
Group 2	√	√ X √ X √ X X	√	√
Group 3	√	√ √ X √ √ √ X	√	√

Group 1: participants in this group were the control group; they were not administered any training

Group 2: participants in this group were athletes for three (3) training sessions per week.

Group 3: participants in this group were track athletes for five (5) training sessions per week

The population for this study consisted of all track event athletes at Adekunle Ajasin University (AAUA)**,** Ondo State, with 68 registered athletes from various faculties. A total of 24 participants (19 males and 5 females) were randomly selected using a simple random sampling method without replacement. These participants were then divided into three groups, each consisting of 8 individuals**:** a control group, a group training three times per week, and a group training five times per week.

The sample size was determined through power analysis**,** ensuring the study had sufficient power to detect significant differences between the groups. A medium effect size (Cohen's d = 0.5) was assumed, based on similar studies examining muscular strength and endurance (Schoenfeld, 2015; Grgic et al., 2018). The significance level (α) was set at 0.05**,** and the desired power was set at 0.80, meaning there was an 80% chance of detecting a true effect. Based on these parameters, the power analysis indicated that 8 participants per group would be adequate to detect meaningful differences in strength and endurance, without requiring an impractically large sample size.

Thus, the selected sample size of 24 participants ensures sufficient statistical power for reliable results while remaining feasible given the available resources at AAUA. This balance between statistical rigor and practicality makes the chosen sample size appropriate for the study's objectives.

Instrumentation

Muscular Strength: Push-up test (One minute)

Men executed the typical "military style" pushup, commencing with only their hands and toes touching the ground. With their hands on either side of their chests and their knees on the floor, women executed the "bent knee" push-up. Participants were instructed to maintain a straight back in order to accomplish this. To return to the starting posture, extend your arms after lowering your chest toward the floor, keeping your elbows at a 90-degree angle. The participants completed as many push-ups as they could in a minute while performing continuous push-up actions. We counted and recorded the number of push-ups completed successfully in a minute.

Endurance: Running-Based Anaerobic Sprint Test (RAST).

Before the test, the participants were weighed for computation purposes, and then they warmed up. A 35-meter running track has cones placed at either end. Since one person timed each 35-meter run and the other timed the 10-second recuperation interval, two testers were needed. At the word "go," the competitors began a maximal sprint from their starting position at one end of the 35-meter track. Every time, it was made sure that the players ran as fast as they could through the line. The next sprint began from the other end of the 35-meter track ten seconds later. This process was repeated until six sprints were finished and recorded.

Training Procedure.

An effective way to improve local muscular endurance, strength, and power is through resistance training. Nonetheless, prescription patterns should be connected to the participant's objectives and specific needs (American College of Sports Medicine, 2011).

Data Analysis

The mean, standard deviation, frequency counts, percentage, and Analysis of Covariance (ANCOVA) statistics were used for data analyses, and the two null hypotheses were tested at the 0.05 level of significance

Results

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Table 1: Frequency Distribution of the participants by gender, age, and height

	Frequency	Percentage
Male	19	79.2
Female	5	20.8
Total	**24**	**100.0%**
Age group	**Frequency**	**Percentage**
17 to 18 years	9	37.5
19 to 20 years	10	41.7
21 to 22 years	5	20.8
Total	**24**	**100.0%**
Height group	**Frequency**	**Percentage**
1.49 to 1.60m	4	16.7
1.62 to 1.69m	11	45.8
1.70 to 1.77m	9	37.5
Total	**24**	**100.0%**

Table 1 shows the frequency distribution by participant age range, as well as the distribution of male and female participants, with 19 (79.2%) males and 5 (20.8%) females, respectively. Nine (37.5%) of the total respondents were between the ages of 17 and 18, ten (41.7%) were between the ages of 19 and 20, and five (20.8%) were between the ages of 21 and 22, respectively. This suggested that the majority of participants were between the ages of 19 and 20. It also showed the frequency distribution by participant height range. The findings indicated that 4 (16.7%) of the participants had a height range of 1.49 to 1.60 meters, 11 (45.7%) had a height range of 1.62 to 1.69 meters, and 9 (37.5%) had a height range of 1.70 to 1.77 meters. According to this, the majority of responders are between 1.62 and 1.69 meters tall.

Hypotheses Testing

Hypothesis One: There is no significant difference in the pretest and posttest scores (measurements) of muscular strength of the athletes exposed to eight (8) weeks of three (3) training frequency and five (5) training frequency.

Table 2:

ANCOVA: Effect of training frequency on muscular strength after 8 weeks of three (3) training frequency, five (5) training frequency, and control group on Pre and Post Test

Source	Type III Sum of Squares	df	Mean Square	F	p-value	η^2
Pre-Test	2599.092	1	2599.092	75.799	0.000*	.791
Treatment	238.923	1	238.923	6.968	0.016*	.258
Model	882.515	2	441.257	12.869	0.000*	.563
Residual	3212.176	20	1070.725			
Total	72485.000	24				

$p < 0.05$ denotes statistical significance. η^2 = Partial Eta Squared, indicating the effect size of the treatment.

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The results presented in Table 2 showed that the ANCOVA table assesses the effect of different training frequencies on muscular strength after 8 weeks, adjusting for pretest scores. The dependent variable in this analysis is the post-test muscular strength, which is adjusted for baseline strength (pre-test scores). The intercept represents the baseline muscular strength, unaffected by the training frequencies, providing a reference point for comparison.

The treatment effect evaluates how different training frequencies (three sessions per week, five sessions per week, and the control group) influence muscular strength. The significant result for the treatment effect **(**$F(2, 20) = 12.87$, $p = <0.001$**)** indicates that training frequency has a meaningful impact on muscular strength. This suggests that participants who trained more frequently (either three or five times a week) showed greater improvements in strength compared to the control group.

The residual error represents the unexplained variance in the post-test strength scores after accounting for the treatment effect, which is crucial for determining how much variation remains unexplained by the training intervention.

In terms of effect size, the partial eta-squared (η^2) for the treatment effect is 0.563, indicating that training frequency accounts for 56.3% of the variance in muscular strength post-test scores. This demonstrates a moderate to large effect, indicating that the frequency of training has a significant influence on strength outcomes.

Finally, the covariate (pre-test scores) is significant **(**$p = <0.001$**)**, highlighting that baseline muscular strength plays a critical role in predicting post-test outcomes. This reinforces the importance of accounting for initial strength levels when evaluating the effect of the intervention.

Table 3: Estimated Marginal Mean for the Treatment and Control Groups

Treatment Group	Mean	Standard Error	95% Confidence Interval
5 Days per Week of Training	60.97	2.075	[56.642, 65.299]
3 Days per Week of Training	53.36	2.070	[49.042, 57.680]
Control Group (CG)	46.04	2.076	[41.713, 50.374]

Table 3 presents the estimated marginal means for the three groups: 5 days per week of training, 3 days per week of training, and the Control Group (CG). It includes the mean scores for each group, the standard errors, and the 95% confidence intervals. Five days per week of training: This group had a mean score of 60.97, with a standard error of 2.075. The 95% confidence interval for this group ranges from 56.642 to 65.299, indicating that we are 95% confident the true mean score for this group lies within this interval. Three days per week of training: The group training 3 times per week had a mean score of 53.36, with a standard error of 2.070. The 95% confidence interval for this group spans from 49.042 to 57.680, suggesting that the true mean score for this

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group is likely to fall within this range. Control Group (CG): The control group, which did not engage in any training, had a mean score of 46.04, with a standard error of 2.076. The 95% confidence interval for this group ranges from 41.713 to 50.374, indicating the range within which the true mean score is likely to lie.

Table 3 shows that the group training 5 days per week had the highest mean score, followed by the group training 3 days per week, with the control group having the lowest mean score. The confidence intervals provide additional assurance that these differences are statistically significant, with the true mean scores for each group lying within the specified ranges.

Table 4

ANCOVA: Summary of effects of training frequency on endurance after 8 weeks of three (3) training frequencies, five (5) training frequencies, and control group on Pre and Post Tests

Source	Type III Sum of Squares	df	Mean Square	F	p-value	η^2
Pretest (Covariate)	4.127	1	4.127	33.848	0.000*	.629
Main Effect (Intercept)	0.000	1	0.000	0.000	0.974	.000
Treatment	3.832	2	1.916	15.713	0.000*	.611
Model	6.357	3	2.119	17.378	0.000*	.723
Residual (Error)	798.735	20	39.937			
Total	824.307	24				

$p < 0.05$ denotes statistical significance. η^2 = Partial Eta Squared, indicating the effect size of the treatment.

The ANCOVA table examines the effects of different training frequencies on muscular endurance after 8 weeks of training, adjusting for pretest scores. The dependent variable is the posttest endurance score, which reflects the participants' endurance levels after the 8-week intervention.

The main effect (intercept) represents the baseline endurance, which is not influenced by the training groups. It serves as a reference point for comparing the effects of the treatment. The treatment effect assesses how the different training frequencies (three sessions per week, five sessions per week, and the control group) affect muscular endurance. The significant treatment effect **(**$F(2, 20) = 15.713$, $p = <0.001$) indicates that the frequency of training has a meaningful impact on endurance, with differences observed between the groups. The partial eta-squared (η^2) value for the treatment effect is 0.611, suggesting that training frequency accounts for 61.1% of the variance in posttest endurance scores. This indicates a large effect, emphasizing the importance of training frequency in enhancing endurance.

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The pretest score was also found to be a significant predictor of posttest endurance **(**$F(1, 20) = 33.848$, $p = <0.001$**).** This finding confirms that baseline endurance plays a crucial role in determining the extent to which participants improve over the 8-week training period. Finally, the residual error represents the unexplained variance after accounting for the treatment and pretest effects, indicating the presence of other factors that may contribute to differences in endurance outcomes.

In conclusion, the analysis reveals that training frequency has a significant effect on muscular endurance, with a large effect size. Additionally, baseline endurance (pretest scores) plays a critical role in shaping post-test endurance outcomes.

Table 5:

Marginal Mean for the Treatment and Control Groups

Treatment and Control Groups	Mean	Standard Error	95% Confidence Interval
5 Days per Week Training	5.315	0.124	[5.056, 5.573]
3 Days per Week Training	5.597	0.125	[5.336, 5.858]
Control Group (CG)	4.300	0.122	[4.035, 4.565]

*The **mean** represents the estimated score for each group. The **95% confidence interval** indicates the range within which the true mean score is likely to fall with 95% confidence.*

Table 5 presents the estimated marginal means for three groups: 5 days per week training, 3 days per week training, and the Control Group (CG). It includes the mean score for each group, the standard error of the mean, and the 95% confidence intervals.

5 days per week training: This group has a mean score of 5.315 with a standard error of 0.124. The 95% confidence interval ranges from 5.056 to 5.573, indicating that we are 95% confident that the true mean score for this group lies within this interval. 3 days per week training: The group training 3 days per week has a mean score of 5.597 with a standard error of 0.125. The 95% confidence interval spans from 5.336 to 5.858, suggesting that the true mean score for this group falls within this range. Control Group (CG): The control group (no training) has a mean score of 4.300 with a standard error of 0.122. The 95% confidence interval for this group ranges from 4.035 to 4.565, indicating that the true mean score for the control group is likely to lie within this interval.

Discussion of findings

This study, conducted among AAUA track event athletes, aligns with previous research on the impact of training frequency on muscular strength but offers unique insights into muscular endurance outcomes. The study shows that both three and five training sessions per week positively impacted strength, but the differences in endurance were not as pronounced, suggesting the need for a deeper understanding of endurance adaptations.

Muscular Strength and Training Frequency

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Our findings support those of Schoenfeld (2015) and Grgic et al. (2018), who observed that higher training frequencies lead to greater strength gains due to increased volume and stimulus. This is especially relevant for AAUA athletes, who may require more frequent training to meet the physical demands of competitive track events. However, these results diverge from Gentil et al. (2017a), who found that strength improvements can occur with as few as two sessions per week, likely due to the more advanced experience of AAUA athletes in our study.

Muscular Endurance and Training Frequency

While both training frequencies improved muscular endurance over the control group, the differences between the three-day and five-day groups were not statistically significant. This contrasts with Hunter (2013), who demonstrated that more frequent training led to noticeable endurance gains. The lack of significant differences may be due to the 8-week intervention period, which might not have been sufficient to fully capture endurance adaptations. This is consistent with findings by Schoenfeld (2015) and Hoffman et al. (2007), who suggested that endurance adaptations take longer to manifest compared to strength.

Physiological Adaptation Timelines

The results of this study align with Grgic et al. (2018), indicating that while strength can improve within 6–8 weeks, endurance adaptations generally require longer training durations. Haff (2015) emphasized that endurance gains are more gradual, and our 8-week intervention was likely too short to observe optimal endurance improvements. These findings suggest that AAUA athletes would benefit from a more integrated training program combining strength and endurance training over a longer period to optimize performance in both explosive and sustained events.

The study's small sample size (8 participants per group) limits its statistical power and generalizability. Additionally, the 8-week duration may not have been long enough to fully capture endurance adaptations. Future research should extend the intervention period to 12–16 weeks and incorporate larger, more diverse samples to improve the external validity of the findings. Future studies should explore longer interventions to capture complete endurance adaptations and consider mixed training modalities combining resistance training with aerobic conditioning or HIIT. Examining biochemical markers, such as mitochondrial activity, could also offer deeper insights into the physiological changes driving endurance improvements. For AAUA athletes, developing well-rounded training programs that balance strength and endurance would better prepare them for intercollegiate competitions like the Nigerian University Games Association (NUGA), where both strength and endurance are critical,

Conclusion

Based on the findings of this study, it was concluded that;

1. Muscular strength was significant after 8 weeks of three (3) training frequency and five (5) training frequency among track and field athletes of A.A.U.A.

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2. Muscular endurance was not significant after 8 weeks of three (3) training frequency and five (5) training frequency among track events athletes of A.A.U.A.

Recommendations

Based on the findings of this study, the following actionable recommendations are offered for AAUA track athletes to optimize their training for both muscular strength and endurance

1. To maximize muscular strength gains, training five times per week is the most effective frequency, as this group showed the greatest improvements. This aligns with Schoenfeld (2015) and Grgic et al. (2018). For athletes unable to train five days a week with three sessions per day, a focus on progressive overload can still yield noticeable strength gains.
2. Since endurance improvements were less pronounced, a 12–16 week training program is recommended to allow for sufficient physiological adaptations. HIIT or aerobic-based training combined with resistance exercises can enhance endurance, as supported by Schoenfeld (2015).
3. Training sessions should last 60–90 minutes, including both strength and endurance components. For strength, aim for 3–5 sets of 8–12 reps at 70–85% of 1RM. For endurance, incorporate moderate to high-intensity intervals, such as 30 seconds of maximal effort followed by 1–2 minutes of rest. Combining steady-state runs (45–60 minutes) and short, intense intervals can further improve both aerobic and anaerobic endurance.
4. Athletes should prioritize at least one rest day between strength sessions for optimal recovery. For endurance, active recovery (light jogging, cycling, or swimming) should be done between high-intensity sessions. Foam rolling and stretching after training can help reduce soreness and improve flexibility, aiding in recovery.
5. A periodized training plan alternating between strength-focused and endurance-focused blocks (e.g., 4-6 weeks per block) can optimize long-term performance, preventing overtraining and ensuring balanced improvements.

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