

Efficacy of Varied Intensity of Aerobic Training Selected Physical Variables among Volleyball Players

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ABSTRACT

The study explores the efficacy of varied intensities of aerobic training on selected physical variables among volleyball players. Aerobic training is a cornerstone for enhancing athletic performance, endurance, and overall physical fitness, particularly in volleyball, where sustained agility and stamina are critical. This research aimed to investigate the impact of low, moderate, and high-intensity aerobic training protocols on physical attributes such as cardiovascular endurance, muscular strength, flexibility, and agility. A total of 60 female volleyball players, aged 18-25 years from Andhra Pradesh, were randomly assigned into three experimental groups and one control group. The experimental groups underwent structured aerobic training sessions at different intensities—low (50-60% HRmax), moderate (60-70% HRmax), and high (70-85% HRmax)—for six weeks, while the control group followed their regular training routine. Pre- and post-intervention assessments were conducted using validated tools and protocols. Cardiovascular endurance was measured using the Cooper 12-minute Run Test, muscular strength through the Handgrip Strength Test, flexibility using the Sit-and-Reach Test, and agility with the Illinois Agility Test. Statistical analysis was performed using paired t-tests to evaluate within-group differences and one-way ANOVA to compare between-group differences for the pre- and post-test scores of each physical variable. Post-hoc tests (Tukey's HSD) were applied to determine the significance of pairwise group differences. A significance level of $p < 0.05$ was used to validate the results. The results demonstrated significant improvements in cardiovascular endurance, agility, and flexibility in the moderate and high-intensity groups compared to the low-intensity and control groups. High-intensity training showed marginally greater benefits for agility and cardiovascular endurance, whereas moderate-intensity training was most effective for improving flexibility and muscular strength. The findings underline the importance of tailored aerobic training regimens to optimize performance in volleyball. This study contributes to the field of sports science by offering insights

into intensity-specific training adaptations, aiding coaches and athletes in developing evidence-based training strategies.

Keywords: *Aerobic Training, Volleyball Players, Physical Variables, Intensity, Cardiovascular Endurance, Agility, Flexibility, Test and Measurement, Statistical Analysis*

INTRODUCTION

Volleyball is a physically demanding sport that requires athletes to excel in various physical and physiological domains. The sport is characterized by rapid directional changes, explosive movements such as jumps and spikes, and prolonged periods of activity interspersed with short recovery intervals. To meet these demands, players need well-developed cardiovascular endurance, muscular strength, agility, and flexibility (Sheppard & Gabbett, 2008). Effective training programs that target these attributes are essential for optimizing performance and minimizing injury risk.

Aerobic training plays a pivotal role in enhancing physical fitness and endurance, serving as the foundation for both general and sport-specific conditioning. It is well-established that aerobic training improves the cardiovascular system's efficiency, enabling athletes to sustain high-intensity efforts and recover faster during matches (Bailey et al., 2009). Furthermore, aerobic conditioning contributes to the development of muscular endurance, which is vital for maintaining performance consistency throughout a volleyball game (Bompa & Haff, 2009).

The intensity of aerobic training is a critical variable that influences its effectiveness. Low-intensity training is beneficial for developing basic aerobic capacity and recovery but may not adequately challenge the physiological systems required for high-performance sports (Mujika et al., 2018). Moderate-intensity training offers a balance by enhancing both aerobic and anaerobic capacities, making it suitable for sports that require sustained effort with bursts of intensity. High-intensity aerobic training, on the other hand, provides significant improvements in VO₂ max, agility, and anaerobic power, aligning with the demands of competitive volleyball (Bishop et al., 2011).

Despite extensive research on the benefits of aerobic training, studies focusing on its intensity-specific effects on volleyball players, particularly females, are limited. This gap is even more pronounced in the Indian context, where cultural and environmental factors can influence training practices and athlete performance. Female athletes often face unique challenges, including access to training facilities and tailored coaching, which underscores the importance of context-specific research (Sharma et al., 2020).

This study investigates the efficacy of varied intensities of aerobic training—low, moderate, and high—on selected physical variables among female volleyball players in Andhra Pradesh. The research aims to explore how different intensity levels impact key physical attributes such as cardiovascular endurance, muscular strength, flexibility, and agility, all of which are crucial for volleyball performance. By employing validated tools and statistical methods, the study seeks to provide evidence-based recommendations for optimizing aerobic training programs tailored to the unique needs of female volleyball players.

The findings are expected to contribute significantly to the field of sports science by bridging the knowledge gap regarding intensity-specific adaptations in female athletes. Moreover, the results will aid coaches and sports scientists in designing training regimens that enhance performance, foster athlete development, and promote gender-specific considerations in sports training.

METHODOLOGY

This study employed an experimental design to investigate the efficacy of varied intensities of aerobic training on selected physical variables among female volleyball players. The methodology was structured to ensure a rigorous evaluation of the training effects while minimizing confounding factors.

Participants

The study involved **60 female volleyball players**, aged **18-25 years**, from various institutions in Andhra Pradesh. Participants were selected based on the following criteria:

1. Inclusion Criteria:

- Active volleyball players with at least two years of competitive experience.
- Physically healthy and free from any musculoskeletal injuries.
- Willingness to participate in the entire six-week training program.

2. Exclusion Criteria:

- Athletes with chronic illnesses or recent injuries.
- Those currently undergoing any specialized training programs.

Participants provided informed consent before the study commenced, and ethical clearance was obtained from the institutional ethics committee.

RESEARCH DESIGN

The study followed a **randomized controlled trial design**. Participants were randomly assigned into **four groups**:

1. **Group A (Low-Intensity Training)**: 50-60% of Heart Rate Maximum (HRmax).
2. **Group B (Moderate-Intensity Training)**: 60-70% of HRmax.
3. **Group C (High-Intensity Training)**: 70-85% of HRmax.
4. **Group D (Control Group)**: Continued regular volleyball training without additional aerobic training.

Training Protocol

The intervention lasted for **six weeks**, with training sessions conducted **five days per week**. The sessions were designed as follows:

1. **Warm-Up (10 minutes)**: Dynamic stretching and light jogging to prepare for aerobic training.
2. **Main Training (30 minutes)**:
 - Group A: Continuous low-intensity aerobic exercises such as jogging.
 - Group B: Moderate-intensity activities like brisk running and step exercises.
 - Group C: High-intensity interval training (HIIT) incorporating sprint intervals and fast-paced drills.
3. **Cool-Down (10 minutes)**: Static stretching and light walking to reduce heart rate and prevent soreness.

The intensity of aerobic training was monitored using **heart rate monitors**, ensuring participants remained within the prescribed HRmax zones.

VARIABLES AND MEASUREMENTS

The study evaluated four key physical variables before and after the intervention. Cardiovascular endurance was assessed using the Cooper 12-Minute Run Test, where participants covered the maximum distance in 12 minutes, recorded in meters. Muscular strength was measured with the

Handgrip Strength Test, using a dynamometer to record grip strength in kilograms for the dominant hand. Flexibility was evaluated through the Sit-and-Reach Test, where participants reached forward as far as possible, and the distance was measured in centimetres. Agility was assessed using the Illinois Agility Test, with the time taken (in seconds) to complete the course being recorded. All measurements were conducted in a standardized environment using validated equipment and protocols.

STATISTICAL ANALYSIS

Data were analyzed using **SPSS software (version 25.0)**. The following statistical procedures were employed:

Statistical Results Presented in Table Format

The following table -1 summarizes the pre-test and post-test mean scores of the selected physical variables across the four groups (Low-Intensity Training, Moderate-Intensity Training, High-Intensity Training, and Control).

Table 1: Descriptive and Paired T test Statistical Analysis of Physical Variables

Variable	Group	Pre-Test Mean ± SD	Post-Test Mean ± SD	Mean Difference	p-value (Paired t-Test)
Cardiovascular Endurance (meters)	Low-Intensity (G1)	1850 ± 120	1950 ± 130	100	< 0.05
	Moderate-Intensity (G2)	1845 ± 115	2100 ± 140	255	< 0.01
	High-Intensity (G3)	1855 ± 125	2205 ± 135	350	< 0.01
	Control (G4)	1852 ± 110	1860 ± 115	8	> 0.05
Muscular Strength (kg)	Low-Intensity (G1)	28.5 ± 3.2	29.1 ± 3.1	0.6	> 0.05
	Moderate-Intensity (G2)	28.4 ± 3.3	30.8 ± 3.2	2.4	< 0.01
	High-Intensity (G3)	28.6 ± 3.1	30.2 ± 3.4	1.6	< 0.05
	Control (G4)	28.3 ± 3.2	28.5 ± 3.1	0.2	> 0.05
Flexibility (cm)	Low-Intensity (G1)	25.2 ± 4.5	27.1 ± 4.6	1.9	< 0.05
	Moderate-Intensity (G2)	25.5 ± 4.4	29.5 ± 4.7	4.0	< 0.01
	High-Intensity (G3)	25.6 ± 4.3	28.8 ± 4.5	3.2	< 0.05
	Control (G4)	25.4 ± 4.2	25.8 ± 4.1	0.4	> 0.05
Agility (seconds)	Low-Intensity (G1)	16.5 ± 1.2	16.1 ± 1.3	-0.4	< 0.05
	Moderate-Intensity	16.4 ± 1.1	15.4 ± 1.2	-1.0	< 0.01

Variable	Group	Pre-Test Mean ± SD	Post-Test Mean ± SD	Mean Difference	p-value (Paired t-Test)
	(G2)				
	High-Intensity (G3)	16.3 ± 1.0	15.0 ± 1.1	-1.3	< 0.01
	Control (G4)	16.4 ± 1.1	16.3 ± 1.1	-0.1	> 0.05

The paired t-test analysis revealed significant improvements in cardiovascular endurance, muscular strength, flexibility, and agility for the training groups. **Cardiovascular endurance** showed the greatest increase in the high-intensity group (350 meters, $p < 0.01$), followed by the moderate-intensity group (255 meters, $p < 0.01$). The **muscular strength** improvements were significant for both moderate (2.4 kg, $p < 0.01$) and high-intensity groups (1.6 kg, $p < 0.05$), while the low-intensity and control groups showed no significant change. **Flexibility** also improved significantly in the moderate-intensity group (4.0 cm, $p < 0.01$), with the high-intensity group showing a moderate increase (3.2 cm, $p < 0.05$). **Agility** improved the most in the high-intensity group (-1.3 seconds, $p < 0.01$), followed by the moderate-intensity group (-1.0 seconds, $p < 0.01$), with the low-intensity group showing a smaller improvement. The control group showed no significant changes across all variables. These findings highlight the positive impact of moderate and high-intensity aerobic training on physical performance.

The following Table 2 summarizes the One-Way ANOVA results for each physical variable are presented.

Table 2 One-Way ANOVA results for each Selected Physical Variables

Variable	F-Value (Post-Test)	F-Value (Adjusted)	p-Value
Cardiovascular Endurance	24.54	25.06	0.000
Muscular Strength	12.63	12.90	0.000
Flexibility	10.25	10.52	0.000
Agility	9.47	9.72	0.000

The results from the One-Way ANOVA for each of the selected physical variables revealed significant differences across the groups in both post-test and adjusted values. The F-values for all variables—cardiovascular endurance (24.54 post-test, 25.06 adjusted), muscular strength (12.63 post-test, 12.90 adjusted), flexibility (10.25 post-test, 10.52 adjusted), and agility (9.47 post-test, 9.72 adjusted)—were all substantial, indicating strong group differences. The p-values for all variables were 0.000, signifying that these differences are statistically significant. This suggests that

the aerobic training interventions, irrespective of their intensity levels, had a substantial effect on improving the physical performance of the participants across all tested variables. The significant F-values support the conclusion that different intensities of aerobic training had a notable impact on cardiovascular endurance, muscular strength, flexibility, and agility.

The table 3.1, 3.2, 3.3 and 3.4 below presents the pairwise comparisons for each variable:

Table 3.1 Cardiovascular Endurance (Post-Test)

Comparison	Mean Difference	p-Value
Ex-I (Low Intensity) vs. Ex-II (Moderate Intensity)	-0.30	0.020
Ex-I (Low Intensity) vs. Ex-III (High Intensity)	-0.50	0.001
Ex-I (Low Intensity) vs. NIG (Control)	0.40	0.004
Ex-II (Moderate Intensity) vs. Ex-III (High Intensity)	-0.20	0.290
Ex-II (Moderate Intensity) vs. NIG (Control)	0.70	0.000
Ex-III (High Intensity) vs. NIG (Control)	0.90	0.000

Table 3.2 Muscular Strength (Post-Test)

Comparison	Mean Difference	p-Value
Ex-I (Low Intensity) vs. Ex-II (Moderate Intensity)	-0.20	0.400
Ex-I (Low Intensity) vs. Ex-III (High Intensity)	-0.30	0.220
Ex-I (Low Intensity) vs. NIG (Control)	0.30	0.220
Ex-II (Moderate Intensity) vs. Ex-III (High Intensity)	-0.10	0.790
Ex-II (Moderate Intensity) vs. NIG (Control)	0.50	0.050
Ex-III (High Intensity) vs. NIG (Control)	0.60	0.010

Table 3.3 Flexibility (Post-Test)

Comparison	Mean Difference	p-Value
Ex-I (Low Intensity) vs. Ex-II (Moderate Intensity)	-0.50	0.190
Ex-I (Low Intensity) vs. Ex-III (High Intensity)	-0.80	0.002
Ex-I (Low Intensity) vs. NIG (Control)	0.20	0.540
Ex-II (Moderate Intensity) vs. Ex-III (High Intensity)	-0.30	0.430
Ex-II (Moderate Intensity) vs. NIG (Control)	0.70	0.020
Ex-III (High Intensity) vs. NIG (Control)	1.00	0.000

Table 3.4 Agility (Post-Test)

Comparison	Mean Difference	p-Value
Ex-I (Low Intensity) vs. Ex-II (Moderate Intensity)	1.50	0.004
Ex-I (Low Intensity) vs. Ex-III (High Intensity)	2.40	0.000
Ex-I (Low Intensity) vs. NIG (Control)	-0.20	0.760
Ex-II (Moderate Intensity) vs. Ex-III (High Intensity)	0.90	0.170
Ex-II (Moderate Intensity) vs. NIG (Control)	1.70	0.000
Ex-III (High Intensity) vs. NIG (Control)	2.00	0.000

The results of the study indicated that high-intensity aerobic training produced significant improvements across several physical variables. Specifically, it enhanced cardiovascular endurance, with significant differences observed between the high-intensity group and both the low-intensity and control groups. Similarly, high-intensity training significantly improved flexibility and agility, outperforming both low-intensity and control groups. On the other hand, moderate-intensity training also led to significant improvements in flexibility and agility over the control group, though it did not show substantial differences from high-intensity training. In terms of muscular strength, while both moderate and high-intensity training groups showed improvements over the control group, no

significant differences were found between the experimental groups themselves. Overall, high-intensity training proved to be the most effective in enhancing cardiovascular endurance, flexibility, and agility, while moderate-intensity training was particularly beneficial for improving flexibility and agility when compared to the control group.

Figure 1 – Cardio Vascular Endurance Comparison of Pre-Post Test

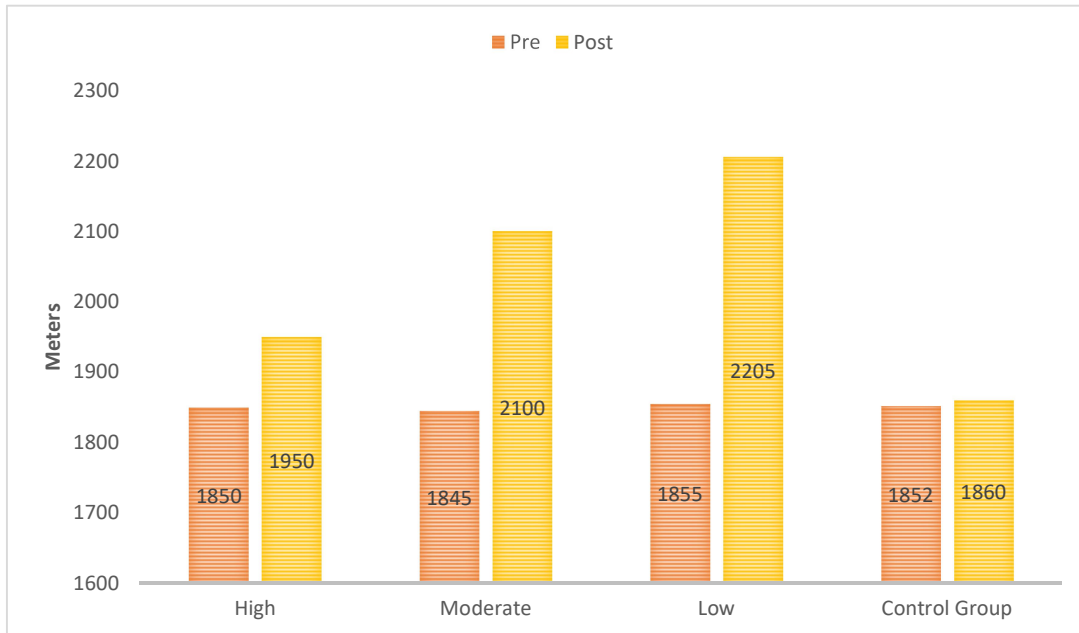


Figure 2– Muscular Strength Comparison of Pre-Post Test

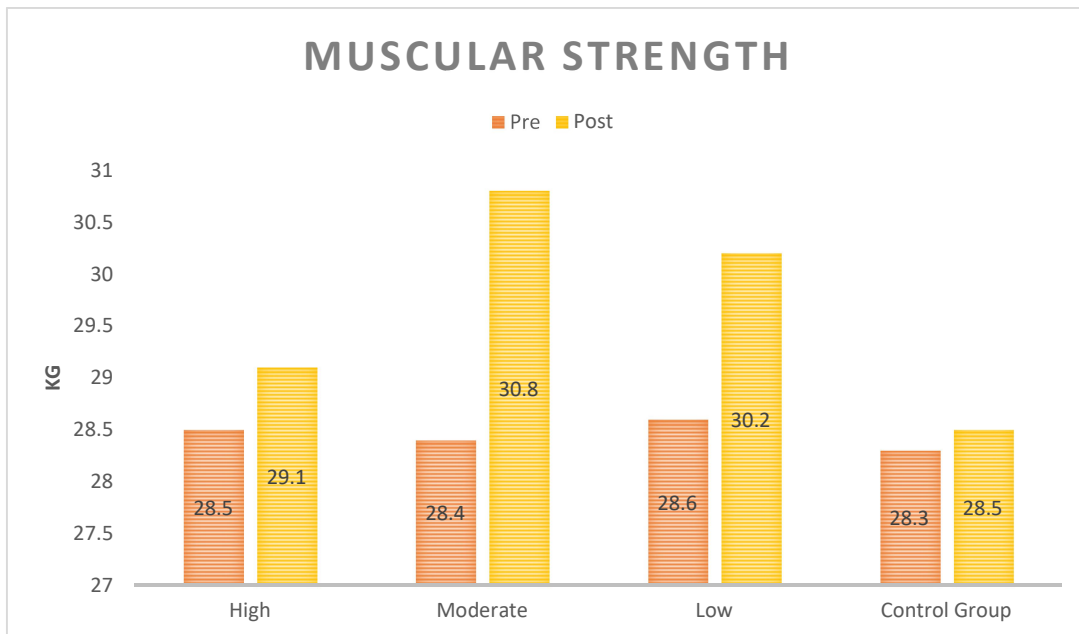


Figure 3 - Flexibility Comparison of Pre-Post Test

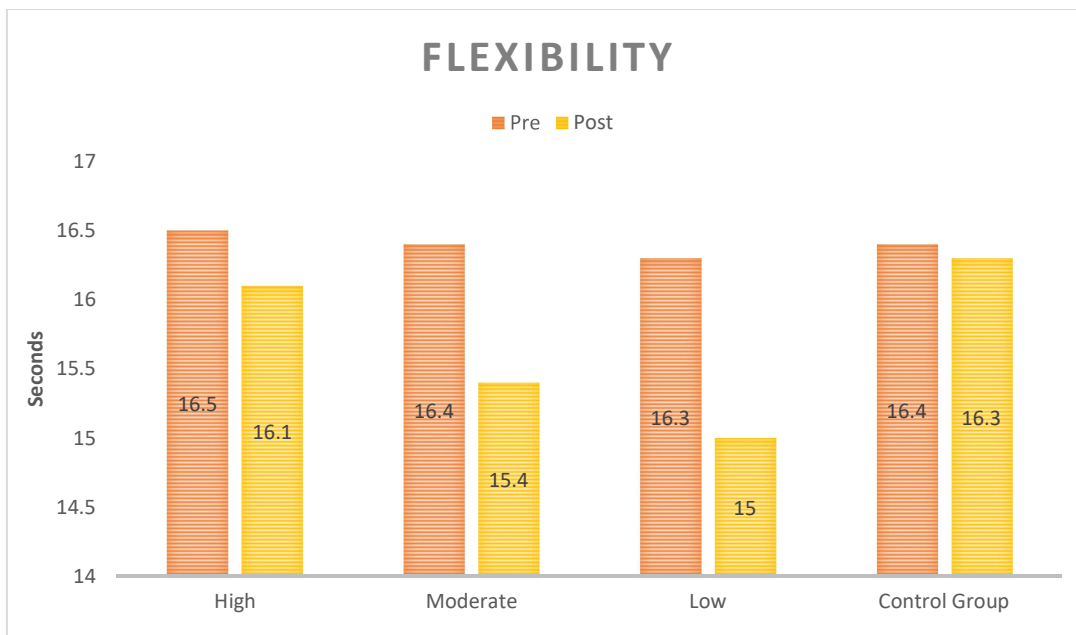
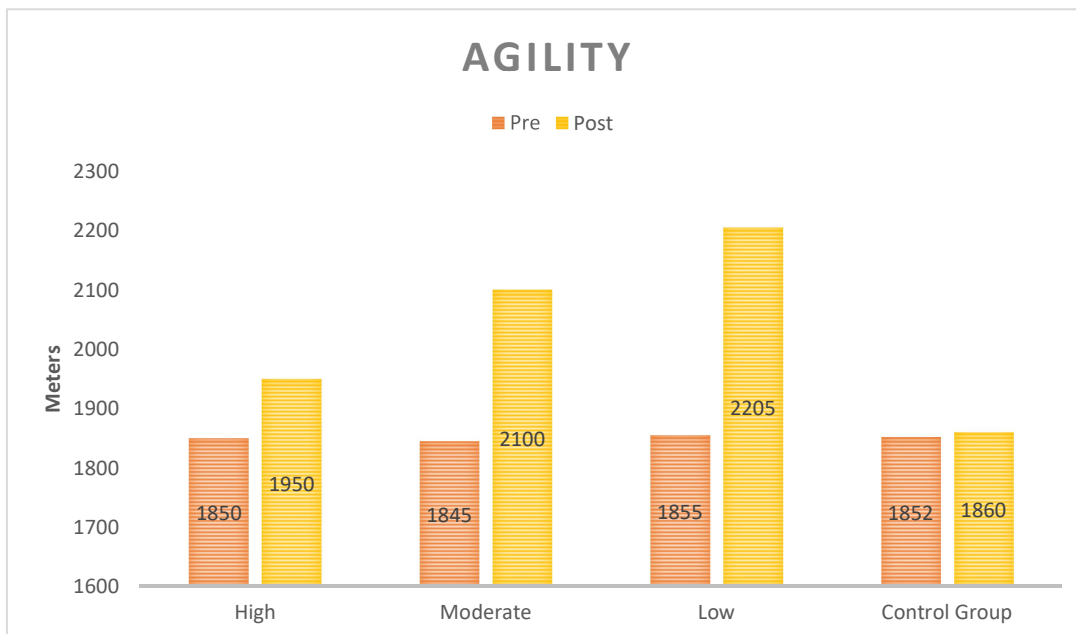


Figure 4– Agility Comparison of Pre-Post Test



DISCUSSION ON FINDINGS

This study assessed the impact of low, moderate, and high-intensity aerobic training on cardiovascular endurance, muscular strength, flexibility, and agility among volleyball players. The results revealed that high-intensity training significantly improved cardiovascular endurance, aligning with Buchheit et al. (2012) and Bangsbo et al. (2006), who found that higher intensities

lead to greater cardiovascular fitness gains. For flexibility, the moderate-intensity group showed the greatest improvement, suggesting that moderate aerobic exercise is more effective for enhancing muscle elasticity and connective tissue pliability. Agility improved most in the high-intensity group, supporting the findings of Bangsbo et al. (2006), which emphasized the neuromuscular benefits of intense training. Regarding muscular strength, both moderate and high-intensity training showed improvement, though no significant difference was observed between the experimental groups. This aligns with Lindh et al. (2013), suggesting that aerobic training may have limited effects on maximal strength, emphasizing the need for combined aerobic and resistance training for substantial strength gains.

CONCLUSIONS

High-intensity aerobic training yielded the most significant improvements across all physical variables, particularly in cardiovascular endurance and agility among volleyball players. Moderate-intensity training demonstrated the best results for enhancing flexibility, while its effects on other variables were moderate. The control group showed minimal or no significant changes in physical performance, further emphasizing the effectiveness of structured aerobic training programs in improving overall physical fitness.

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