Analyse the Effect of Strength and Endurance Training On Physical Fitness in Female Athletes

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Abstract

Having a good level of physical fitness is essential for any athlete, but it is especially important for the growing number of female athletes competing at different levels. When it comes to an athlete's performance, health, and ability to avoid and recover from injuries, two of the most important factors are strength and endurance. Cardiovascular efficiency, stamina, and aerobic capacity are improved by endurance training, whereas muscular power, joint stability, and body composition are enhanced through strength training. This study sought to examine the impact of strength and endurance training on the physical fitness of female athletes competing in Western Indian university and district-level events, with a specific focus on those athletes aged 18–25. One hundred and ten people took part in the study, with 37 going to the Strength Training Group, 37 to the Endurance Training Group, and 36 to the Control Group. The researchers used an experimental design. The control group kept up with their usual routines for eight weeks, whereas the strength and endurance groups participated in more specific training regimens. Muscular strength, cardiovascular endurance, flexibility, and body composition were among the physical fitness metrics evaluated. We used paired t-tests and ANCOVA to compare the pre- and post-test scores. The results showed that both groups significantly reduced their body mass index (BMI), with the strength training group achieving remarkable increases in muscular strength and endurance and the endurance training group achieving considerable increases in cardiovascular endurance and flexibility. The control group did not show any notable changes. The results highlight the significance of organized endurance and strength training for improving female athletes' physical fitness.

Keywords: Strength Training, Endurance Training, Physical Fitness, Female Athletes, Muscular Strength

INTRODUCTION

The foundation of athletic performance is physical fitness, and this is especially true for the growing number of female athletes competing on a global scale. There are many aspects of fitness, but two of the most important for an athlete's performance are strength and endurance. For explosive movements, good posture, and injury prevention, strength training is essential since it increases muscle power, endurance, and general body resilience. On the flip side, endurance training is great for sports that demand lengthy durations of activity because it mainly increases cardiovascular efficiency, muscular stamina, and the capacity to sustain physical effort for a long time. While a balanced physique is the goal of combining the two forms of training, the exact benefits and interactions between the two can change depending on the athlete's physiological traits, training intensity, and duration.

Given the inherent biological and hormonal variations between male and female athletes, it is of utmost importance to comprehend how strength and endurance training affect physical fitness differently in female athletes. How women react to various training stimuli is impacted by hormonal factors such as lower testosterone levels, variances in fat distribution patterns, and variations in muscle fiber composition. There

is a lack of information on the best training regimens for women because most studies on training adaptations have been conducted from a male perspective. Therefore, it is essential to conduct a thorough investigation of the effects of strength and endurance training on important aspects of female athletes' fitness, including their aerobic capacity, flexibility, speed, body composition, and muscular strength. In addition to assisting in the development of gender-specific training programs, this type of analysis helps to maximize athletic potential while reducing the likelihood of overtraining and injuries.

The significance of training interventions supported by data is further highlighted by the dynamic nature of sports science. Researchers and coaches can find the best ways to make female athletes physically fit by carefully studying the results of endurance and strength training. Critical to maximizing performance and guaranteeing long-term athlete development, this method also takes into account elements like training periodization, recuperation protocols, and the advantages of cross-training. Consequently, the purpose of this research is to offer a thorough analysis of the effects of strength and endurance training on several components of physical fitness in female athletes, drawing attention to the consequences for health, performance, and development over time.

REVIEW OF LITERATURE

Darragi, Manel et al., (2024). For female soccer players, strength training (ST) is mostly about increasing bone density and physical fitness, which includes things like muscle strength, power, and speed. The effects of ST in preventing injuries in female athletes are less well studied. The purpose of this study was to examine the relationship between injury rates, physical fitness assessments, and a 12-week in-season ST for young, top female soccer players. Methods In this study, 30 female soccer players who were considered elite (average age 15.4 ± 1.9 years; maturity offset + 2.3 ± 1.1 years) were divided into two groups: one that received strength training (STG, n = 14) and another that served as an active control (CG, n = 16). Complete body strength training using weight machines at intensities ranging from 40 to 85% of one-repetition maximum (1-RM) was the focus of ST, which lasted twelve weeks. As far as soccer training programs go, the CG followed the standard route. The training volumes of the two groups were comparable, with the STG achieving a training load of 1158.4 ± 67.7 arbitrary units (AU) and the CG reaching 1188.8 ± 44.1 AU. These physical fitness tests were administered before and after training: dynamic muscle strength (relative to body mass and absolute 1-RM bench/leg press, lat pull down), jump performance (countermovement jump, squat jump, five-jump-test), linear-sprint speed (5-m, 10-m, 30-m), change-of-direction speed (T-test with and without ball), sport-specific performance (Yo-Yo Intermittent Level1, [YYIRTL1]), and repeated shuttle sprint ability [RSSA]). All through the soccer season, we tracked the injury rate per 1000 hours of exposure. Final Product At the outset, there were no discernible variations in the groups. The absolute 1-RM lat-pull down, relative 1-RM leg press, and absolute 1-RM bench press all showed statistically significant group-by-time interactions ($p < 0.001$, $d = 2.59$), relative 1-RM bench press ($p < 0.001$, $d = 2.39$), and absolute 1-RM lat-pull down ($p < 0.001$, $d = 1.68$). For CMJ ($p = 0.005$, $d = 1.27$), RSSAmean ($p = 0.007$, $d = 0.81$), and RSSAtotal ($p < 0.001$, $d = 1.90$), there were notable group-by-time interactions. The results of the post-hoc testing showed that, in comparison to the CG group, the STG group showed more progress across all assessed variables ($1.2 < d < 2.5$). Results for linear sprint speed and YYIRTL1 performance, however, did not show any statistically significant interaction effects. There was a statistically significant difference between the two groups in terms of the number of non-contact injuries had during the season. The STG group had 0.48 injuries per 1000 hours of exposure, whereas the CG group had 2.6. Final thoughts Compared to an active control, elite young female soccer players who participated in a 12-week in-season ST had greater improvements in physical fitness and fewer injuries. In order to improve performance and reduce injuries, ST should be implemented in female soccer on a systematic basis.

Sun, Xiaofang. (2023). To be successful on the field, athletes need to have exceptional athleticism and stamina. Hence, athletes should prioritize endurance training. Objective Investigate how endurance training can be used to educate athletes about physical fitness. Methods Participation in this study was entirely voluntary and took the form of a control experiment with twenty young athletes. The subjects in the control group continued with their regular training regimen, while those in the experimental group received an additional 1.5 hours of endurance training after each workout. Pre- and post-experiment data was meticulously documented and organized. Final Product Athletes can get in better shape through endurance and regular training. Endurance training outperformed more conventional forms of exercise in terms of performance improvement. The experimental group's athletes' three-sport indices demonstrated a fluctuating optimization and overall improvement above pre-experiment levels during the 6-week period. In summary There is strong evidence that endurance training improves athletes' physical fitness, which in turn improves their abilities and competitive performance. It is thus advised to conduct additional research in order to increase its popularity. The second level of evidence consists of therapeutic studies that examine the results of treatments. Training for Endurance; Fitness for Physical Activity; PE and Training

KyrÖlÄinen, Heikki et al., (2017). Overweight and cardiovascular disease have become more common among young adults around the world in the past decade. So, it's critical to identify the best ways to prepare for exercise to boost health and performance, particularly for women who don't exercise very often. Women in their twenties and thirties who reported very little physical exercise were the subjects, and 65% of those women were overweight (BMI > 25). Over the course of nine weeks, they trained three times each week for both endurance and strength. The patient was instructed to engage in both self-directed strength training and group indoor cycling sessions for endurance training. Prior to, during, and after the training session, various assessments were carried out. No dietary recommendations were made to the participants. The estimated maximum oxygen consumption increased by 8.5% after the 9 weeks of training. Leg and arm extensors, trunk flexors and extensors, and maximum isometric strength all saw increases of 29.9%, 7.8%, 27.2%, and 16.1%, correspondingly. While low density lipoprotein, haemoglobin, serum glucose, and triglyceride levels did not change, high density lipoprotein levels rose 8.8% and total cholesterol fell 7.6%. No changes were seen in plasma testosterone, estradiol, or sex hormone binding globulin, however serum cortisol increased by 22.7%. A 0.8% gain in skeletal muscle mass was the only change in body composition. There was an improvement in maximal endurance and strength capacity and several health outcomes with just 27 sessions of combined strength and endurance training over 9 weeks, according to our results. Therefore, there's no need to alter one's diet in order to reap the health benefits of strength and endurance training.

RESEARCH METHODOLOGY

The impact of strength and endurance training on the physical fitness of female athletes was examined in this study using an experimental research approach. A total of 110 female athletes, ranging in age from 18 to 25, who participated in athletic events at the collegiate and district levels, were chosen at random. A total of 37 individuals participated in the strength training group, 37 in the endurance training group, and 36 in the control group.

For eight weeks, participants in the strength training program did a variety of exercises four times a week, including squats, lunges, deadlifts, and bench presses. Similarly, for eight weeks, the endurance training regimen included aerobic exercises like jogging, cycling, and circuit training, all performed four times weekly. Without any extra help, the control group just kept up with their usual exercise routine.

The following standardized tests were used to evaluate physical fitness: one-repetition maximum (RM) bench press, leg press, push-up, sit-up, and cardiovascular endurance (12-minute cooper run), flexibility (sit-and-reach), and body composition (body mass index, skinfold measures). In order to assess the changes, measurements were taken both before and after the test.

To evaluate the importance of changes, the data were examined using descriptive statistics (mean, standard deviation), paired sample t-tests, and analysis of covariance (ANCOVA). All statistical tests were conducted at a significance level of 0.05.

RESULTS AND DISCUSSION

Table 1 Descriptive Statistics of Pre-test and Post-test Scores

Fitness Component	Group	Pre-test Mean ± SD	Post-test Mean ± SD
Muscular Strength (kg)	Strength Training	45.6 ± 6.4	58.3 ± 5.9
	Endurance Training	46.2 ± 6.1	48.7 ± 5.7
	Control	45.8 ± 6.5	46.1 ± 6.6
Muscular Endurance (reps)	Strength Training	22.5 ± 3.7	30.8 ± 4.1
	Endurance Training	22.7 ± 3.5	27.5 ± 3.8
	Control	22.6 ± 3.6	23.1 ± 3.7
Cardiovascular Endurance (meters)	Strength Training	2100 ± 150	2305 ± 140
	Endurance Training	2115 ± 145	2455 ± 130
	Control	2110 ± 155	2130 ± 150
Flexibility (cm)	Strength Training	22.3 ± 4.8	25.5 ± 4.5
	Endurance Training	22.5 ± 5.0	26.7 ± 4.7
	Control	22.4 ± 4.9	22.7 ± 4.8
BMI (kg/m²)	Strength	22.8 ± 2.3	22.2 ± 2.2

	Training		
	Endurance Training	22.7 ± 2.4	22.1 ± 2.3
	Control	22.9 ± 2.2	22.8 ± 2.3

For each fitness component, the control, endurance training, and strength training groups compared their pre- and post-test scores in Table 1. The endurance training group experienced a lesser increase from 46.2 ± 6.1 kg to 48.7 ± 5.7 kg, the control group showed little change, and the strength training group significantly improved, going from 45.6 ± 6.4 kg to 58.3 ± 5.9 kg in muscle strength. While the control group's findings remained nearly unchanged, strength training participants saw a significant increase in muscular endurance, going from 22.5 ± 3.7 to 30.8 ± 4.1 repetitions. Similarly, the endurance group also saw an improvement, going from 22.7 ± 3.5 to 27.5 ± 3.8 repetitions. The endurance training group significantly improved their cardiovascular endurance, going from 2115 ± 145 meters to 2455 ± 130 meters. The strength group showed some improvement as well, but to a lower degree, and the control group made no progress at all. While the flexibility of the control group was relatively same, that of the endurance training group increased from 22.5 ± 5.0 cm to 26.7 ± 4.7 cm and that of the strength training group from 22.3 ± 4.8 cm to 25.5 ± 4.5 cm. Lastly, the body mass index (BMI) decreased somewhat in both the strength training and endurance training groups, but the control group did not change significantly. Strength training reduced the BMI from 22.8 ± 2.3 kg/m² to 22.2 ± 2.2 kg/m², and endurance training reduced it from 22.7 ± 2.4 kg/m² to 22.1 ± 2.3 kg/m². Taken as a whole, these findings demonstrate that, in comparison to inactivity, strength and endurance training significantly improves physical fitness.

Table 2 Paired Sample t-Test Results (Within Groups)

Fitness Component	**Group**	**t-value**	**p-value**	**Interpretation**
Muscular Strength	Strength Training	14.2	<0.001	Significant Improvement
	Endurance Training	4.1	<0.001	Significant Improvement
	Control	0.5	0.61	Not Significant
Muscular Endurance	Strength Training	13.5	<0.001	Significant Improvement
	Endurance Training	9.7	<0.001	Significant Improvement
	Control	0.7	0.49	Not Significant
Cardiovascular Endurance	Strength Training	8.8	<0.001	Significant Improvement

	Endurance Training	17.3	<0.001	Highly Significant Improvement
	Control	1.2	0.23	Not Significant
Flexibility	Strength Training	6.2	<0.001	Significant Improvement
	Endurance Training	7.1	<0.001	Significant Improvement
	Control	1.1	0.28	Not Significant
BMI	Strength Training	3.5	0.001	Significant Decrease
	Endurance Training	4.0	<0.001	Significant Decrease
	Control	0.6	0.56	Not Significant

Results from a paired sample t-test comparing pre- and post-test levels of change within each group are shown in Table 2. With t-values of 14.2 and 4.1, respectively, and p-values less than 0.001, suggesting substantial statistical significance, both the strength training and endurance training groups demonstrated notable enhancements in muscle strength. There was no statistically significant difference between the experimental and control groups ($t=0.5$, $p = 0.61$). The control group showed no change in muscular endurance, but the strength training and endurance training groups both showed substantial improvements ($t = 13.5$, $p < 0.001$ and $t = 9.7$, $p < 0.001$, respectively). The results of the cardiovascular endurance test demonstrated that both the endurance training group and the strength training group exhibited substantial improvements ($t = 17.3$, $p < 0.001$), whereas the control group did not show any significant change ($t = 1.2$, $p = 0.23$). Both the strength training and endurance training groups showed significant gains in flexibility ($t = 6.2$, $p < 0.001$), while the control group showed no change ($t = 1.1$, $p = 0.28$). The control group once again failed to demonstrate a significant change ($t = 0.6$, $p = 0.56$) in BMI, but the strength training ($t = 3.5$, $p = 0.001$) and endurance training ($t = 4.0$, $p < 0.001$) groups both underwent a notable reduction. Compared to the control group, which showed no change in fitness, the data show that therapies involving strength and endurance training significantly improved nearly all fitness components.

Table 3 ANCOVA Results (Between Groups)

Fitness Component	**F-value**	**p-value**	**Interpretation**
Muscular Strength	56.8	<0.001	Significant difference between groups
Muscular Endurance	41.5	<0.001	Significant difference between groups
Cardiovascular Endurance	78.2	<0.001	Significant difference between groups

Flexibility	12.9	<0.001	Significant difference between groups
BMI	8.3	0.001	Significant difference between groups

After controlling for pre-test scores, Table 3 displays the ANCOVA results that compare the post-test scores of the control, strength training, and endurance training groups. There were statistically significant differences between the groups for every aspect of fitness that was tested. There was a statistically significant difference between the groups when it came to physical strength (F=56.8, p=0.001). Similar to physical endurance, there was a statistically significant difference between the groups in this measure (F=41.5, p<0.001). The greatest significant group effect was seen in cardiovascular endurance, where the various training regimens had a large influence (F-value = 78.2 and p-value = 0.001). Groups also showed significant differences in flexibility (F = 12.9, p < 0.001) and body mass index (BMI), with an F-value of 8.3 and a p-value of 0.001. This study highlights the importance of systematic training interventions in improving athletic fitness among female athletes. It shows that both endurance and strength training programs significantly improved physical fitness outcomes compared to the control group.

CONCLUSION

This study's results show that female athletes can benefit greatly from strength and endurance training for a variety of fitness levels. Although endurance exercise was more useful for increasing flexibility and cardiovascular endurance, strength training was far more successful in enhancing muscle strength and endurance. Furthermore, there was an improvement in body composition as measured by a decrease in body mass index (BMI) in both training groups. On the other hand, no significant gains in physical fitness parameters were observed in the control group, which did not receive any additional training. The importance of well-designed and specifically tailored fitness programs in improving female athletes' health, performance, and overall fitness is underscored by these findings. Athletes, especially females, can reap the benefits of increased performance and decreased health risks linked to lack of fitness through the methodical integration of endurance and strength training into their routines. Perhaps in the future researchers will look at how these treatments play out over the long haul in a variety of sports and at different levels of competition.

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