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Influence on physiological variables due to Soccer-specific training with and without interval training in Women Soccer players

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Abstract
This study intends to evaluate the impact of soccer-specific training, with and without interval training, on Anaerobic power and VO2 max in female soccer players. Consequently, 45 female football players aged 18 to 23 from Annamalai University in Chidambaram, Cuddalore District, Tamil Nadu, participated in the study. The training period was limited to 10 weeks. Anaerobic power and VO2max, the selected dependent variables, were assessed before to and during the training program use a running-based anaerobic power test and the Cooper test. Subjects selected at random were categorised into three groups: two experimental groups and one control group. Group one participated in soccerspecific training, group two engaged in soccer-specific training combined with interval training, while group three acted as the control group. The soccer-specific training included skills-based exercises and particular motions such as brief sprints, leaps, and agility drills. The interval training included runs of 30, 50, 100, 150, 300, and 500 meters at varying intensities. The starting intensity was established at 75% and subsequently increased by 5% biweekly. The individuals traversed these distances at their optimal relaxed pace and with the specified intensity. Analysis of covariance (ANCOVA) was utilised as a statistical method to determine if a significant difference existed between the pretest and post-test data of the selected dependent variable. The paired mean differences were calculated using Scheffe's post hoc test where the adjusted post-test 'F' ratio was significant. The established significance threshold was P≥ 0.05. The results indicated that substantial gains occurred due to both training sessions. The SSTG group exhibited percentage improvements of 1.44 and 2.31, whereas the CTG demonstrated enhancements of 2.31 and 3.54 in anaerobic power and VO2max, respectively. The calculated F ratios were 7.91 for anaerobic power and 28.38 for VO2max, respectively.

Keywords: Soccer-specific training, interval training, bio-motor fitness markers, adolescent females

Introduction

Football is a physically rigorous sport necessitating players to exhibit a combination of technical proficiency, tactical acumen, and outstanding physical conditioning. Critical physical traits for optimal football play include anaerobic power and aerobic capacity, often assessed by VO2 max (Hoff *et al*., 2002). Anaerobic power is essential for performing brief, high-intensity activities like sprints, tackles, and leaps, whereas aerobic capacity influences a player's endurance and recovery throughout extended matches (Stølen *et al*., 2005) [12]. With the growing global popularity of women's football, there is a rising scientific interest in optimising training routines tailored for female athletes. Notwithstanding this advancement, a disparity persists in comprehending the impact of varied training regimens on the physiological adaptations essential for the performance of female football players. This study seeks to enhance existing information by examining the collective and individual impacts of soccer-specific training and interval training on anaerobic power and VO2 max.

This study is based on the increasing acknowledgement that customised training programs may improve football play. Soccer-specific training focusses on drills and exercises that replicate match situations, enhancing players' technical and tactical skills while concurrently activating the essential energy systems for the sport (Impellizzeri *et al*., 2006) [7]. Interval training specifically enhances cardiovascular fitness and anaerobic ability with organised segments of high-intensity exercise interspersed with rest or low-intensity recovery phases (Buchheit & Laursen, 2013) [4]. Although both strategies demonstrate advantages, their relative and synergistic impacts on anaerobic power and VO2 max in female football players are yet inadequately investigated. Female athletes have unique physiological and hormonal traits in contrast to male athletes, potentially affecting their reactions to training stimuli (Andersen *et al*., 2019). Consequently, comprehending the impact of soccerspecific and interval training on these critical performance markers in female soccer players can guide coaches and trainers in developing effective training programs suited to their requirements.

Soccer-specific training denotes a focused routine that integrates drills and exercises directly related to the physical and technical requirements of football. This training often encompasses exercises including dribbling, passing, shooting, agility drills, and small-sided games that simulate match situations (Dellal *et al*., 2012). The primary objective of soccer-specific training is to improve players' technical abilities, tactical understanding, and game-related conditioning. Soccer-specific training is defined by its emphasis on replicating actual game scenarios. Exercises including dribbling in confined areas, one-touch passing, and shooting under duress aim to enhance technical accuracy and decision-making (Williams & Reilly, 2000). Tactical drills, encompassing positional strategies and offensive or defensive transitions, improve a player's spatial awareness and comprehension of team dynamics. Furthermore, including fitness elements such as endurance running or plyometric training guarantees that athletes are physically equipped for the demands of a 90-minute competition. This training enhances individual abilities while also promoting improved team cohesion and performance.

Soccer-specific training for female football players can address deficiencies in technical skills and tactical comprehension that are frequently neglected in generalised training programs (Vescovi & McGuigan, 2008). Through participating in drills that simulate match conditions, female athletes may enhance their response speeds, adaptability, and capacity to manage pressure. This training also fosters confidence, as players gain greater familiarity with game-like scenarios. Moreover, it diminishes the likelihood of accidents by enhancing balance, coordination, and joint stability (Malliou *et al*., 2004). As women's football evolves, it is essential to establish efficient training regimens tailored to the special demands of female players to optimise their performance and overall physical development.

Interval training consists of organised phases of high-intensity exercise alternated with recovery intervals of low-intensity activity or rest. This training method is well-regarded for enhancing both aerobic and anaerobic fitness. In football, interval training often comprises sprints, shuttle runs, and other high-intensity exercises executed over designated distances or durations, interspersed with recuperation intervals. This method assists players in acclimating to the sporadic dynamics of soccer matches, which necessitate periods of great exertion during the game. Interval training is adaptable and may be customised to address many fitness components. High-intensity intervals may vary from brief sprints of 10-20 seconds to extended runs of 2-3 minutes, contingent upon the intended result. Recovery intervals may include ambulation, gentle jogging, or total rest to facilitate adequate energy restoration. Integrating interval training into football routines enhances explosive power, speed endurance, and the capacity to maintain high-intensity performance throughout matches. Modifications like highintensity interval training (HIIT) and repeated sprint training (RST) augment its relevance to football.

Interval training provides several physiological and performance advantages for female football players. It markedly enhances cardiovascular fitness, allowing athletes to recuperate more rapidly between high-intensity activities. Improved aerobic and anaerobic capabilities enable athletes to sustain peak performance levels during the competition. Interval training facilitates fat reduction and muscle definition, enhancing body composition and overall athletic performance. Moreover, by emulating the stop-and-go dynamics of football, interval training equips players for the physical exigencies of competitive matches and mitigates tiredness during pivotal times.

This study seeks to elucidate the physiological advantages of soccer-specific and interval training in women's football. The analysis of their impact on anaerobic power and VO2 max will optimise training programs and deepen the understanding of how various training modalities might improve the performance of female football players. As women's football increasingly gains competitiveness and attention, such study is crucial for adapting training approaches to the specific needs of the sport and its participants.

Objectives of the Study

This study seeks to examine the effect of soccer-specific training with and without interval training on anaerobic power and VO2max

among women soccer players. By comparing the outcomes of these two training protocols, the research aims to identify effective strategies for enhancing the physical performance of women athletes in soccer.

Significance of the Study

The findings of this study will provide evidence-based insights into the design of training programs for women soccer players, potentially leading to improved performance on the field. Furthermore, the research will contribute to the scientific understanding of how different training modalities impact key physiological metrics, helping to bridge the knowledge gap in women's sports science. Additionally, this study has the potential to influence the development of gender-specific training guidelines in soccer, fostering an environment where women athletes can achieve peak performance. By addressing the physiological and technical demands unique to women soccer players, the study aims to promote equality in sports science research and ensure that female athletes receive training interventions that are both effective and scientifically validated.

Materials and Methods

Subjects and Variables

The goal of the current study was to examine the effect of soccer-specific training with and without interval training on anaerobic power and vo2max among women soccer players. 45 female soccer players from Annamalai University in Chidambaram, Cuddalore District, Tamilnadu, who were between the ages of 18 and 23, participated in the study for this reason. Anaerobic power and VO2max, the chosen dependent variable, was evaluated before and after the training program using a running-based anaerobic power test and cooper test.

Training protocol

The randomly chosen subjects were divided into 3 groups: two experimental groups and a control group. Group one underwent soccer-specific training and two underwent soccer-specific training and interval training, three served as the control group. The soccer-specific training comprised skills-based activities and specific movements like short sprints, jumps, agility drills etc. The interval training comprised 30,50,100,150,300,500 meters run with different intensities. The initial intensity was set at 75% before being raised by 5% every two weeks. The subjects ran these distances at their most relaxed speed and with the designated intensity.

Table 1: Criterion measures and selection of tests

Variable	Test	Unit
Anaerobic power	RAST	Watts
VO2max	Cooper test formula	Ml/Kg/Min

Statistical Analysis and Experimental Design

Thirty volunteers were included in the random group design experiment employed for this study. Analysis of covariance (ANCOVA) was employed as a statistical approach to ascertain whether there was, in fact, a significant difference between the data from the chosen dependent variable's pretest and post-test. The paired mean differences were determined using Scheffe's post hoc test whenever the adjusted post-test 'F' ratio value was found to be significant. The accepted level of significance was P 0.05.

Result of the study

Table 1: Paired 't' test and % of changes on soccer player's Anaerobic power of SSTG, CTG & CG

Groups Name	Assessment Periods	Subjects	Mean Values	SD Values	MD	DM	't' Value	Percentage
SSTG	pre-test	15	618.3	8.85	8.93	.77	11.58	1.44
	post-test		627.2	9.54				
CTG	pre-test	15	619.3	8.85	14.33	.67	21.27	2.31
	post-test		633.3	9.89				
CG	pre-test	15	620.3	8.85	1.53	4.00	0.383	0.24
	post-test		621.8	9.84				
df 14 =2.15 (table value) (*significant)								

The assessed pre and post-test anaerobic power values of three training (SSTG, CTG&CG) groups differ noticeably since the 't' values of SSTG (21.27), as well as CTG (11.58) groups were greater than the table value (df14=2.15). following 8 weeks of SST, and CT treatment, the soccer player's anaerobic power (SSTG=1.44%, and CG =2.31%), enhanced greatly.

Table 2: Computation of analysis of covariance of pre-test, post-test and adjusted post-test on Anaerobic power for experimental groups and control group

	SSTG	CTG	CG	SOV	SS	df	MS	F
pre-test	618.3	619.7	620.7	B	30	2	15	1.91
SD	8.85	8.6	8.6	W	3296.8	42	78.5	
post-test	627.2	633.6	621.8	B	1046.8	2	523.4	5.48
SD	9.89	9.85	9.54	W	4006.6	42	95.4	
Adjusted post-test	627.7	633.6	621.2	B	1144.6	2	572.3	7.91
				W	2963.1	41	72.3	
Required F (0.05), (df 2 and 42) = 3.22, (df 2 and 41) = 3.23 at 0.05, significance.								

BG - Between Groups, WG - Within Groups, df – Degrees of Freedom

The means of the adjusted post-test of the training groups of soccer specific, soccer specific training with interval training and control groups were 627.7,633.3 and 621.2 respectively. The F ratio 7.91 obtained, and it was greater than 3.23 of table value for degree of 2 and 41 necessary for significance level at 0.05.

The analysis mentioned above shows that the means of the adjusted post-test measures of the four chosen groups differed significantly.

Table 3: For post hoc test Scheffe's test was used in order to identify which specific group had significant difference and showed in the table

SSTG	CTG	CG	MD	CI
627.7	633.6		5.9	7.88
627.7		621.3	6.4	
	633.6	621.3	12.3*	

The above table presents the results of the Scheffe's Post hoc test. It could be observed that the mean difference among the combined training group control group was 12.3 (P>0.05) and the measured C. I value was 7.88 (P< 0.05).and mean differences of other pairs are not less than CI value.

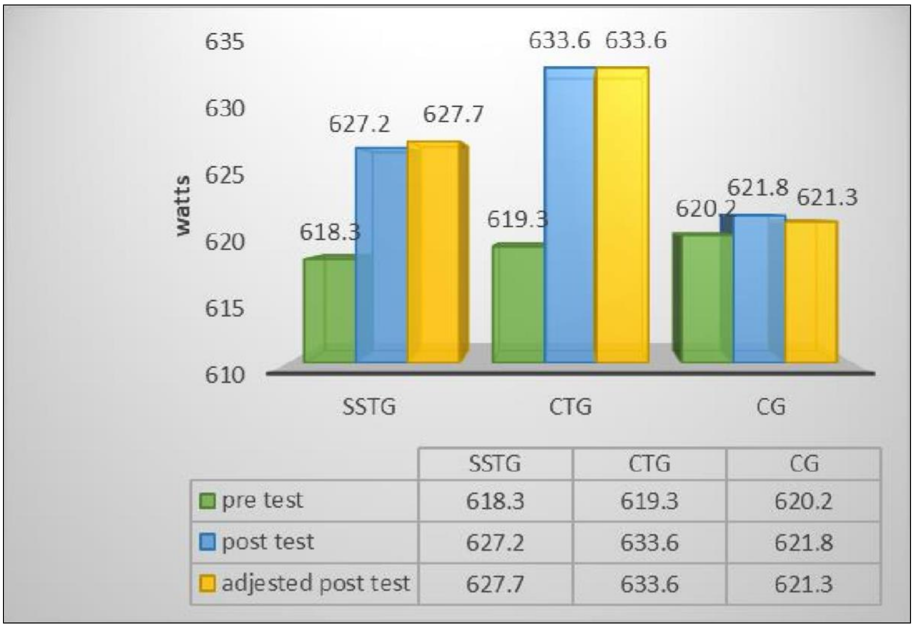

Fig 1: Graphical presentation of Pre, Post and Adjusted means of anaerobic power

Table 4: Paired 't' test and % of changes on soccer player's Vo2max of SSTG, CTG&CG

Groups Name	Assessment Periods	Subjects	Mean Values	SD	MD Values	DM Values	't'	Percentage
SSTG	Pre-test	15	41.21	1.17	0.96	0.165	5.87	2.31
	Post-test		42.17	0.74				
CTG	Pre-test	15	41.14	0.41	1.46	0.106	13.8	3.54
	Post-test		42.61	0.47				
CG	Pre-test	15	40.9	0.41	0.264	0.185	1.42	1.42
	Post-test		40.63	0.78				

df 14=2.15 (table value) (*significant)

The assessed pre and post-test anaerobic power values of three training (SSTG, CTG&CG) groups differ noticeably since the 't' values of SSTG (5.87), as well as CTG (13.8) groups were greater than the table value (df14=2.15). following 8 weeks of SST, CT treatment, soccer player's Vo2 max (SSTG=2.31%, and CG =3.54%), enhanced greatly.

Table 5: Computation of analysis of covariance of pre-test post- test and adjusted post- test on Vo2 max for experimental groups and control group

	SSTG	CTG	CG	SOV	SS	df	MS	F
pre-test	41.09	40.83	40.89	B	.559	2	.279	.267
SD	1.1	.93	1.03	W	44.03	42	1.04	
post-test	42.61	42.17	40.86	B	24.75	2	12.38	20.0
SD	.742	.681	.916	W	25.99	42	.62	
Adjusted post-test	42.11	46.66	40.89	B	24.65	2	12.32	28.4
				W	17.80	41	.43	

Required F (0.05), (df 2 and 42) = 3.22, (df 2 and 41) = 3.23 at 0.05, significance. BG - Between Groups, WG - Within Groups, df – Degrees of Freedom

The means of the adjusted post-test of the training groups of soccer specific, soccer specific training with interval training and control groups were 42.11,46.66 and 40.89 respectively. The F ratio 7.91 obtained, and it was greater than 3.23 of table value for degree of 2 and 41 necessary for significance level at 0.05.

The analysis mentioned above shows that the means of the adjusted post-test measures of the four chosen groups differed significantly. For post hoc test Scheffe's test was used in order to identify which specific group had the significant difference and showed significance of difference and the results of the analysis are shown in the table.

Table 6

SSTG	CTG	CG	MD	CI
42.11	46.66		4.55*	
42.11		40.89	1.22*	.6
	46.66	40.89	5.77*	

The above table presents the results of the Scheffe's Post hoc test. It could be observed that the mean difference among the isolated interval training group and isolated soccer specific training group was 4.55 (P>0.05), isolated soccer specific training group and control group was 1.22, combined training and control group was 5.77. And the measured C.I value was .60(P< 0.05).

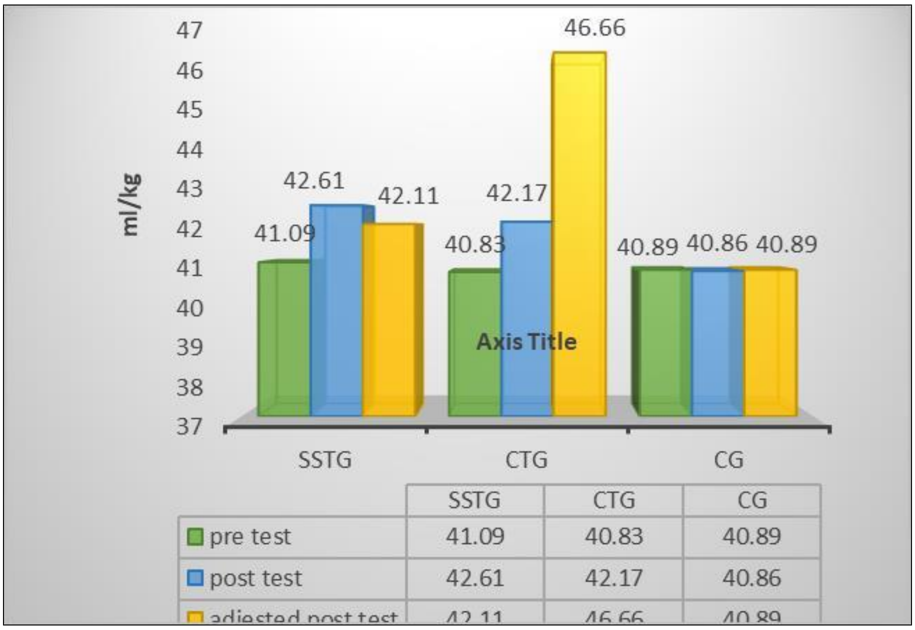

Fig 2: Graphical presentation of Pre, Post and Adjusted means of anaerobic power

Discussion

Aerobic power and VO2max are essential factors in football performance, affecting endurance, recovery, and total athletic efficacy. This study sought to assess the impact of soccer-specific training, both with and without interval training, on essential physiological indicators in female football players. The results were juxtaposed with prior research to evaluate the importance of the findings. The research examined the effects of an 8-week soccer-specific training group (SSTG) and a soccer-specific training program incorporating interval training (CTG). The statistical findings indicated that the CTG group had markedly superior enhancements in anaerobic power and VO2max compared to both the SSTG and control groups. A post hoc study further indicated that soccer-specific training combined with interval training (CTG) was more effective than soccer-specific training alone (SSTG) in enhancing anaerobic power. Soccer-specific training (SSTG) demonstrated much greater efficacy compared to the control group (CG). The 10-week SSTG intervention shown enhancements; nevertheless, the CTG group still surpassed both SSTG and CG in VO2max improvements. The findings underscore the advantages of integrating interval training into soccer-specific programs to improve both anaerobic and aerobic capacity in female soccer players. Interval training is a systematic approach that combines phases of high-intensity effort with specified recovery intervals (Trisaptono & Sumintarsih, 2020; Christiansen *et al*., 2021). This approach is divided into extensive and intense interval training, with intensive interval training being very efficient in enhancing VO2max (Haugen *et al*., 2019; Yamin & Gusril, 2020). The results of this investigation correspond with prior studies. Iaia, Ermanno, and Bangsbo (2009) examined the physiological effects of high-intensity and speed-endurance training in football, indicating that both training modalities improve intermittent high-intensity performance provided sport-specific requirements are satisfied.

Moghaddam *et al*. (2023) shown that sprint interval training on stationary air bikes markedly enhanced VO2max. Parra *et al*. (2000) and Bompa & Haff (2009) discovered that anaerobic interval training increases enzyme activity associated with glycolysis, including phosphofructokinase, lactate dehydrogenase, and glycogen phosphorylase. MacDougall *et al*. (1998) corroborated these findings by demonstrating enhancements in glycolytic and oxidative muscle enzyme activity, peak short-term power production, and VO2max following seven weeks of sprint interval training.

The enhancements noted in this study can be ascribed to numerous critical physiological modifications elicited by interval training, such as augmented mitochondrial density, greater buffering capacity, and enhanced cardiovascular performance. These modifications enhance endurance and recuperation, crucial for optimising football performance. not with standing the encouraging results, several limits must be recognised. The limited sample size of the study may not be applicable to larger populations. The short-term intervention failed to evaluate the long-term consequences of these training approaches. Furthermore, changes in training protocols were not investigated, leaving the ideal work-to-rest ratios, intensity levels, and duration of interval training sessions indeterminate. Future studies should investigate the enduring effects of integrated soccer-specific and interval training regimens on performance in bigger and more heterogeneous populations. Furthermore, determining the ideal parameters for incorporating interval training into soccer-specific programs would yield significant insights for players and coaches aiming to enhance performance outcomes. This study highlights the enhanced advantages of integrating soccer-specific training with interval training to improve both anaerobic power and VO2max in female football players. These findings underscore the necessity of integrating organised interval training into football conditioning regimens to enhance athletic performance

Conclusion

This study contributes to the increasing data showing the efficacy of integrating soccer-specific training with interval training. The findings indicate that although soccer-specific training alone yields beneficial adaptations, the incorporation of interval training markedly improves anaerobic power and VO_2max in female soccer players. This indicates a synergistic effect, wherein interval training enhances the physiological advantages of soccer-specific drills. These findings underscore the need of including interval training into training regimens to optimise performance. Future study should examine the long-term impacts and best implementation tactics of integrated training methods, especially for athletes participating in events requiring both aerobic and anaerobic capacities.

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