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Enhancing cardiorespiratory and muscular endurance in football players: The impact of a six-week interval training program

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ABSTRACT

Background Problem: The integration of interval training programs has emerged as a focal point for enhancing the cardiorespiratory endurance and muscular endurance of players. **Research Objectives**: The main purpose of the present study is to investigate the effect of interval training program on cardiorespiratory endurance and muscular endurance of football payers. **Methods**: A total of thirty male football players (age 18-24 year) were selected from Imphal West District, Imphal, Manipur (India) who participated in the national level competition. The subjects were randomly assigned into two equal groups, experimental group (n = 15) and control group (n = 15). Before the intervention featuring a six-week interval training program five days of sessions per week (Monday to Friday) each lasting 60 minutes, groups underwent initial assessments through which Cooper's 12-minute run/walk test for cardiorespiratory endurance and bent-knee sit-ups for muscular endurance. Pre and post-test scores underwent statistical analysis, utilizing descriptive statistics and the Analysis of Covariance test (ANCOVA). The level of significance was set at 0.05 level of confidence. **Findings and Results**: The experimental group showed improved scores in the cardiorespiratory endurance and muscular endurance compared to the control group ($p < 0.05$). The mean of the cardiorespiratory endurance and muscular endurance for pretest and posttest of the experimental group were 25.68 ± 25.85 and 27.82 ± 26.25 respectively. The mean of the cardiorespiratory endurance and muscular endurance for pre-test and post-test of the control group were 28.24 ± 28.42 and 32.58 ± 28.80 respectively. **Conclusion**: It was concluded that the interval training program group had shown significantly improved cardiorespiratory endurance and muscular endurance and the control group had insignificant improvement. It was confirmed that a six weeks interval training program was effective to improve the cardiorespiratory endurance and muscular endurance of football players.

Keywords: Interval training; cardio respiratory endurance; muscular endurance; football players

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INTRODUCTION

In the last decade, various scientific studies have assessed endurance training techniques suitable for soccer players. Such training takes the form of standardized running drills or is structured through small-sized games. Recent breakthroughs in these training methods include the application of tracking technology to monitor player performance and progress, which allows coaches to tailor training programs more effectively (Cossich et al., 2023; Seçkin et al., 2023). In addition, recent studies have shown that the combination of strength and endurance training improves players' ability to maintain stamina during matches, extending their ability to play at high intensity until the end of the match (Hughes et al., 2018). Although high-intensity aerobic training is beneficial for endurance events such as running and cycling, its limitations in relation to football need to be recognized (Wang & Zhang, 2023).

Modern football is very fast by its nature, the spectators and the players enjoy the game. Nowadays with the demand for high sports performance the concept of football has been changed (Farooque et al., 2023a). The concept of football has applied skill, technical, tactical development, development of all-important motor components and physiological parameters which are closely associated and contributes to performance in football (Farooque et al., 2023b). Enhanced endurance has proven advantageous for top-tier football performance. It leads to increased overall and high-intensity running during matches, along with less of a drop in match intensity during the latter half (Faude et al., 2013). Not only technical, physiological development, the sports scientists are also making efforts to develop the intellectual ability of the football players. As in the literature, it has been shown that endurance, speed, agility, maximum leg strength, upper body strength, leg power, muscular endurance, flexibility, coordination, and reaction time are important prerequisites for efficient football performance (Singh, 2016; Turner & Stewart, 2014; Yan et al., 2022).

It must execute skilled movements under generalized conditions of restricted space, limited time, physical and mental fatigue and opposite players (Farrow & Robertson, 2017). The skills involved in the game are simple, natural and yet are highly stimulating and satisfying to anyone who participants in the game (Ryan et al., 2018). It is one of those rare games which demands not only speed but agility, strength, power, and endurance along with skill (Singh et al., 2022b). Training is essentially a preparation of the individual athlete so that he can withstand competition stress when he encounters and performs to maximum effectiveness (Mujika et al., 2018). Soccer training process is partly designed to improve the capacities of individual players to ensure a capability to cope with the loads that competitive match play involves (Barrera-Díaz et al., 2023). A high level of match play, which involves kicking, short sprinting, throwing, catching, trapping, etc. (Halder & Chakraborty, 2014). The activities of the game include short sprinting as well as casual recovery movements. As the players have to cover a big area in the ground during attack and defense, the game demands the activities of the game include short sprinting as well as casual recovery movements for aerobic as well as anaerobic fitness (Mohr et al., 2022).

The implementation of a well-developed interval training program helps soccer players to maintain repetitive high-intensity actions during a soccer match, accelerate their recovery process, and maintain their physical condition at an optimum level throughout the entire game and competition season (Novack et al., 2018). Interval training is a training system interspersed with intervals in the form of periods of rest, such as running - resting - running - resting and so on (Harrison et al., 2015). Before conducting the interval training method, a training plan or training program must be prepared first (Briand et al., 2022). There are several factors that must be planned as thoroughly as possible in the interval training program so that the objectives and results of the exercise can be achieved, including: the duration of the exercise, the load (intensity) of training, sets and repetitions (repetitions) of each set, recovery (resting period), and frequency of exercise in a week (Atakan et al., 2022).

In training, rest time is very important between each repetition of training load one to the next training load to restore athlete's fitness to be able to carry out the next exercise (Reiman & Lorenz, 2011). Improving explosive activities and aerobic endurance simultaneously is crucial for soccer players, but the outcomes of combining muscle strength and endurance training have varied in previous studies. Some found they complement each other, enhancing various aspects like maximal oxygen uptake and aerobic speed, while others observed interference, possibly due to strength training's potential to hinder aerobic improvements by

promoting muscle hypertrophy and reducing oxidative enzymes (Mackała et al., 2019). Conversely, endurance training boosts mitochondrial capacity but might impact explosive performance negatively. Interestingly, there is no prior research on how interval training specifically affects amateur soccer players. This study delves into the efficacy of interval training in enhancing both cardiorespiratory endurance and muscular endurance, essential facets for sustaining peak performance in the dynamic sport of football. By meticulously examining the effects of this training program. Therefore, the objective of the study is to find the effect of interval training on cardiorespiratory endurance and muscular endurance football players.

METHOD

Total thirty male football players were randomly selected from the Imphal West District, Manipur (India) who participated in the national level competition. The age groups of subjects were ranged between 18 to 24 years. To measure the cardiorespiratory endurance by using the cooper's 12 minutes run/walk test and the muscular endurance by using the bent knees sit ups test was selected as a test administered. The criterion measures for administering the tests for cardiorespiratory endurance by using the cooper's 12 minutes run/walk test and recorded in minutes (Castro-Piñero et al., 2021).

The muscular endurance by using the bent knees sit ups test was used and measured in number (count in correct number) in per minutes. The goal of the study was to determine how interval training improved football players' cardiorespiratory and muscular endurance. Two equal groups of participants, the experimental group (n = 15) and the control group (n = 15), were randomly allocated. The groups were measured before the intervention with the interval training. The parameters selected for the study were cooper's 12 minutes run/walk test for cardiorespiratory endurance and bent knees sit ups for muscular endurance. The interval training programs were carried out for the period of six weeks, five days training (Monday to Friday) and 60 minutes each session to the training group where the control group did not receive a specific exercise. In additon, this research has been proceeding from 25th October to 25th December 2022.

From the purpose of the study, the study has been training followed by the six-week interval training program. These training program by following the recommended exercise allowance which was suggested in Donath et al. (2014) and Hogan et al. (2013), we have processed total 60 minutes work out with warm-up exercise for 10 min, main exercise for 40 min, warm-down exercise for 10 min. The exercise was applied for 6 weeks with 5 times a week. With increasing the scale and number of exercise movements which increases the intensity of exercise (Singh et al., 2018), we have created a routine that stays within the limits of the peak performance exercise intensity that was previously defined. In addition, when practicing each move, we have focused on safety more than accuracy so we suggested a bit changed movement in parts which was tough to follow. The specific contents of the weekly training programmeme and the interval training programmeme are presented in Tables 1 and 2.

Table 1. Weekly Training Program for Interval Training

Sl. No	Particulars	Duration
1.	Number of weeks	6 weeks
2.	Number of sessions per week	60 minutes
3.	Duration of each training	45 minutes
4.	Rest interval between repetition	3 minutes
5.	Rest interval between exercise	1 minute
6.	Warm up and cooling down	15 minutes

Table 2. Training Program for Interval Training

Sl. No	Days	Time	Repetition	Interval Training
1	Monday	10 mins.	-	Warm Up
		45 mins.	2	Fartlek training
		5 mins.	-	Cooling down
2	Tuesday	10 mins.	-	Warm Up
		45 mins.	9	Sprint interval training
		5 mins.	-	Cooling down
3	Wednesday	10 mins.	-	Warm Up

Sl. No	Days	Time	Repetition	Interval Training
		45 mins.	15	High-intensity interval training
		5 mins.	-	Cooling down
4	Thursday	10 mins.	-	Warming Up
		45 mins.	2	Fartlek training
		5 mins.	-	Cooling Down
5	Friday	10 mins.	-	Warm Up
		45 mins.	9	Sprint interval training
		5 mins.	-	Cooling down
6	Saturday	Rest	Rest	-
7	Sunday	Rest	Rest	-

Statistical Analysis

The collected data were entered into an excel sheet and statistical analyses were conducted using the IBM SPSS software (version 22.0; SPSS Inc., Chicago, IL, USA). The pre and posttest scores where statistical distribution was tested by using descriptive statistics and analysis of covariance test (ANCOVA) was applied to examine differences among groups. The level of significance used in the statistical analyses was 0.05.

Ethical Approval:

The study was approved by the Institutional Human Ethical Committee of Manipur University, Canchipur, Imphal (India) with Ref. No. MU/IHEC/2022/021 and informed consent was obtained from the participants.

RESULT AND DISCUSSION

The result of the study showed that there was significant improvement of cardiorespiratory endurance of selected subjects of the experimental and control group. The descriptive analysis of data collected of pretest and posttest after six weeks of interval training of the experimental and control group was presented in Table 3.

Table 3. Pre and Post Means Score of Cardiorespiratory Endurance for Experimental and Control Group

Variables	Test	Experimental Group	Control Group	Source of Variance	Sum of Square	df	Mean Square	'F' Ratio
Cardio Respiratory Endurance	Pretest	25.68	25.85	Between	1.1374	2	1.1374	1.620
				Within	3.020	28	1.0640	
	Posttest	27.82	26.25	Between	1.391	2	1.391	14.640*
				Within	3.726	28	1.310	
	Adjusted Post mean test	26.86	25.88	Between	75379.8	2	75379.8	58.84*
				Within	45754.2	27	2515.8	
	Mean Diff.	-2.14	-0.04					

Significant at .05 level, Table F-ratio at 0.05 level of confidence for 2 and 28 (df) =4.20 and 57 (df) =4.215.

As shown in Tables 3, the obtained pre-test means on cardiorespiratory endurance on interval training group was 25.68 and control group was 25.85. The obtained pre-test F-value was 1.620 and the required table F-value was 4.20, which proved that there was no significant difference among initial scores of the subjects. The obtained post-test means on cardiorespiratory endurance on interval training group was 27.82 and control group was 26.25. The obtained post-test F-value was 14.640* and the required table F-value was 4.20, which proved that there was significant difference among post-test scores of the subjects. Taking into consideration of the pre-test means and post-test means adjusted post-test means were determined and analysis of covariance was done and the obtained F-value 58.84* was greater than the required value of 4.20 and hence, it was accepted that there were significant differences among the treated groups. Further, the mean score of cardiorespiratory endurance for the experimental group, control group, and adjusted post mean test were presented in Figure 1.

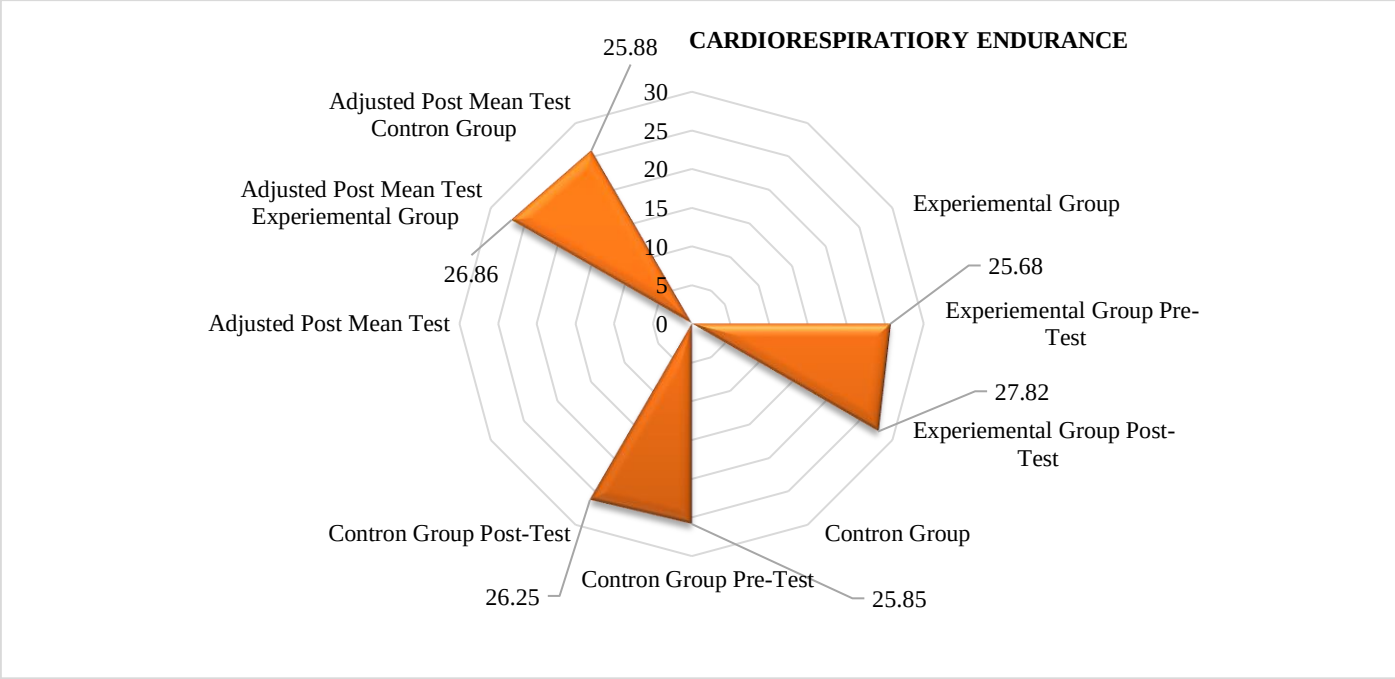

Figure 1. Graphical Presentation on Pre and Post Means Score of Cardiorespiratory Endurance for Experimental Group, Control Group and Adjusted Post Mean Test

Since, significant differences were recorded, the results were subjected to post hoc analysis using Scheffe's Confidence Interval test. The results were presented in Table 4.

Table 4. Scheffe's Confidence Interval Test Scores on Cardiorespiratory Endurance

Experimental Group	Control Group	Mean Difference	Required CI
26.86	25.88	-1.09	4.00

Further, the result of the study showed that there was insignificant improvement of muscular endurance of selected subjects of the experimental and control group. The descriptive analysis of data collected of pretest and posttest after six weeks of interval training of the experimental and control group was presented in Table 5.

Table 5. Pre and Post Means Score of Muscular Endurance for Experimental and Control Group.

Variables	Test	Experimental Group	Control Group	Source of Variance	SS	df	Mean Square	'F' Ratio
Muscular Endurance	Pretest	28.24	28.42	Between Within	54.246 426.52	2 28	54.246 21.261	3.40
	Posttest	32.58	28.80	Between Within	418.5 425.28	2 28	418.5 27.62	26.20*
	Adjusted Post mean test	34.42	30.04	Between Within	238.28 48.28	2 27	238.28 2.82	85.82*
	Mean Diff.	-4.34	-0.38					

Significant at .05 level, Table F-ratio at 0.05 level of confidence for 2 and 28 (df) = 4.20 and 57 (df) = 4.215.

As shown in Table 5, the obtained pre-test means on muscular endurance on interval training group was 28.24 and control group was 28.42. The obtained pretest F-value was 3.40 and the required table F-value was 4.20, which proved that there was no significant difference among initial scores of the subjects. The obtained posttest means on muscular endurance on interval training group was 32.58 and control group was 28.80. The obtained posttest F-value was 26.20* and the required table F-value was 4.20, which proved that there was significant difference among posttest scores of the subjects. Taking into consideration of the pretest means and posttest means adjusted posttest means were determined and analysis of covariance was done and the

obtained F-value 85.82* was greater than the required value of 4.20 and hence, it was accepted that there were significant differences among the treated groups. Further, the mean score of muscular endurance for the experimental group, control group, and adjusted post mean test were presented in Figure 2.

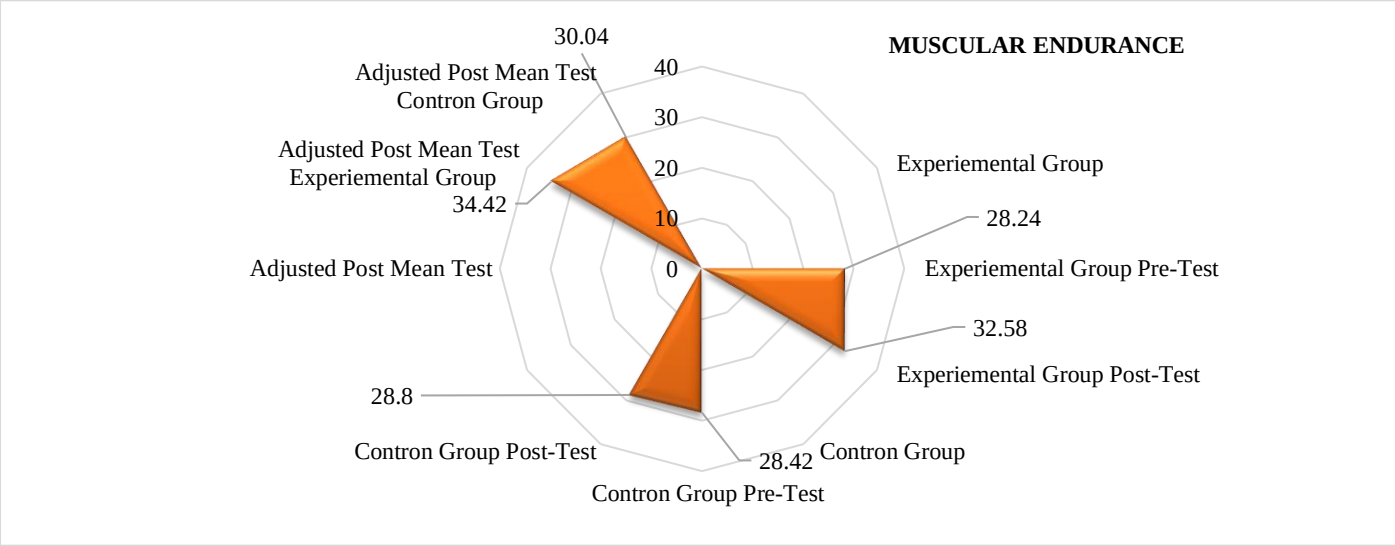

Figure 2. Graphical Presentation on Pre and Post Means Score of Muscular Endurance for Experimental Group, Control Group and Adjusted Post Mean Test

Since, significant differences were recorded, the results were subjected to post hoc analysis using Scheffe's Confidence interval test. The results were presented in Table 6.

Table 6. Scheffe's Confidence Interval Test Scores on Cardiorespiratory Endurance

Experimental Group	Control Group	Mean Difference	Required CI
34.42	30.04	-2.36	4.12

The result of the study indicates that the interval training group had significantly improved the selected dependent variables namely cardiorespiratory endurance and muscular endurance however control group did not show any improvement on the selected variables as it was not involved in any of the specific training means. It is inferred from the results of the present study that all the dependent variables were significantly improved due to the influence interval training program. In the present study, a significant increase was predicted on endurance in the interval training group. Such advancement is consistent with earlier research on exercise training. Zhang et al. (2023) and may appear unexceptional. Nevertheless, it is important to note that these improvements in cardiorespiratory fitness have had a relatively modest effect on the amount of exercise. In the exercise of about six minutes a day, Fartlek training has been shown to have an equivalent improvement for maximal oxygen conception as being walked in 45 minutes every day. Furthermore, continuing this level of training by a further 4-6 weeks has been shown to further improve and in the case of very unfit men by as much as 25%.

Kulothungan and Kirubananth (2023) conducted a study on effect of aerobic training on performance during soccer matches and concluded that the training group improved soccer performance by increasing cardiorespiratory endurance. Zhang et al. (2023) conducted a study of high intensity exercise and concluded that to sustain muscle contraction, ATP needs to be regenerated at a rate complementary to ATP demand and which improved the cardiorespiratory endurance (Falcone et al., 2015). Furthermore, Gillen et al. (2016) also found a significant improvement in sprint performance in adolescent soccer players in response to both high intensity and high-volume training. The findings of Thomas et al. (2022) showed that there was a significant improvement in cardiorespiratory endurance after the resistance training program. Singh et al. (2022b) reported that an experimental group showed improved scores in resting heart rate and cardiorespiratory endurance compared to the control group ($p < 0.05$). The findings of Thomas et al. (2022) showed that there

was a significant improvement in cardiorespiratory endurance after the resistance training program. Singh et al. (2022b) reported that an experimental group showed improved scores in resting heart rate and cardiorespiratory endurance compared to the control group ($p < 0.05$). The mean of the resting heart rate for the pre-test and post-test of the experimental group were 58.60 and 56.45 respectively. The values of the cardiorespiratory endurance were 72.41 and 80.47 respectively. The significant improvement in skipping rope training of the experimental group might be due to the six weeks of the soccer players. Skipping rope training programs significantly improved physiological variables such as resting heart rate and motor fitness variables such as cardiorespiratory endurance of the male soccer players. Kirthika et al. (2019) and Singh et al. (2022a) studied the effects of stair climbing on selected endurance parameters such as cardiorespiratory endurance and muscular endurance among football players, and the result of this study reported that the stair climbing programmed improves cardiorespiratory endurance and muscular endurance among football players as compared to the control group.

Moreover, Dodd and Newans (2018) examined the viability of useful preparation for football. They found that flexibility, power, speed, endurance, and football skills improved after functional training. Gavanda et al. (2022) also indicated similar results in 7-weeks of functional training on fitness ability outcomes in young adults. Further, Allison et al. (2017); Bassuk and Manson (2014), and Singh et al. (2022a) observed a critical enhancement in physical wellness components (speed, endurance, muscular endurance, strength, explosive power, flexibility, and agility).

CONCLUSION

The study revealed enhancements in both cardiorespiratory and muscular endurance among football players due to the interval training program, several limitations should be considered. The relatively modest sample size drawn from a specific geographic region may constrain the broader applicability of these findings to a more diverse population. Additionally, the absence of varied activities within the control group could have affected the observed outcomes, suggesting a need for a more diversified control regimen to better understand the specific impact of the interval training program on athletic performance. In conclusion, that the interval training was significantly improved the endurance parameters such as cardiorespiratory endurance and muscular endurance among Football players of Imphal West District, Imphal, Manipur (India). In addition, similar studies may also recommend other games and sports in order to enhance the performance of the players.

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CONFLICT OF INTEREST

There is no conflict of Interest.

REFERENCE

Allison, M. K., Baglole, J. H., Martin, B. J., Macinnis, M. J., Gurd, B. J., & Gibala, M. J. (2017). Brief Intense Stair Climbing Improves Cardiorespiratory Fitness. *Medicine & Science in Sports & Exercise*, *49*(2), 298–307. https://doi.org/10.1249/MSS.0000000000001188

Atakan, M. M., Guzel, Y., Shrestha, N., Kosar, S. N., Grgic, J., Astorino, T. A., Turnagol, H. H., & Pedisic, Z. (2022). Effects of High-Intensity Interval Training (HIIT) and Sprint Interval Training (SIT) on Fat Oxidation during Exercise: a Systematic Review and Meta-Analysis. *British Journal of Sports Medicine*, *56*(17), 988–996. https://doi.org/10.1136/bjsports-2021-105181

Barrera-Díaz, J., Figueiredo, A. J., Field, A., Ferreira, B., Querido, S. M., Silva, J. R., Ribeiro, J., Pinto, I., Cornejo, P., Torres, H., Saffa, A., & Sarmento, H. (2023). Contemporary Practices of Physical Trainers in Professional Soccer: A Qualitative Study. *Frontiers in Psychology*, *14*, 1101958. https://doi.org/10.3389/fpsyg.2023.1101958

Bassuk, S. S., & Manson, J. E. (2014). Physical Activity and Health in Women. *American Journal of Lifestyle Medicine*, *8*(3), 144–158. https://doi.org/10.1177/1559827613510870

Briand, J., Tremblay, J., & Thibault, G. (2022). Can Popular High-Intensity Interval Training (HIIT) Models Lead to Impossible Training Sessions? *Sports*, *10*(1), 10. https://doi.org/10.3390/sports10010010

Castro-Piñero, J., Marin-Jimenez, N., Fernandez-Santos, J. R., Martin-Acosta, F., Segura-Jimenez, V., Izquierdo-Gomez, R., Ruiz, J. R., & Cuenca-Garcia, M. (2021). Criterion-Related Validity of Field-Based Fitness Tests in Adults: A Systematic Review. *Journal of Clinical Medicine*, *10*(16), 3743. https://doi.org/10.3390/jcm10163743

Cossich, V. R. A., Carlgren, D., Holash, R. J., & Katz, L. (2023). Technological Breakthroughs in Sport: Current Practice and Future Potential of Artificial Intelligence, Virtual Reality, Augmented Reality, and Modern Data Visualization in Performance Analysis. *Applied Sciences*, *13*(23), 12965. https://doi.org/10.3390/app132312965

Dodd, K. D., & Newans, T. J. (2018). Talent Identification for Soccer: Physiological Aspects. *Journal of Science and Medicine in Sport*, *21*(10), 1073–1078. https://doi.org/10.1016/j.jsams.2018.01.009

Donath, L., Faude, O., Roth, R., & Zahner, L. (2014). Effects of Stair-Climbing on Balance, Gait, Strength, Resting Heart Rate, and Submaximal Endurance in Healthy Seniors. *Scandinavian Journal of Medicine & Science in Sports*, *24*(2). https://doi.org/10.1111/sms.12113

Falcone, P. H., Tai, C.-Y., Carson, L. R., Joy, J. M., Mosman, M. M., McCann, T. R., Crona, K. P., Kim, M. P., & Moon, J. R. (2015). Caloric Expenditure of Aerobic, Resistance, or Combined High-Intensity Interval Training Using a Hydraulic Resistance System in Healthy Men. *Journal of Strength and Conditioning Research*, *29*(3), 779–785. https://doi.org/10.1519/JSC.0000000000000661

Farooque, S., Das, P. K., Mitra, M., & Dhar, K. (2023a). Effect of 12 Weeks SAQ and Circuit Training on Dribbling and Shooting Ability of Soccer Player. *European Journal of Physical Education and Sport Science*, *9*(5), 74-81. https://doi.org/10.46827/ejpe.v9i5.4750

Farooque, S., Mitra, M., & Das, P. K. (2023b). Effect of 12-Week Endurance Training on Biochemical Parameters in Elite Football Players: a Comprehensive Analysis. *Journal Sport Area*, *8*(3), 388–395. https://doi.org/10.25299/sportarea.2023.vol8(3).13856

Farrow, D., & Robertson, S. (2017). Development of a Skill Acquisition Periodisation Framework for High-Performance Sport. *Sports Medicine*, *47*(6), 1043–1054. https://doi.org/10.1007/s40279-016-0646-2

Faude, O., Schnittker, R., Schulte-Zurhausen, R., Müller, F., & Meyer, T. (2013). High Intensity Interval Training vs. High-Volume Running Training during Pre-Season Conditioning in High-Level Youth Football: A Cross-Over Trial. *Journal of Sports Sciences*, *31*(13), 1441–1450. https://doi.org/10.1080/02640414.2013.792953

Gavanda, S., Isenmann, E., Geisler, S., Faigenbaum, A., & Zinner, C. (2022). The Effects of High-Intensity Functional Training Compared with Traditional Strength or Endurance Training on Physical Performance in Adolescents: A Randomized Controlled Trial. *Journal of Strength and Conditioning Research*, *36*(3), 624–632. https://doi.org/10.1519/JSC.0000000000004221

Gillen, J. B., Martin, B. J., MacInnis, M. J., Skelly, L. E., Tarnopolsky, M. A., & Gibala, M. J. (2016). Twelve Weeks of Sprint Interval Training Improves Indices of Cardiometabolic Health Similar to Traditional Endurance Training despite a Five-Fold Lower Exercise Volume and Time Commitment. *PLOS ONE*, *11*(4), e0154075. https://doi.org/10.1371/journal.pone.0154075

Halder, S., & Chakraborty, B. (2014). Effect of a Specific Training Programme on Development of Soccer Playing Ability of 14-Year-Old Young Soccer Players. *International Journal of Physical Education, Fitness and Sports*, *3*(3), 39–44. https://doi.org/10.26524/1438

Harrison, C., Kinugasa, T., Gill, N., & Kilding, A. (2015). Aerobic Fitness for Young Athletes: Combining Game-based and High-intensity Interval Training. *International Journal of Sports Medicine*, *36*(11), 929–934. https://doi.org/10.1055/s-0034-1396825

Hogan, C. L., Mata, J., & Carstensen, L. L. (2013). Exercise holds immediate benefits for affect and cognition in younger and older adults. *Psychology and Aging*, *28*(2), 587–594. https://doi.org/10.1037/a0032634

Hughes, D. C., Ellefsen, S., & Baar, K. (2018). Adaptations to Endurance and Strength Training. *Cold Spring Harbor Perspectives in Medicine*, *8*(6), 1-18. https://doi.org/10.1101/cshperspect.a029769

Kirthika, S. V., Lakshmanan, R., Padmanabhan, K., Sudhakar, S., & Selvam, P. S. (2019). The Effect of Skipping rope Exercise on Physical and Cardiovascular fitness among Collegiate Males. *Research Journal of Pharmacy and Technology*, *12*(10), 4831. https://doi.org/10.5958/0974-360X.2019.00836.9

Kulothungan, M., & Kirubananth, V. (2023). Effect of Aerobic Training on Selected Skill Related Performance Variables among Soccer Players. *International Journal of Physical Education, Sports and Health*, *10*(1), 247-249.

Mackała, K., Kurzaj, M., Okrzymowska, P., Stodółka, J., Coh, M., & Rożek-Piechura, K. (2019). The Effect of Respiratory Muscle Training on the Pulmonary Function, Lung Ventilation, and Endurance Performance of Young Soccer Players. *International Journal of Environmental Research and Public Health*, *17*(1), 234. https://doi.org/10.3390/ijerph17010234

Mohr, M., Nassis, G. P., Brito, J., Randers, M. B., Castagna, C., Parnell, D., & Krustrup, P. (2022). Return to Elite Football after the COVID-19 Lockdown. *Managing Sport and Leisure*, *27*(1–2), 172–180. https://doi.org/10.1080/23750472.2020.1768635

Mujika, I., Halson, S., Burke, L. M., Balagué, G., & Farrow, D. (2018). An Integrated, Multifactorial Approach to Periodization for Optimal Performance in Individual and Team Sports. *International Journal of Sports Physiology and Performance*, *13*(5), 538–561. https://doi.org/10.1123/ijspp.2018-0093

Novack, L. F., Souza, G. C. de, Conde, J. H. S., Souza, R. O. de, & Osiecki, R. (2018). Quantification of Match Internal Load and its Relationship with Physical Fitness and Recovery State of Professional Soccer Athletes during the Competitive Period. *Human Movement*, *19*(3), 30–37. https://doi.org/10.5114/hm.2018.76077

Reiman, M. P., & Lorenz, D. S. (2011). Integration of Strength and Conditioning Principles Into a Rehabilitation Program. *International Journal of Sports Physical Therapy*, *6*(3), 241–253. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3164002/

Ryan, D., Lewin, C., Forsythe, S., & McCall, A. (2018). Developing World-Class Soccer Players: An Example of the Academy Physical Development Program from an English Premier League Team. *Strength & Conditioning Journal*, *40*(3), 2–11. https://doi.org/10.1519/SSC.0000000000000340

Singh, L. S., Lamani, C. G., & Goa, P. K. K. B., (2016). Study of Training Load On Selected Physical and Physiological Variables of Soccer Players of Manipur State. Academic Sports Scholars, 5(11), 1-10. https://doi.org/10.13140/RG.2.2.12826.47042

Singh, L. S., Singh, S. O., & Thapa, S. K. (2018). Effect of Plyometric and Weight Training on Selected Physiological Variable of Football Players. Journal of Advances in Sports and Physical Education, 1(3), 75-78. https://doi.org/10.36348/jaspe.2018

Singh, L. S., Pungding, L., Singh, W. J., Bjelica, B., Burhaein, E., & Zelenovic, M. (2022a). Effect of Skipping Rope Training on Resting Heart Rate and Cardiorespiratory Endurance Among Soccer Players. *JUMORA: Jurnal Moderasi Olahraga*, *2*(2), 115–124. https://doi.org/10.53863/mor.v2i2.426

Singh, L. S., Singh, S. O., Devi, O. P., Singh, W. J., & Singh, s. Sen. (2022b). Effect of Pranayama Exercise on Breath-Holding Capacity of Soccer Players. *International Journal of Disabilities Sports and Health Sciences*, *5*(2), 97–105. https://doi.org/10.33438/ijdshs.1172462

Seçkin, A. Ç., Ateş, B., & Seçkin, M. (2023). Review on Wearable Technology in Sports: Concepts, Challenges and Opportunities. *Applied Sciences*, *13*(18), 10399. https://doi.org/10.3390/app131810399

Thomas, H. J., Marsh, C. E., Maslen, B. A., Lester, L., Naylor, L. H., & Green, D. J. (2022). Endurance Versus Resistance Training in Treatment of Cardiovascular Risk Factors: A Randomized Cross-Over Trial. *PLOS ONE*, *17*(9), e0274082. https://doi.org/10.1371/journal.pone.0274082

Turner, A. N., & Stewart, P. F. (2014). Strength and Conditioning for Soccer Players. *Strength & Conditioning Journal*, *36*(4), 1–13. https://doi.org/10.1519/SSC.0000000000000054

Wang, M., & Zhang, J. (2023). Effect of High-Intensity Interval Training on Football Players' Performance. *Revista Brasileira de Medicina Do Esporte*, *29*. e2022-e2038. https://doi.org/10.1590/1517-8692202329012022_0238

Yan, S., Kim, Y., & Choi, Y. (2022). Aerobic and Anaerobic Fitness according to High-Intensity Interval Training Frequency in Youth Soccer Players in the Last Stage of Rehabilitation. *International Journal of Environmental Research and Public Health*, *19*(23), 15573. https://doi.org/10.3390/ijerph192315573

Zhang, Z. Y., Ji, H. S., He, J. X., Huang, L. J., Ding, S. C., Sun, J., & Li, D. Y. (2023). A Meta-analysis of the Effects of High-Intensity Interval Training and Small-Sided Games on Sprint Performance in Adolescents. *Strength & Conditioning Journal*, *45*(5), 587–597. https://doi.org/10.1519/SSC.0000000000000773