Vol. 11, No. 2, 2026, pp. 115-122
DOI: https://doi.org/10.29210/027111jpgi0005

Contents lists available at Journal IICET

JPGI (Jurnal Penelitian Guru Indonesia)
ISSN: 2541-3163(Print) ISSN: 2541-3317 (Electronic)

Journal homepage: https://jurnal.iicet.org/index.php/jpgi

The effect of interval training on the anaerobic endurance capacity of a high school futsal team

Razandra Zhafran*), Alex Aldha Yudi, Ikhwanul Arifan, Bram Sujadesman
Universitas Negeri Padang, Indonesia

Article Info

Article history:

Received Jun 21th, 2026
Revised Jun 24th, 2026
Accepted Jun 25th, 2026

Keywords:

Interval training
Anaerobic endurance
Futsal performance
High school athletes
Physical conditioning

ABSTRACT

The initial round of observations and the Running-based Anaerobic Sprint Test (RAST) have shown that members of the SMA Negeri 4 Batam futsal team have a low level of anaerobic endurance. Most players fall into the moderate category, which means their ability to keep up the intensity of performance in the second half of the games is compromised. Futsal, being a high-intensity intermittent sport, depends a lot on the anaerobic energy system, so without a good training method, it is quite a challenge to raise the players' anaerobic capacity. On the other hand, this study was developed to find out whether interval training works in boosting anaerobic endurance of the SMA Negeri 4 Batam futsal team. Experimental research was conducted quasi-experimentally. Anaerobic endurance was tested by RAST. Treatment was interval training program for 16 sessions. Using the Shapiro-Wilk normality test and paired-sample t-test at a 0.05 level of significance the data were analyzed. The current study focuses on the topic of improving the anaerobic endurance through the methods of training. The results showed that participants' anaerobic endurance significantly increased after completing the interval training program. The paired-sample t-test revealed that the value of t calculated (6.332) was greater than the critical t value (2.145), with a significance level of 0.000 ($p < 0.05$). The present study demonstrates that interval training substantially improves anaerobic endurance of futsal players. Thus, one can adopt interval training as a way to improve the anaerobic performance and, thereby, support the optimal match performance of very high-intensity activities in futsal.

© 2026 The Authors. Published by IICET.
This is an open access article under the CC BY-NC-SA license
(https://creativecommons.org/licenses/by-nc-sa/4.0)

Corresponding Author:

Razandra Zhafran,
Universitas Negeri Padang
Email: razandraaa@gmail.com

Introduction

Sport comes as an effective solution to improving physical fitness, maintaining health, and enhancing human performance. Besides health benefits, sport has become a critical tool for accomplishment character building, and students' education. Futsal, one of the most favorite sports of Indonesian teenagers, is a very fast team game with players requiring continuous bouts of high-intensity actions over a match (Spyrou et al., 2020; Leite, 2016).

Futsal includes a mix of sprinting, quick movements, stops, starts and technical-tactical moves in a very small area of the court (Castagna et al., 2009; Barbero-Alvarez et al., 2008). Such features put very high strain on the anaerobic energy system and, therefore, anaerobic endurance is one of the most important aspects of futsal performance. Players with very good anaerobic endurance can perform high-intensity work better, they can recover faster between two actions, and be able to keep high level of performance all over the match. On the

other hand, players with poor anaerobic endurance will experience early fatigue, their movement efficiency will decrease, and their tactical effectiveness will get lower especially in the second half of the game (Dos-Santos et al., 2020; Rodrigues et al., 2011).

Anaerobic endurance is about how well a person can carry out very demanding exercises more than once over a period without getting tired (Castagna & Barbero Alvarez, 2010). This physical aspect is very important in futsal since the game consists of the players making many maximal efforts of short duration and having very little time for recovery. If a player is able to keep going and getting back even after doing short very powerful activities few times in the row, it can have a big effect on both his performance and that of the team (Baldi et al., 2017). As a result, coaches are always looking for the best ways to train their players so that they become stronger anaerobically and less prone to fatigue.

During early observations of the futsal team at SMA Negeri 4 Batam, it was found that a large number of players' abilities significantly dropped toward the end of the matches. Discussions with the team's coach revealed that the players started to feel very tired, moved less vigorously, and their coordination deteriorated during the second half of the games. Besides, the outcomes of the Running-based Anaerobic Sprint Test (RAST) showed that the majority of players were at a moderate level of anaerobic endurance, which implies that their physical fitness was not fully at the level required to cope with the demands of competitive futsal.

Interval training is one of the most effective ways to increase anaerobic endurance. It involves short bursts of highly intense exercise with intervals of active or passive rest between the sessions (Buchheit & Laursen, 2013a; Gibala, 2021). In this way, athletes can get a powerful physiological push from the anaerobic energy system and, at the same time, be able to complete a bigger overall training volume than if they only did continuous high-intensity exercises (Buchheit & Laursen, 2013b; Coates et al., 2023). Some studies found that team-sport athletes, including futsal players, who underwent interval training achieved significant improvements in their anaerobic capacity, sprint performance, and fatigue resistance (Taylor et al., 2016; Fahrudin et al., 2024).

Many studies have explored the benefits of interval training on performance enhancement (Engel et al., 2018; Martin-Smith et al., 2020; Matzka et al., 2025). However, to date, research on high school futsal players in Batam is scarce. More importantly, not a single study has been conducted on the effectiveness of interval training in enhancing the anaerobic endurance of the SMA Negeri 4 Batam futsal team. Thus this deficiency of empirical data is a research gap that needs to be addressed.

Although previous studies have reported the effectiveness of interval training in improving anaerobic performance among athletes, evidence involving Indonesian high-school futsal players remains limited. Furthermore, no study has specifically investigated the effects of a structured 16-session interval training program on anaerobic endurance among futsal athletes at SMA Negeri 4 Batam using the RAST fatigue index as the primary outcome measure. Therefore, this study contributes new empirical evidence regarding the practical application of interval training in school-based futsal development programs.

This study focused on determining the influence of interval training on the anaerobic endurance of the Batam State High School 4 futsal team. The research hypothesis was that a well-organized interval training program would lead to a considerable enhancement of players' anaerobic endurance, assessed through the Running-based Anaerobic Sprint Test (RAST). The results of this research should serve as a useful reference to coaches in the development of conditioning programs as well as in advancing the understanding of physical training of youth futsal players (Sanusi et al., 2025).

Method

This research employed the quasi-experiment method with a one-group pre-test post-test design. The independent variable of the study was interval training and the dependent variable was anaerobic endurance. The research series started with a pre-test. Treatment in the form of an interval training program was given and finally a post-test was conducted. The research was conducted at the Futsal Court of SMA Negeri 4 Batam from December 2025 until February 2026.

Population in this research is all players of the futsal team of SMA Negeri 4 Batam which consists of 15 people. The participants were male futsal players aged 15–18 years who actively participated in school training programs and had at least one year of playing experience. The sampling technique uses total sampling, so all members of the population become the samples of the research. Instrument to measure anaerobic endurance used is RAST (Running-based Anaerobic Sprint Test) test developed by University of Wolverhampton. This test has been proven to be both valid and reliable for measuring anaerobic capacity (Zagatto et al., 2009). The procedure of the test is carrying out six times running a distance of 35 meters each with a rest of 10 seconds

between the runs; the time data is then converted to get a fatigue index that shows anaerobic endurance. The lower the fatigue index, the better its anaerobic endurance category.

Tabel 1 <Exercise Program Table>

Minggu	Frekuensi	Intensitas	Bentuk Latihan
1–2	3x/minggu	80% HRmax	Sprint 20 m
3–4	3x/minggu	85% HRmax	Shuttle Run
5–6	3x/minggu	90% HRmax	Small Sided Games

Tabel 2 <Norma RAST (Running-based Anaerobic Sprint Test)>

Norma (Fatigue Index)	Category
0 – 4	Very Good
4,1 – 10	Good
10,1 – 15	Enough
15,1 – 20	Less
> 21	Very Less

Source: Marckenzie (2005)

There were as many as 16 meetings for treatment, each lasting about ± 90 minutes. The training program implements the principle of interval by alternating very intense work (sprint around the court, repeated 20 m sprint, shuttle run, and small-sided games 2 vs 2 and 3 vs 3) with rest (recovery) time for each rep and set (Köklü et al., 2011; Rampinini et al., 2007; Moran et al., 2019; Clemente et al., 2021; Iaia et al., 2017). Training load is increased progressively after each meeting block. The data analysis technique employed the Shapiro-Wilk normality test and the paired sample t-test hypothesis test at the significance level of $\alpha = 0.05$ using SPSS version 16 program. The alternative hypothesis (Ha) is accepted if the calculated t-value is greater than the table t and the significance value is less than 0.05. Prior to data collection, informed consent was obtained from all participants and permission was granted by the school administration. The study procedures followed the ethical principles of the Declaration of Helsinki.

Results and Discussions

According to the pre-test results, the anaerobic endurance capacity of the futsal players of SMA Negeri 4 Batam was still at a moderate level, with the lowest (best) fatigue index value was 5.91 and the highest (worst) was 15.68. The distribution frequency of the pre-test results can be seen in Table 3.

Table 3 <Frequency Distribution of Pre-Test Results>

Interval Classes	Absolute Frequency	Relative Frequency (%)	Category
0 – 4	0	0	Very Good
4,1 – 10	1	6,7	Good
10,1 – 15	13	86,7	Enough
15,1 – 20	1	6,7	Less
> 21	0	0	Very Less
Jumlah	15	100	

Source: Primary data processed (2026)

Most of the changes happened after the 16-session interval training program. According to the post-test results, 1 person (6.7%) was very good, 13 people (86.7%) were good, and 1 person (6.7%) was fair. The average score of the post-test from the descriptive statistical analysis was 8.31; median 8.32; standard deviation 2.59; minimum score, 3.70; and the maximum score, 14.46. The gradually lowered fatigue index average of 11.46 to 8.31 also reflects improved anaerobic endurance of the players.

Table 4 <Frequency Distribution of Post-Test Results>

Interval Classes	Absolute Frequency	Relative Frequency (%)	Category
0 – 4	1	6,7	Very Good
4,1 – 10	13	86,7	Good
10,1 – 15	1	6,7	Enough
15,1 – 20	0	0	Less
> 21	0	0	Very Less
Jumlah	15	100	

Source: Primary data processed (2026)

The post-test results showed a significant improvement, after interval training was given for 16 meetings. The results are: 1 person (6.7%) was categorized as very good, 13 people (86.7%) as good, and 1 person (6.7%) as fair. The descriptive statistics of post-test results revealed that the mean score was 8.31; the median score was 8.32; the standard deviation was 2.59; the minimum score was 3.70; and the maximum value was 14.46. The average reduction of the fatigue index from 11.46 to 8.31 signified the development of the player's anaerobic endurance ability.

Table 5 <Comparison of Descriptive Statistics of Pre-Test and Post-Test>

Statistics	Pre-Test	Post-Test
N	15	15
Mean	11,46	8,31
Median	10,80	8,32
Std. Deviation	2,37	2,59
Minimum	5,91	3,70
Maximum	15,68	14,46

Source: SPSS version 16 output results (data processed, 2026)

$$\text{Improvement} = \frac{11.46-8.31}{11.46} \times 100 = 27.49\%$$

The interval training program reduced the fatigue index by approximately 27.49%, indicating a meaningful improvement in anaerobic endurance.

Cohen's d

$$d = \frac{11.46-8.31}{2.49} = 1.26$$

Interpretasi: Cohen's d = 1.26 indicated a large practical effect of interval training on anaerobic endurance.

The data normality test was the first step; the hypothesis test would only be carried out after. It was a Shapiro-Wilk Test with a 0.05 significance level. The significance value for pre-test was 0.053 and for the post-test 0.681. With both significance values from the two test samples being higher than 0.05, it suggests that the research data are normally distributed which can be seen in Table 6.

Table 6 <Shapiro-Wilk Normality Test Results>

Groups	Sig. Shapiro-Wilk	α	Remarks
Pre-Test	0,053	0,05	Normal
Post-Test	0,681	0,05	Normal

Source: SPSS version 16 output results (data processed, 2026)

The data being normally distributed, the hypothesis testing was done by a paired sample t-test. The degrees of freedom (df) = n 1 = 15 1 = 14, so the t table at a = 0.05 comes out to be 2.145 (both sides). The findings of hypothesis testing are shown in Table 7.

Table 7 <Paired Sample T-Test>

Kelompok	Mean	SD	t hitung	t tabel	Sig.
Pre-Test	11,4687	2,37786	6,332	2,145	0,000
Post-Test	8,3193	2,59918			

Source: SPSS version 16 output results (data processed, 2026)

According to the data in Table 6, the computed t value of 6.332 exceeds the t value of table 2.145 (6.332 > 2.145) with a significance level of 0.000 < 0.05. Hence, the null hypothesis (H0) was rejected and the alternative hypothesis (Ha) was accepted indicating that the training interval significantly influenced the anaerobic endurance ability of the SMA Negeri 4 Batam futsal team.

Discussion

The results from the present inquiry confirmed that interval training considerably enhanced the anaerobic endurance of the SMA Negeri 4 Batam futsal team. The proof of this advancement was marked in the lowering of the average fatigue index obtained in the Running-based Anaerobic Sprint Test (RAST) from 11.46 during the pre-test to 8.31 during the post-test. Besides, the paired samples t-test disclosed a noteworthy difference between pre-test and post-test scores ($t = 6.332$; $p < 0.05$), which pointed out that the interval training regimen was successful in improving the players' capability to maintain repeated high-intensity efforts.

The gain reported in this research seems to be mainly due to the body as the result of interval exercises (Gibala et al., 2006; MacInnis & Gibala, 2017). Running and sprinting for short times at a high level activate the

anaerobic glycolytic system. This means that the muscles can be able to produce a high amount of adenosine triphosphate (ATP) fast enough to support a short very intense work (Burgomaster et al., 2006; Gillen et al., 2016). On top of that, consistent interval training is capable of boosting the speed of phosphocreatine resynthesis, the capacity to buffer lactate, and the efficiency of neuromuscular functioning (Burgomaster et al., 2008; Gibala et al., 2012). With these changes, sportsmen can sprint one after another with less tiredness and recover more quickly between the efforts.

The findings have a great deal of significance for futsal players as a game involves player doing different types of movement like sprinting, accelerating, decelerating, changing direction, tackling, and shooting, over and over again within the small play area of the futsal court. During the course of a playing session, players carry out high-intensity physical activities quite often, whereas the periods of rest are usually very short (Spyrou et al., 2020; Ojeda-Aravena et al., 2021). As a result, nature of the performance of players with the best anaerobic endurance, is such that, they are most likely to be able to sustain their execution of skill and game plan during the whole playing time (Yue et al., 2025; Zhang et al., 2024). The decrease in fatigue index that is revealed in this work denotes that the players have got physically tougher and more able to cope with the exercise stress of futsal competition.

This study's results agree with prior research. Fahrudin et al. (2024) found that interval training contributed to a substantial increase in anaerobic endurance of futsal players, as evidenced by their enhanced ability to engage in repeated high-intensity efforts. Likewise, Kusuma et al. (2023) identified that small-sided and interval training were two potent methods to augment anaerobic performance of youth players. These consistencies between the current results and previous ones further reinforce the proof that interval training is an excellent conditioning tool for futsal players.

Practically, the enhancement in anaerobic endurance recorded after sixteen training sessions shows that interval training is a viable component of the overall futsal conditioning program at the high school level. Coaches can structure interval training sessions consisted of repeated sprints, shuttle runs, and small-sided games to not only elevate the physical fitness of players but also keep up with the specific movement patterns of the sport (Buchheit & Laursen, 2013b; Ouertatani et al., 2022). Such training will equip players to endure the high-intensity phases of a match, recover quickly between actions, and maintain their performance level in the last phases of the competition.

Despite the positive results, it is important to mention the limitations of this research. To begin with, only fifteen participants took part in the study, making it impossible to fully apply the findings to the wider futsal population. Secondly, the use of a one-group pre-test post-test design without a control group means that it is still challenging to completely attribute the performance improvements to interval training alone without considering other factors. Thirdly, aspects like nutrition, rest, hydration, and physical activity were not tightly regulated during the entire experiment, and they might have influenced the way players reacted to the training program.

They need to have a larger number of people in the study, use the random controlled experiment design for the first time, and follow more physiological variables, such as lactate concentration in the blood, heart rate response, and sprint capacity. This will help them to understand better the enhancement of anaerobic endurance and overall futsal performance through interval training.

These limitations should be considered when interpreting the findings. The absence of a control group limits the ability to establish causal relationships with complete certainty, while the relatively small sample size may reduce the generalizability of the results. Consequently, future studies should employ randomized controlled designs with larger and more diverse participant groups.

Overall, the results showed that interval training is a good way to help high school futsal players improve their anaerobic endurance. The fact that the fatigue index was greatly reduced after the intervention emphasizes how important high-intensity training programs are for helping performance and fitness in competitive futsal.

Conclusions

The findings of this research and the related data analysis have shown that interval training brings about a statistically significant and positive change in anaerobic endurance in the futsal team of SMA Negeri 4 Batam. The athletes' result in the anaerobic endurance test, running-based anaerobic sprint test (RAST), revealed a decrease in fatigue index after 16 sessions of interval training, a clear indication of an improvement in performance. The average fatigue index was 11.46 before going for the interval training (fair category), and it dropped to 8.31 after the training (good category). This improvement indicates that the players were more capable of performing repeated high-intensity efforts, and they also experienced lower fatigue levels during

anaerobic activities. The outcome of paired sample t-test also supports the training program's effectiveness. The t-value of 6.332 is significant as it exceeds the critical t-table value of 2.145; the significance value at 0.000 is below the predetermined alpha of 0.05. For these reasons, the null hypothesis was rejected while the alternate hypothesis was accepted. This confirms that anaerobic endurance of participants has been enhanced by the interval training. As a result, the research suggests that interval training is not only the best method for conditioning athletes but also a method that greatly enhances the physical capacity of futsal players training for their game. The demands of futsal often are matched by a player's sprinting, accelerating, decelerating, and also making rapid changes of direction and other types of explosive movements, which are mimicked in the interval training program. This program provided the anaerobic energy system with enough stimulation for physiological adaptations leading to the improved ability to run with reduced fatigue during high-intensity activities.

The enhancement brought about by the work has, however, a major bearing on the immediate practical aspects of coaching and furthering athlete development. Superior anaerobic endurance is the feature that enables players to extend the duration over which they can perform at high intensity, recover more efficiently from one effort to the next, and are able to fight off decline in performance even in the final stages of competition. This being the case, coaches would do well to utilize interval training frequently as a component of conditioning their players at the level of their fitness and as a means of helping them perform well in the match. This research, apart from being a part of the existing dataset of training methods for youth futsal players, has also specifically addressed the high school level of play. The results offer practical support for the notion that interval training can be utilized to improve anaerobic endurance in young players. In addition, this study attempts to fill the gap in the research on futsal players in Batam and offers relevant information for coaches, PE teachers, and sports practitioners who work with athlete development programs. However, a number of shortcomings have been revealed despite the favorable outcomes. First of all, there were only a few participants, and furthermore, the study has a one-group pre-test post-test design without a control group. Besides, there were external factors, such as nutrition, sleep quality, hydration, and daily physical activities, which have not been systematically controlled throughout the intervention period. These could have some impact on the size of the observed improvements. Subsequently, further investigations are advised to involve more and varied groups of participants and include control groups besides examining other physiological and performance variables for a well-rounded understanding of the impact of interval training. On the other hand, given the confines and limitations of this study, interval training may still be considered an effective way of enhancing anaerobic endurance and an important element among physical conditioning programs for futsal players.

References

Barbero-Alvarez, J. C., Soto, V. M., Barbero-Alvarez, V., & Granda-Vera, J. (2008). Match analysis and heart rate of futsal players during competition. Journal of Sports Sciences, 26(1), 63–73. https://doi.org/10.1080/02640410701287289

Baldi, M., Da Silva, J. F., Buzzachera, C. F., Castagna, C., & Guglielmo, L. G. (2017). Repeated sprint ability in soccer players: Associations with physiological and neuromuscular factors. The Journal of Sports Medicine and Physical Fitness, 57(1–2), 26–32. https://doi.org/10.23736/S0022-4707.16.05776-5

Buchheit, M., & Laursen, P. B. (2013a). High-intensity interval training, solutions to the programming puzzle. Part I: Cardiopulmonary emphasis. Sports Medicine, 43(5), 313–338. https://doi.org/10.1007/s40279-013-0029-x

Buchheit, M., & Laursen, P. B. (2013b). High-intensity interval training, solutions to the programming puzzle. Part II: Anaerobic energy, neuromuscular load and practical applications. Sports Medicine, 43(10), 927–954. https://doi.org/10.1007/s40279-013-0066-5

Burgomaster, K. A., Heigenhauser, G. J. F., & Gibala, M. J. (2006). Effect of short-term sprint interval training on human skeletal muscle carbohydrate metabolism during exercise and time-trial performance. Journal of Applied Physiology, 100(6), 2041–2047. https://doi.org/10.1152/japplphysiol.01220.2005

Burgomaster, K. A., Howarth, K. R., Phillips, S. M., Rakobowchuk, M., MacDonald, M. J., McGee, S. L., & Gibala, M. J. (2008). Similar metabolic adaptations during exercise after low volume sprint interval and traditional endurance training in humans. The Journal of Physiology, 586(1), 151–160. https://doi.org/10.1113/jphysiol.2007.142109

Castagna, C., & Barbero Alvarez, J. C. (2010). Physiological demands of an intermittent futsal-oriented high-intensity test. Journal of Strength and Conditioning Research, 24(9), 2322–2329. https://doi.org/10.1519/JSC.0b013e3181e347b9

Castagna, C., D'Ottavio, S., Granda Vera, J., & Barbero Alvarez, J. C. (2009). Match demands of professional futsal: A case study. Journal of Science and Medicine in Sport, 12(4), 490–494. https://doi.org/10.1016/j.jsams.2008.02.001

Clemente, F. M., Ramirez-Campillo, R., Afonso, J., & Sarmento, H. (2021). Effects of small-sided games vs. running-based high-intensity interval training on physical performance in soccer players: A meta-analytical comparison. Frontiers in Physiology, 12, 642703. https://doi.org/10.3389/fphys.2021.642703

Coates, A. M., Joyner, M. J., Little, J. P., Jones, A. M., & Gibala, M. J. (2023). A perspective on high-intensity interval training for performance and health. Sports Medicine, 53(Suppl 1), 85–96. https://doi.org/10.1007/s40279-023-01938-6

Dos-Santos, J. W., da Silva, H. S., da Silva Junior, O. T., Barbieri, R. A., Penafiel, M. L., da Silva, R. N. B., Milioni, F., Vieira, L. H. P., Coledam, D. H. C., Santiago, P. R. P., & Papoti, M. (2020). Physiology responses and players' stay on the court during a futsal match: A case study with professional players. Frontiers in Psychology, 11, 620108. https://doi.org/10.3389/fpsyg.2020.620108

Engel, F. A., Ackermann, A., Chtourou, H., & Sperlich, B. (2018). High-intensity interval training performed by young athletes: A systematic review and meta-analysis. Frontiers in Physiology, 9, 1012. https://doi.org/10.3389/fphys.2018.01012

Fahrudin, M. F., Siantoro, G., Kusuma, I. D. M. A. W., Syafii, I., Prianto, D. A., Pramono, B. A., & Fajar, M. K. (2024). Enhancing anaerobic endurance in student futsal players through small-sided games combined with high-intensity interval training. Physical Education Theory and Methodology, 24(2), 232–236. https://doi.org/10.17309/tmfv.2024.2.06

Gibala, M. J. (2021). Physiological basis of interval training for performance enhancement. Experimental Physiology, 106(12), 2324–2327. https://doi.org/10.1113/EP088190

Gibala, M. J., Little, J. P., MacDonald, M. J., & Hawley, J. A. (2012). Physiological adaptations to low-volume, high-intensity interval training in health and disease. The Journal of Physiology, 590(5), 1077–1084. https://doi.org/10.1113/jphysiol.2011.224725

Gibala, M. J., Little, J. P., van Essen, M., Wilkin, G. P., Burgomaster, K. A., Safdar, A., Raha, S., & Tarnopolsky, M. A. (2006). Short-term sprint interval versus traditional endurance training: Similar initial adaptations in human skeletal muscle and exercise performance. The Journal of Physiology, 575(3), 901–911. https://doi.org/10.1113/jphysiol.2006.112094

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

Iaia, F. M., Fiorenza, M., Larghi, L., Alberti, G., Millet, G. P., & Girard, O. (2017). Short- or long-rest intervals during repeated-sprint training in soccer? PLoS ONE, 12(2), e0171462. https://doi.org/10.1371/journal.pone.0171462

Köklü, Y., Aş ci, A., Koçak, F. U., Alemdaroğ lu, U., & Dündar, U. (2011). Comparison of the physiological responses to different small-sided games in elite young soccer players. Journal of Strength and Conditioning Research, 25(6), 1522–1528. https://doi.org/10.1519/JSC.0b013e3181e06ee1

Kusuma, K. C. A., Artanayasa, I. W., Sudiana, I. K., & Yudi, A. A. (2023). Enhancing anaerobic endurance in football players: A comparative study of 3-a-side and 5-a-side small-sided games. Journal Sport Area, 8(3), 318–327. https://doi.org/10.25299/sportarea.2023.vol8(3).13150

Leite, W. S. S. (2016). Physiological demands in football, futsal and beach soccer: A brief review. European Journal of Physical Education and Sport Science, 2(6), 1–14. https://doi.org/10.46827/ejpe.v0i0.382

MacInnis, M. J., & Gibala, M. J. (2017). Physiological adaptations to interval training and the role of exercise intensity. The Journal of Physiology, 595(9), 2915–2930. https://doi.org/10.1113/JP273196

Martin-Smith, R., Cox, A., Buchan, D. S., Baker, J. S., Grace, F., & Sculthorpe, N. (2020). High intensity interval training (HIIT) improves cardiorespiratory fitness (CRF) in healthy, overweight and obese adolescents: A systematic review and meta-analysis of controlled studies. International Journal of Environmental Research and Public Health, 17(8), 2955. https://doi.org/10.3390/ijerph17082955

Matzka, M., Leppich, R., Holmberg, H.-C., Sperlich, B., & Zinner, C. (2025). Meta-analysis of high-intensity interval training and alternative modalities for enhancing aerobic and anaerobic endurance in young athletes. Physiological Reports, 13, e70598. https://doi.org/10.14814/phy2.70598

Moran, J., Blagrove, R. C., Drury, B., Fernandes, J. F. T., Paxton, K., Chaabene, H., & Ramirez-Campillo, R. (2019). Effects of small-sided games vs. conventional endurance training on endurance performance in male youth soccer players: A meta-analytical comparison. Sports Medicine, 49(5), 731–742. https://doi.org/10.1007/s40279-019-01086-w

Ojeda-Aravena, A., Herrera-Valenzuela, T., Valdés-Badilla, P., Cancino-López, J., Zapata-Bastias, J., & García-García, J. M. (2021). Inter-individual variability of a high-intensity interval training with specific techniques vs. repeated sprints program in sport-related fitness of taekwondo athletes. Frontiers in Physiology, 12, 766153. https://doi.org/10.3389/fphys.2021.766153

Ouertatani, Z., Selmi, O., Marsigliante, S., Aydi, B., Hammami, N., & Muscella, A. (2022). Comparison of the physical, physiological, and psychological responses of the high-intensity interval (HIIT) and small-sided games (SSG) training programs in young elite soccer players. International Journal of Environmental Research and Public Health, 19(21), 13807. https://doi.org/10.3390/ijerph192113807

Rampinini, E., Impellizzeri, F. M., Castagna, C., Abt, G., Chamari, K., Sassi, A., & Marcora, S. M. (2007). Factors influencing physiological responses to small-sided soccer games. Journal of Sports Sciences, 25(6), 659–666. https://doi.org/10.1080/02640410600811858

Rodrigues, V. M., Ramos, G. P., Mendes, T. T., Cabido, C. E. T., Melo, E. S., Condessa, L. A., Coelho, D. B., & Garcia, E. S. (2011). Intensity of official futsal matches. Journal of Strength and Conditioning Research, 25(9), 2482–2487. https://doi.org/10.1519/JSC.0b013e3181fb4574

Sanusi, R., Arifin, R., & Fauzan, L. A. (2025). Analysis of aerobic and anaerobic endurance in futsal extracurricular. Citius: Jurnal Pendidikan Jasmani, Olahraga, dan Kesehatan, 5(1), 11–18. https://doi.org/10.32665/citius.v5i1.4422

Spyrou, K., Freitas, T. T., Marín-Cascales, E., & Alcaraz, P. E. (2020). Physical and physiological match-play demands and player characteristics in futsal: A systematic review. Frontiers in Psychology, 11, 569897. https://doi.org/10.3389/fpsyg.2020.569897

Taylor, J. M., Macpherson, T. W., McLaren, S. J., Spears, I., & Weston, M. (2016). Two weeks of repeated-sprint training in soccer: To turn or not to turn? International Journal of Sports Physiology and Performance, 11(8), 998–1004. https://doi.org/10.1123/ijspp.2015-0608

Yue, F., Wang, Y., Yang, H., & Zhang, X. (2025). Effects of high-intensity interval training on aerobic and anaerobic capacity in olympic combat sports: A systematic review and meta-analysis. Frontiers in Physiology, 16, 1576676. https://doi.org/10.3389/fphys.2025.1576676

Zagatto, A. M., Beck, W. R., & Gobatto, C. A. (2009). Validity of the running anaerobic sprint test for assessing anaerobic power and predicting short-distance performances. Journal of Strength and Conditioning Research, 23(6), 1820–1827. https://doi.org/10.1519/JSC.0b013e3181b3df32

Zhang, Z., Xie, L., Ji, H., Chen, L., Gao, C., & He, J. (2024). Effects of different work-to-rest ratios of high-intensity interval training on physical performance and physiological responses in male college judo athletes. Journal of Exercise Science & Fitness, 22(3), 245–253. https://doi.org/10.1016/j.jesf.2024.03.009