

Effect of Extensive Interval Training on Endurance Performance in Long-Distance Runners

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ABSTRACT: This study discusses the low endurance of Club Fair Running athletes in the long-distance running category (5000 and 10,000 meters). This condition can be seen from the tendency of athletes to experience fatigue earlier when doing long-distance running which has a negative impact on their performance and running results. The purpose of this study was to determine the effect of extensive interval training on increasing the endurance of long-distance athletes (5000 and 10,000 meters). This study used a quasi-experimental method with a one-group pretest-posttest design. The population in this study were 20 Fair Running athletes. The research sample was selected by purposive sampling based on certain criteria, namely 15 male athletes who were specialists in long-distance running (5000 and 10,000 meters aged between 20 and 27 years. The instrument used was a 12-minute running test (Cooper Test) which was carried out before and after the training intervention. The results showed that extensive interval training had a significant effect on increasing endurance. The calculated t value (8.03) is greater than the critical t value (1.753) which indicates a statistically significant difference. Furthermore, the pre-test mean value of 1834.67 increased to 1929.33 in the post-test. Thus, it can be concluded that extensive interval training is effective in improving the endurance performance of Fair Running athletes in long-distance running races of 5000 and 10,000 meters).

KEYWORDS: Long-distance, aerobic, endurance, athletic, extensive interval

I. INTRODUCTION

Track and field is one of the oldest and most fundamental forms of sport, with historical evidence tracing its existence back to Ancient Greece around the sixth century BCE. Archaeological findings and historical records indicate that athletic activities such as running, jumping, and throwing formed an integral part of Greek civilization and later evolved into organized competitive events (Mardia & Yuliawan, 2024; Sukendro & Yuliawan, 2019). Today, athletics remains a cornerstone of modern sports because it encompasses basic human movement patterns that underpin performance in many other sporting disciplines (Efendi et al., 2024; Hidayat et al., 2021).

Among the various disciplines within athletics, long-distance running requires a high level of physiological adaptation, particularly aerobic endurance. Endurance is the ability of the body to sustain physical activity for an extended period while delaying the onset of fatigue (Indrayana, 2012; Indrayana & Yuliawan, 2019). For long-distance runners, endurance serves as a critical determinant of performance because it enables athletes to maintain running speed and efficiency throughout the race (Blagrove et al., 2020; García-Pinillos et al., 2021; Morishima et al., 2021). Therefore, the development of endurance capacity is a primary objective in long-distance training programs.

Training is a systematic, planned, repetitive, and progressive process designed to improve an athlete's physical, technical, tactical, and psychological capacities (DeWeese et al., 2015). The effectiveness of a training program is strongly influenced by the selection of appropriate training methods that correspond to the physiological demands of the sport. In endurance-based events, one of the most widely applied methods is interval training (Delfan et al., 2026; González-Fernández et al., 2026; Regalado-Cabello et al., 2026; Wang et al., 2026; Wei et al., 2025). Interval training consists of repeated bouts of exercise interspersed with recovery periods, allowing athletes to accumulate a greater training volume at a specific intensity than would be possible during continuous exercise (Herlan & Komarudin, 2020; Sunjoyo et al., 2023).

A specific form of interval training that has attracted considerable attention is extensive interval training (Duan et al., 2025; Rocha Conceição et al., 2025; Zhou et al., 2025). This training method is characterized by moderate-to-high intensity exercise

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performed repeatedly with relatively short recovery intervals (Moerdijk et al., 2026; Wiens et al., 2026), preventing complete physiological recovery between repetitions (Wajib et al., 2022). Extensive interval training primarily stimulates aerobic energy production while also engaging anaerobic pathways, making it particularly suitable for improving aerobic capacity and endurance performance (Tyler et al., 2025). Previous studies have reported that extensive interval training can enhance cardiovascular efficiency, oxygen utilization, and fatigue resistance during prolonged exercise.

Despite the well-documented benefits of interval training, endurance performance remains a challenge for many long-distance runners. This issue is also evident among athletes of Fair Running Club, a running club based in Padang, West Sumatra. According to interviews with the coaching staff, several athletes continue to demonstrate inadequate endurance capacity, which has been reflected in fluctuating and declining competitive performances over the last two years. Although the club achieved podium finishes in several competitions, performance consistency has decreased, particularly in long-distance events. The inability to maintain competitive results indicates that the current training process may not yet provide optimal endurance adaptations.

Previous studies have generally examined interval training as a broad training method; however, limited research has specifically investigated the implementation of extensive interval training programs among competitive long-distance runners at the club level in Indonesia. Furthermore, few studies have evaluated its effectiveness using a 5000-meter running performance test as the primary indicator of endurance improvement. This situation highlights a practical and scientific gap that warrants further investigation.

To address this issue, extensive interval training is proposed as an alternative training intervention to improve endurance performance among Fair Running Club athletes. The method is expected to enhance aerobic capacity, improve resistance to fatigue, and ultimately contribute to better running performance in the 5000-meter event.

The novelty of this study lies in the application of a structured extensive interval training program specifically designed for competitive long-distance runners at Fair Running Club and the evaluation of its effectiveness through 5000-meter performance outcomes. Unlike previous studies that focused on general endurance indicators, this study emphasizes sport-specific performance assessment in a real training environment.

Therefore, the purpose of this study is to determine the effect of extensive interval training on the endurance performance of Fair Running Club athletes in the 5000-meter event. This research is important because its findings are expected to provide scientific evidence regarding the effectiveness of extensive interval training and serve as a practical reference for coaches in designing evidence-based endurance training programs. Furthermore, improving endurance capacity is essential for enhancing athlete performance, maintaining competitive consistency, and strengthening the club's competitiveness at regional and national levels.

II. METHODOLOGY

This study employed a quantitative approach using a quasi-experimental design to examine the effect of extensive interval training on endurance performance among long-distance runners. Specifically, the study adopted a one-group pretest-posttest design, in which participants were assessed before and after the training intervention. This design was selected to evaluate changes in endurance performance resulting from the implementation of an extensive interval training program.

The research was conducted at Fair Running Club, Padang, West Sumatra, Indonesia. The independent variable in this study was extensive interval training, while the dependent variable was endurance performance. The study focused on determining whether the training intervention could significantly improve the endurance capacity of long-distance runners.

A purposive sampling technique was employed to select participants based on specific inclusion criteria. The participants consisted of 15 male athletes from Fair Running Club who specialized in long-distance running events (5000 and 10,000 meters) and were aged between 20 and 27 years. Athletes were selected based on their active participation in regular training programs and competitive long-distance running events.

The study was conducted in three stages. First, participants completed a pretest to determine their baseline endurance performance. Second, participants underwent an extensive interval training program administered systematically over the designated training period. Finally, a posttest was conducted to evaluate changes in endurance performance following the intervention.

The instrument used to measure endurance performance was the 12-minute run test (Cooper Test). This test is widely recognized as a valid and reliable measure of aerobic endurance capacity and has been extensively used in sports performance assessment. The distance covered by each athlete during the 12-minute run was recorded and used as the primary performance indicator.

Data collection was carried out in two phases: pretest and posttest. During the pretest phase, all participants performed the Cooper Test under standardized testing conditions. Following the completion of the extensive interval training program, participants performed the same test under identical conditions during the posttest phase.

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To ensure consistency, all tests were conducted on the same running track and supervised by the research team and coaching staff. The recorded distances from both testing sessions were documented and prepared for statistical analysis.

The collected data were analyzed using IBM SPSS Statistics software. Descriptive statistics, including mean and standard deviation, were calculated to summarize participants' endurance performance. Prior to hypothesis testing, prerequisite analyses consisting of normality and homogeneity tests were conducted to ensure that the data met the assumptions required for parametric analysis.

To determine the effect of extensive interval training on endurance performance, a paired-sample t-test was employed to compare pretest and posttest scores. Statistical significance was established at the 0.05 level.

A. Page Layout

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III. RESULTS

The study conducted to examine the effect of extensive interval training on the endurance performance of Fair Running Club athletes in the 5000-meter event yielded the following results.

After all prerequisite assumptions for statistical analysis had been satisfied, the data were deemed appropriate for hypothesis testing. A paired-sample t-test was employed at a significance level of 0.05. The results indicated that extensive interval training had a significant effect on improving the endurance performance of Fair Running Club athletes in long-distance running events (5000 m and 10,000 m).

The pretest results showed a mean score of 1834.67 with a standard deviation of 127.832. Following the completion of 16 training sessions, the posttest mean score increased to 1929.33 with a standard deviation of 161.133. These findings suggest that the extensive interval training program contributed positively to the improvement of athletes' endurance performance.

Table 1. Result table

Endurance	Means	SD	Value	T-table	Test results	Information
Pre-test	1834.67	127.832	8.03	1.753	Significant	Ha Accepted
Post test	1929.33	161.133				

Based on the table, it can be concluded that there is a significant effect of extensive interval training on the endurance capabilities of Club Fair Running athletes in long-distance events (5000 and 10,000 meters), with a t-value calculation of 8.03, which is greater than the critical t-value of $8.03 > t_{table} 1.753$. Therefore, the proposed hypothesis is accepted.

IV. DISCUSSION

The discussion and analysis of data in this study confirmed that the hypothesis proposed was proven to be true, namely that extensive interval training had a significant effect on increasing the endurance of Club Fair Running athletes in the 5000 meter event. The analysis showed a t-value of 8.03, which is greater than the t-table value of 1.753, showing a significant effect of training on athlete endurance. In addition, the average pre-test score increased from 1834.67 to 1929.33 in post-tests, indicating an increase in endurance capacity. Based on these findings, it can be concluded that a well-structured and continuous extensive interval training program can improve the efficiency and effectiveness of athletes' steps, thereby contributing to increased endurance during running.

Endurance is one of the main components of an athlete's physical condition, especially in long-distance running events like 5000 meter. Interval training aims to increase the endurance of athletes. Extensive interval training is a method characterized by moderate intensity, a high number of repetitions, and a relatively short rest period. This method is implemented through a regular and well-planned training program, with a training load at a moderate intensity level, many repetitions, and short rest durations. In principle, this method is similar to intensive interval training, but differs in terms of the intensity of the exercise and the duration of the rest period provided (Gejl & Nybo, 2021; Hadi & Yudhistira, 2023; Irfan et al., 2023; Kelly et al., 2018; Laursen & Jenkins, 2002). The application of extensive interval training methods has been shown to be effective in increasing athletes' endurance. With a high number of repetitions and short rest times, This exercise stimulates heart function and maximizes oxygen absorption. Meanwhile, the intensive interval training method performed at moderate to high intensity where the athlete's heart rate exceeds 170 beats per minute showed a more significant effect in increasing endurance (Mubarok & Kharisma, 2022). In this method, repetitions are performed in smaller numbers with longer interval durations, up to a maximum of three sets in the exercise. A

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consistent rest period between repetitions and sets has a positive impact on improving the endurance of the athlete (Bachtiar et al., 2025).

Metode pelatihan interval intensif juga efektif dalam meningkatkan koordinasi saraf motorik yang kompleks (Setiawan et al., 2024). The rest periods provided are not completely complete and may include passive rest (such as sleeping, sitting, or standing) as well as active rest (such as light jogging or walking). Extensive interval training places more emphasis on developing endurance. Physical exercise plays an important role in improving and maintaining the physical condition of athletes, where aerobic capacity becomes more optimal along with the improvement of physical ability. Through high-intensity training, limited repetition, and short rest periods, the endurance capacity of athletes can be significantly increased.

Varied exercises can increase the motivation of athletes in each training session. Therefore, a training method is needed that can prevent boredom caused by monotonous routines, keeping sessions interesting for athletes. In this study, the method used was interval training. The implementation of interval training is carried out consistently, with controlled weight and intensity, as well as distances that are in harmony with the training plan. One of the key elements in interval training is the consistent timing of breaks between sets and repetitions.

Physical condition is an important element in the development of athletes to achieve optimal performance in a particular sport. It serves as the primary foundation that determines an individual's achievement and acts as a template in designing training programs. A well-designed physical training program will improve the stability of athletes' performance during competitions, thus positively impacting the overall team's performance. Endurance is one of the important physical aspects that is often overlooked, despite its important role in achieving success. Therefore, a comprehensive training program—which includes technical, tactical, mental, and physical aspects—with extensive interval training is needed as an effective method to increase the endurance of athletes.

Interval training methods are divided into two types: extensive intervals and intensive intervals (D Boumedien Kada et al., 2023). Extensive interval training is performed at low to moderate intensity, where the heart rate during the exercise does not exceed 170 beats per minute. This method involves a high number of repetitions, a short rest time, and a relatively large number of sets, with training distances ranging from 800 to 1200 meters (Mugiarti et al., 2025). In contrast, intensive interval training is performed at moderate to high intensity, where the heart rate exceeds 170 beats per minute. This type of training involves fewer repetitions, longer rest periods, and usually consists of a maximum of three sets.

The interval training method has been shown to be effective in improving physical performance (Danardono, 2013). This type of training aims to develop the body's capacity, including improving the ability to remove lactate from the blood, increasing maximum oxygen consumption ($\text{VO}_2 \text{ max}$), and optimizing aerobic capacity. Therefore, this method is very effective for increasing aerobic and anaerobic capacity.

Based on data analysis, field observations, and support from previous research, researchers found that the application of extensive interval training methods was effective in increasing the endurance capacity of Fair Running athletes in the 5000 meter event. This training has a significant positive impact on increasing the endurance of athletes, which in turn supports the improvement of other aspects of training.

V. CONCLUSION

The findings of this study demonstrate that extensive interval training has a significant positive effect on the endurance performance of Fair Running Club athletes specializing in long-distance running events (5000 m and 10,000 m). The significant increase in endurance scores from pretest to posttest, supported by the statistical analysis ($t = 8.03 > t\text{-table} = 1.753$), indicates that the implementation of extensive interval training effectively enhances aerobic endurance and improves athletes' ability to sustain performance during prolonged running activities. Therefore, extensive interval training can be considered an effective training method for developing endurance in competitive long-distance runners.

The results of this study provide practical implications for coaches and sport practitioners in designing evidence-based endurance training programs for long-distance athletes. The incorporation of extensive interval training into regular training schedules may contribute to improved endurance performance and competitive consistency. Future research is recommended to involve larger sample sizes, include control groups, and examine additional physiological variables such as $\text{VO}_{2\text{max}}$, lactate threshold, and running economy to provide a more comprehensive understanding of the effects of extensive interval training on endurance performance.

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REFERENCES

- 1) Bachtiar, E. F., Imanudin, I., Rusdiana, A., & Fadli, M. (2025). Pengaruh Latihan Small Sided Games Dengan Metode

Effect of Extensive Interval Training on Endurance Performance in Long-Distance Runners

- Interval Terhadap Peningkatan Anaerobik Laktasid. *Jambura Journal of Sports Coaching*, 7(1), 66–74.
- 2) Blagrove, R. C., Howe, L. P., Howatson, G., & Hayes, P. R. (2020). Strength and Conditioning for Adolescent Endurance Runners. *Strength and Conditioning Journal*, 42(1). <https://doi.org/10.1519/SSC.0000000000000425>
 - 3) D Boumedien Kada, Dif Haroun, Bengoua Ali, & D Nghal Mohammed. (2023). The Development of Aerobic Capacity between the Short-term Training 15"/15" and the Long-term Training 3'/3' for Soccer Players U21. *Journal of Namibian Studies : History Politics Culture*, 33. <https://doi.org/10.59670/jns.v33i.831>
 - 4) Danardono, H. (2013). *Perbedaan Pengaruh Jenis Recovery Aktif, Corstability, Dan Pasif, Sesudah Latihan Maksimum Terhadap Penurunan Kadar Asam Laktat Ditinjau Dari Indeks Massa Tubuh*. UNS (Sebelas Maret University).
 - 5) Delfan, M., Negin Zeidi, H. A., Kashani, F. R., Zeynali, F., Juybari, R. A., Rahimpour, M., Willems, M. E. T., Saeidi, A., & Zouhal, H. (2026). Combined high-intensity interval training and spirulina supplementation synergistically improve inflammatory and lipid-associated biomarkers in men with obesity. *Nutrition Research*, 148, 49–64. <https://doi.org/https://doi.org/10.1016/j.nutres.2026.02.003>
 - 6) DeWeese, B. H., Hornsby, G., Stone, M., & Stone, M. H. (2015). The training process: Planning for strength-power training in track and field. Part 1: Theoretical aspects. In *Journal of Sport and Health Science* (Vol. 4, Issue 4). <https://doi.org/10.1016/j.jshs.2015.07.003>
 - 7) Duan, Y., Wang, Y., Liang, W., Wong, H.-S., Baker, J. S., & Yang, S. (2025). Feasibility and effects of high-intensity interval training in older adults with mild to moderate depressive symptoms: A pilot cluster-randomized controlled trial. *Journal of Exercise Science & Fitness*, 23(3), 246–251. <https://doi.org/https://doi.org/10.1016/j.jesf.2025.05.004>
 - 8) Efendi, A., Amrizal, A., & Sulubara, S. M. (2024). Analisis Keseimbangan Dan Power Otot Lengan Terhadap Kemampuan Lempar Cakram. *Inspirasi Dunia: Jurnal Riset Pendidikan Dan Bahasa*, 3(1), 63–70.
 - 9) García-Pinillos, F., Ramírez-Campillo, R., Boullosa, D., Jiménez-Reyes, P., & Latorre-Román, P. (2021). Vertical Jumping as a Monitoring Tool in Endurance Runners: A Brief Review. *Journal of Human Kinetics*, 80(1). <https://doi.org/10.2478/hukin-2021-0101>
 - 10) Gejl, K. D., & Nybo, L. (2021). Performance effects of periodized carbohydrate restriction in endurance trained athletes – a systematic review and meta-analysis. In *Journal of the International Society of Sports Nutrition* (Vol. 18, Issue 1). <https://doi.org/10.1186/s12970-021-00435-3>
 - 11) González-Fernández, F. T., Hsu, K., Silva, R. M., Clemente, F. M., Bezzerra, P., & Chen, Y.-S. (2026). A 4-week running-based High-Intensity Interval Training and small-sided games intervention decreased red blood cells and hematocrit but increased maximal aerobic speed in collegiate male soccer players. *Football Studies*, 1, 100023. <https://doi.org/https://doi.org/10.1016/j.footst.2026.100023>
 - 12) Hadi, & Yudhistira, D. (2023). High-intensity interval training method in karate athletes: Can it improve power, agility, and endurance in the Kumite category? *Journal Sport Area*, 8(1). [https://doi.org/10.25299/sportarea.2023.vol8\(1\).10656](https://doi.org/10.25299/sportarea.2023.vol8(1).10656)
 - 13) Herlan, H., & Komarudin, K. (2020). Pengaruh metode latihan high-intensity interval training (Tabata) terhadap peningkatan VO2Max pelari jarak jauh. *Jurnal Kepeleatihan Olahraga*, 12(1), 11–17.
 - 14) Hidayat, A. S., Dlis, F., & Hanief, S. (2021). *Pengembangan Model Pembelajaran Atletik Nomor Lari Berbasis Permainan Pada Siswa Sekolah Dasar*. Penerbit CV. Sarnu Untung.
 - 15) Indrayana, B. (2012). Perbedaan Pengaruh Latihan Interval Training dan Fartlek terhadap Daya Tahan Kardiovaskular pada Atlet Junior Putra Taekwondo Wild Club Medan 2006/2007. *Jurnal Cerdas Syifa*, 1(1), 1–10. <https://online-journal.unja.ac.id/index.php/csp/article/view/699>
 - 16) Indrayana, B., & Yuliawan, E. (2019). Penyuluhan pentingnya peningkatan vo2max guna meningkatkan kondisi fisik pemain sepakbola fortuna fc kecamatan rantau rasau. *Jurnal Ilmiah Sport Coaching and Education*, 3(1), 41–50.
 - 17) Irfan, I., Yasriuddin, Y., Hudain, M. A., & Martono, M. (2023). THE EFFECT OF CIRCUIT TRAINING AND INTERVAL TRAINING ON LEG MUSCLE ENDURANCE ON WOMEN'S VOLLEYBALL ATHLETES AT VELOCITA. *JURNAL PENDIDIKAN GLASSER*, 7(2). <https://doi.org/10.32529/glasser.v7i2.2478>
 - 18) Kelly, D. T., Tobin, C., Egan, B., McCarren, A., O'Connor, P. L., Mccaffrey, N., & Moyna, N. M. (2018). Comparison of sprint interval and endurance training in team sport athletes. *Journal of Strength and Conditioning Research*, 32(11). <https://doi.org/10.1519/JSC.0000000000002374>
 - 19) Laursen, P. B., & Jenkins, D. G. (2002). The scientific basis for high-intensity interval training: Optimising training programmes and maximising performance in highly trained endurance athletes. In *Sports Medicine* (Vol. 32, Issue 1). <https://doi.org/10.2165/00007256-200232010-00003>
 - 20) Mardia, M. A. A. F., & Yuliawan, E. (2024). Pengaruh Latihan Continuous Running Terhadap Daya Tahan Atlet Petanque Muaro Jambi. *Score*, 4(1), 1–11.
 - 21) Moerdijk, A. S., van Genuchten, W. J., Duijnhouwer, A. L., Snoeren, M. M. M., Hirsch, A., van den Berg, L. E. M., Boersma, E., Kauling, R. M., van den Bosch, A. E., Udink ten Cate, F. E. A., Helbing, W. A., & Bartelds, B. (2026).

Effect of Extensive Interval Training on Endurance Performance in Long-Distance Runners

- Evaluation of high intensity interval training in patients with a right ventricle to pulmonary artery conduit in a randomized controlled trial: Rationale and design of the “Right HIIT” study. *American Heart Journal*, 299, 107477. <https://doi.org/https://doi.org/10.1016/j.ahj.2026.107477>
- 22) Morishima, S., Aoi, W., Kawamura, A., Kawase, T., Takagi, T., Naito, Y., Tsukahara, T., & Inoue, R. (2021). Intensive, prolonged exercise seemingly causes gut dysbiosis in female endurance runners. *Journal of Clinical Biochemistry and Nutrition*, 68(3). <https://doi.org/10.3164/JCBN.20-131>
- 23) Mubarak, M. Z., & Kharisma, Y. (2022). Pengaruh metode latihan interval terhadap peningkatan daya tahan aerobik (VO₂Max). *Biomatika: Jurnal Ilmiah Fakultas Keguruan Dan Ilmu Pendidikan*, 8(1), 128–136.
- 24) Mugiarti, T., Muhtarom, D., & Agustan, B. (2025). Pengaruh Latihan Interval terhadap Kecepatan Lari 100 Meter pada Siswa Kelas VIII SMP Negeri 2 Ampelgading. *Lencana: Jurnal Inovasi Ilmu Pendidikan*, 3(1), 32–46.
- 25) Regalado-Cabello, P., Pérez-Gisbert, L., Brea-Gómez, B., Pazo-Palacios, R., Valenza, M. C., & Torres-Sánchez, I. (2026). High-Intensity Interval Training in Adults With Asthma: Systematic Review and Meta-Analysis. *The Journal of Allergy and Clinical Immunology: In Practice*, 14(4), 874-890.e7. <https://doi.org/https://doi.org/10.1016/j.jaip.2025.11.032>
- 26) Rocha Conceição, L. S., Gauthier, N., Andrade Guimarães, A. L., Gois, C. O., Oliveira, I. K., Souza, D. S., & Carvalho, V. O. (2025). High-Intensity Interval Training in Adults With Congenital Heart Disease: A Systematic Review. *Heart, Lung and Circulation*, 34(1), 16–24. <https://doi.org/https://doi.org/10.1016/j.hlc.2024.09.008>
- 27) Setiawan, C., Jannah, S. M., Kurniawan, M. D., & Nurhayati, S. E. (2024). High Intensity Interval Training (HIIT) dalam meningkatkan daya tahan dan mencegah cedera pada pemain bulu tangkis. *Jurnal Kesehatan Vokasional*, 9(1), 50.
- 28) Sukendro, S., & Yuliawan, E. (2019). *Dasar-Dasar Atletik*. Salim Media Indonesia.
- 29) Sunjoyo, S., Rumpoko, S. sakti, Sholeh, M., Sulistyono, J., Sistiasih, V. S., & Wijayanti, R. A. (2023). Sosialisasi Penyusunan Program Latihan High Intensity Interval Training Untuk Meningkatkan Kebugaran Jasmani. *Proficio*, 4(2), 1–7. <https://doi.org/10.36728/jpf.v4i2.2621>
- 30) Tyler, J., Park, Y., Lu, H., Roeder, N., Richardson, B., Gold, M. S., Blum, K., Pinhasov, A., Baron, D., & Thanos, P. K. (2025). High-intensity interval training exercise decreases brain CB1 receptor levels in male and female adult rats. *Neuroscience*, 573, 254–263. <https://doi.org/https://doi.org/10.1016/j.neuroscience.2025.03.038>
- 31) Wajib, M., Aditya, R. A., Sihombing, H., & Mes, H. (2022). Pengaruh High Intensity Interval Training Terhadap Peningkatan VO₂max Atlet Lari Jarak Jauh. *Jurnal Ilmiah STOK Bina Guna Medan*, 10(2), 44–49.
- 32) Wang, B., Zeng, X., Deng, H., Qiu, B., Xu, K., Tao, M., Zhang, Y., Zheng, H., Xu, Q., Li, S., Zhong, Y., Zhang, X., Li, H., Yan, H., Song, J., Zhang, Z., Liang, Z., Sun, Q., Wu, B., ... Yin, M. (2026). High-intensity interval training and moderate-intensity continuous training are effective, feasible, and safe for patients with metabolic dysfunction-associated steatotic liver disease (MASLD): A systematic review and meta-analysis. *Metabolism*, 182, 156677. <https://doi.org/https://doi.org/10.1016/j.metabol.2026.156677>
- 33) Wei, Z., Ahmad, M., Chen, R., Fatima, S., & Shah, S. (2025). High-intensity interval training improves mitochondrial function and attenuates cardiomyocytes damage in ischemia-reperfusion. *IJC Heart & Vasculature*, 60, 101756. <https://doi.org/https://doi.org/10.1016/j.ijcha.2025.101756>
- 34) Wiens, L., Fliss, M. D., Abercrombie, M. J., Smith, C., Barclay, R., Valiakhmetov, G., Schweitzer, A. M., Beauchamp, B., & Mitchell, C. J. (2026). Are high-intensity interval training and low load resistance training two sides of the same physiological coin: a randomized control trial. *Applied Physiology Nutrition and Metabolism*, 51, 1–17. <https://doi.org/https://doi.org/10.1139/apnm-2026-0003>
- 35) Zhou, L., Mozaffaritarab, S., Tanisawa, K., Kawamura, T., Higuchi, M., Boldogh, I., Ba, X., Goto, S., Brooks, G., Gu, Y., & Radák, Z. (2025). Lactate as a metabolic–epigenetic signal linking high-intensity interval training (HIIT) to miRNA-Centered remodeling of the skeletal muscle methylome and transcriptome. *Redox Biology*, 88, 103943. <https://doi.org/https://doi.org/10.1016/j.redox.2025.103943>



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