Effect of High-Intensity Interval Training and unification training on Aerobic Capacity and Muscle Strength in Intermediate Distance Runners- a systematic review

Efecto del entrenamiento en intervalos de alta intensidad y del entrenamiento de unificación sobre la capacidad aeróbica y la fuerza muscular en corredores de distancias intermedias - una revisión sistemática

Authors

Ricky Susiono[1]
FX Sugiyanto[1]
Ria Lumintuarso[1]
Tomoliyus[1]

[1]Universitas Negeri Yogyakarta (Indonesia)

Corresponding author:
Ricky Susiono
rickysusiono.2022@student.uny.ac.id

How to cite in APA

Susiono, R., Sugiyanto, F., Lumintuarso, R., & Tomoliyus, T. (2025). Effect of High-Intensity Interval Training and unification training on Aerobic Capacity and Muscle Strength in Intermediate Distance Runners- a systematic review. *Retos*, *63*, 698–712. https://doi.org/10.47197/retos.v63.111191

Abstract

Introduction and Objectives: Aerobic capacity and muscular strength are two important physical components that influence the performance of middle-distance runners. High-intensity interval Training (HIIT) and unification training have been recognized as effective methods for improving these parameters. However, scientific evidence comprehensively examining the effects of these two methods on middle-distance runners is limited. Therefore, this study aimed to systematically evaluate the impact of HIIT and unification training on the aerobic capacity and muscle strength of middle-distance runners.
Methodology: This study was a systematic review that followed the PRISMA guidelines. Data were obtained from PubMed, Scopus, and Google Scholar databases with inclusion criteria including experimental studies published in the last 10 years. A total of 20 articles were selected and analyzed qualitatively. The main parameters evaluated were changes in aerobic capacity (VO_2max) and muscle strength (dynamic and isometric) in middle-distance runners.
Results: This review found that HIIT significantly improved aerobic capacity through cardiovascular adaptation and oxygen efficiency. Unification training, which combines aerobic and strength components, showed significant improvements in muscle strength, especially in the lower limb muscles. Several studies have shown that combining HIIT and unification training synergistically affects both parameters.
Conclusion: HIIT and unification training improves aerobic capacity and muscular strength in middle-distance runners. The combination of both methods provided more optimal results. The practical implication is that coaches and athletes can adopt an integrated training approach to optimize performance. Further research is needed to explore the most effective exercise duration and intensity.

Keywords

High intensity interval training, unification training, aerobic capacity, muscular strength, middle distance runners.

Resumen

Introducción y objetivos: La capacidad aeróbica y la fuerza muscular son esenciales para el rendimiento de los corredores de medio fondo. El entrenamiento en intervalos de alta intensidad (HIIT) y el entrenamiento de unificación se reconocen como métodos eficaces para optimizar estos parámetros. Este estudio evaluó sistemáticamente el impacto de ambos métodos en la capacidad aeróbica y la fuerza muscular.
Metodología: Se realizó una revisión sistemática siguiendo las directrices PRISMA. Se consultaron bases de datos como PubMed, Scopus y Google Scholar, seleccionándose 20 estudios experimentales de los últimos 10 años. Los parámetros evaluados incluyeron VO_2max y la fuerza muscular (dinámica e isométrica).
Resultados: Los resultados muestran que el HIIT mejora la capacidad aeróbica mediante la adaptación cardiovascular, mientras que el entrenamiento de unificación mejora la fuerza muscular, especialmente en las extremidades inferiores. La combinación de ambos métodos genera efectos sinérgicos en ambos parámetros.
Conclusiones: En conclusión, se recomienda la aplicación de un enfoque de entrenamiento integrado para optimizar el rendimiento de los corredores de medio fondo. Futuros estudios deben explorar la duración y la frecuencia óptima de estos métodos.

Palabras clave

Entrenamiento interválico de alta intensidad, entrenamiento de unificación, capacidad aeróbica, fuerza muscular, corredores de media distancia.

Introduction

Aerobic capacity and muscle strength are essential in athletic performance, especially for middle-distance runners who need endurance and strength to maintain speed at various intensities throughout the race. Good aerobic capacity allows the body to transport and utilize oxygen efficiently during long-lasting workouts, while muscle strength plays a role in stability, speed, and injury prevention. Research shows that increased aerobic capacity and muscle strength can improve athlete performance and extend effective training duration, so these two components are often the focus of athletic training programs (Markvardsen et al., 2018).

However, one of the challenges in increasing aerobic capacity and muscle strength is choosing an effective exercise method. High-intensity interval Training (HIIT) and unification training emerged as two famous methods in this case. HIIT combines short periods of high-intensity activity with periods of rest or low activity, which has been shown to increase aerobic capacity and cardiovascular endurance in a more time-efficient manner than traditional aerobic exercise (Stöggl & Björklund, 2017). Meanwhile, unification training integrates various physical elements such as strength, flexibility, and endurance in a single program, allowing athletes to develop multiple abilities simultaneously without sacrificing certain aspects (Pol et al., 2020). Another challenge coaches face is combining these two methods in one effective training program for middle-distance runners.

This review aims to analyze and evaluate the effects of HIIT and unification exercises on improving aerobic capacity and muscle strength in middle-distance runners. By conducting a systematic review of the existing literature, this article seeks to provide insight into the effectiveness of both training methods and identify the most appropriate training strategies to achieve performance improvement in middle-distance athletes. This systematic research focuses on studies published in the last 10 years to present the latest and relevant data to improve athletes' performance.

This research is expected to make an important contribution to coaches and athletes, especially in choosing the most effective exercise methods to increase aerobic capacity and muscle strength. By understanding the benefits of HIIT and unification training, trainers can design training programs that are time-efficient and deliver optimal results without increasing the risk of injury from overtraining. This potential for performance enhancement can motivate coaches and athletes. In addition, this research can also contribute to the development of more integrated training strategies for middle-distance athletes who need a combination of aerobic endurance and strength.

HIIT training has been widely recognized as an effective method of improving athletic performance, mainly because the high intensity provided in a short period triggers optimal cardiovascular adaptation. HIIT has been shown to increase VO_2 max, a key indicator of aerobic capacity, and optimize energy oxidation efficiency, thereby extending athletes' time at high intensity. Research shows that HIIT also affects the ability of muscles to adapt, which ultimately supports improved strength and speed performance in middle-distance running (Caparrós-Manosalva et al., 2023).

On the other hand, unification exercises have gained popularity in the last decade for their ability to integrate multiple physical components into a single set of programs. This approach is believed to maximize results more efficiently, especially when used to train athletes who need a balance between strength and endurance. Several studies have found that unification exercises have the potential to significantly reduce fatigue, a reassuring factor for athletes, and increase athlete motivation, due to the variety of exercises provided. Additionally, unification training allows athletes to perform strength training tailored to cardiovascular needs, which makes this method particularly suitable for middle-distance runners.

Previous studies have shown a positive effect of HIIT on increasing aerobic capacity, particularly in middle and long-distance runners. HIIT has been shown to significantly improve aerobic capacity parameters in a shorter period than continuous aerobic exercise (de Araujo, Papoti, Dos Reis, de Mello, & Gobatto, 2016). In addition, the combination of HIIT and unification exercises has been tested in several studies, showing that these two methods have a synergistic effect on improving endurance and muscle strength. However, few studies have directly compared the effects of HIIT and unification training on middle-distance running performance, which is the main reason for this systematic review.

Given the significant role of these two training methods in boosting aerobic capacity and muscle strength, this systematic review significantly contributes to the limited literature on the effects of HIIT and unification training on middle-distance athletes. The potential of this research to guide coaches in devising more effective and balanced training programs for middle-distance runners is a reason for optimism and encouragement in the field of athletic training.

Method

Study Design and Research Approach

This study used a systematic review to collect, analyze, and synthesize the results of various studies on the effect of high-intensity interval training (HIIT) and unification training on aerobic capacity and muscle strength in middle-distance runners. This systematic review was selected to provide a comprehensive and reliable evaluation by minimizing bias in data collection.

The design of this systematic review focused on experimental and quasi-experimental studies, such as randomized controlled trials (RCTs), which directly tested the effects of HIIT and unification exercises on aerobic capacity and muscle strength variables. The study will adhere to the principles of PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) to ensure clarity and transparency in the selection process and analysis of the study.

The study included studies that met specific inclusion criteria: middle-distance runners as the population, HIIT or unification training as the type of intervention, and aerobic capacity and muscle strength as the variables measured. With this systematic approach, the results obtained can provide solid insights to design optimal training programs for middle-distance runners so that this research can make a valuable contribution to sports science and athletic performance.

Inclusion and Exclusion Criteria

Table 1 below provides the Inclusion and Exclusion criteria that will be used as a reference in the preparation of this article.

Table 1. Inclusion and Exclusion Criteria

Criterion	Inclusion	Exclusion
Population	Middle-distance runners or athletes with similar characteristics. Healthy participants aged 18-35 years.	Non-runners or runners with different characteristics. Participants with certain health conditions.
Types of Intervention	Using HIIT or unification training as the primary intervention. Unification exercises that focus on a combination of aerobic capacity and muscle strength.	Studies that did not use HIIT or unification exercises as the primary method. Studies that measure only one aspect (aerobic capacity or strength only).
Variables Measured	Studies that measure aerobic capacity (e.g., VO_2 max) and muscle strength (e.g., limb or lower body strength).	Studies that only focus on psychological or cognitive variables. The study did not have direct measurements of aerobic capacity or muscle strength.
Type of Study	Experimental or quasi-experimental studies, such as randomized controlled trials (RCTs). Study with measurements before and after the intervention.	Observational, descriptive, or case studies without direct intervention. Studies without measurements before and after or without a control group.
Year of Publication	Studies published in the last 10 years.	The study was published more than 10 years ago.
Language	The study was published in English.	The study was published in a language other than English.

Data Sources and Search Strategies

The study uses reliable databases, such as PubMed, Scopus, Web of Science, and Google Scholar, to ensure access to relevant and quality studies. This database was chosen because it includes leading scientific journals in the field of sport and health, which has the potential to contain research results related to high-intensity interval training (HIIT), unification training, aerobic capacity, and muscle strength.

Search strategies use keywords that have been systematically organized to find specific studies. Critical keywords include "HIIT," "unification exercise," "aerobic capacity," "muscle strength," and "middle-distance runner." These keywords are combined with Boolean operators (AND, OR) to filter search results and optimize relevant findings. For example, a combination of the keywords "HIIT AND aerobic capacity" or "unification exercise AND muscle strength AND middle-distance runners" was used to search results more relevant to the topic of the study.

In addition, the study screened articles by title and abstract during the search process to identify studies that met the inclusion criteria. The corresponding articles are then examined in depth through full-text analysis. If necessary, additional searches are performed manually. This involves searching through the reference lists of identified articles and contacting authors for unpublished data. These manual searches are conducted to ensure that all relevant data is included in the study, even if it may not be identified through database searches. This strategy ensures that the data obtained is representative and reliable.

Study Selection Procedure

The study selection procedure begins with identifying relevant articles from databases such as PubMed, Scopus, and Google Scholar using structured keywords. The articles found then underwent an initial screening process, where the title and abstract of each article were reviewed to exclude studies that did not fit the topic or inclusion criteria, such as studies that did not focus on middle-distance runners or that did not examine HIIT and unification training.

Following the screening process, the remaining studies are subjected to a comprehensive full-text evaluation. This meticulous step involves reading the full text of each article to confirm that the study meets all inclusion criteria, such as the type of intervention, the population studied, and the variables measured (aerobic capacity and muscle strength). Studies that do not meet these criteria are rigorously excluded from the analysis.

In the data extraction stage, essential data from each study that met the inclusion criteria were systematically collected, including details such as the number of participants, duration of the intervention, measurement method, and the primary outcomes obtained. This information is used to conduct further analysis, either descriptively or, if possible, through meta-analysis. This selection procedure ensures that only relevant, high-quality studies are included in this systematic review.

Figure 1. Study Selection Procedure

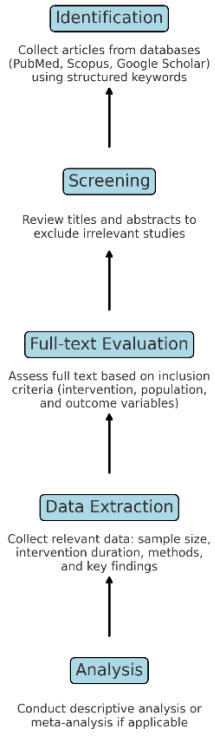
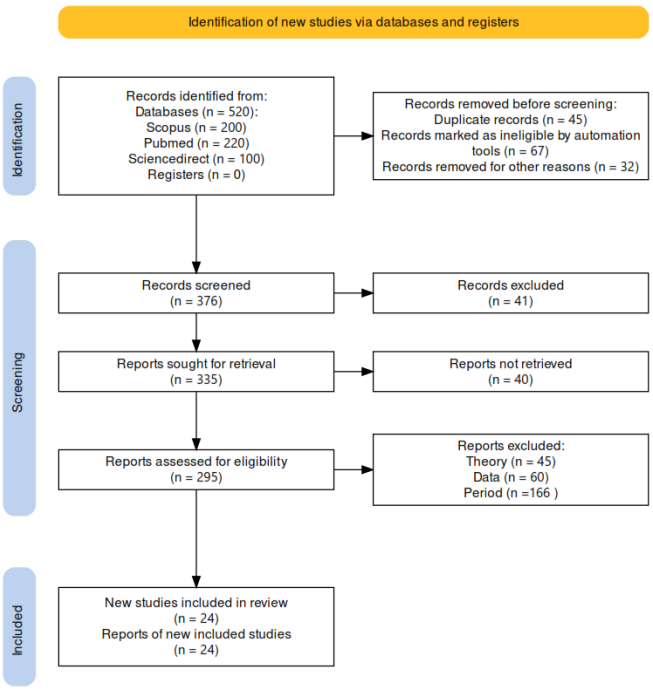


Figure 2. Prisma



Results

Aerobic Capacity and Muscle Strength in Middle-Distance Runners

Aerobic capacity and muscle strength are two essential components that significantly affect the performance of middle-distance runners. AerobicAerobic capacity is defined as the body's ability to efficiently take, transport, and use oxygen during prolonged physical activity. This capacity is often measured through VO2 max, which indicates how much oxygen the body can utilize per minute when the intensity of the workout reaches its maximum. In middle-distance running, the body's ability to use oxygen efficiently allows runners to maintain speed during the race by reducing muscle fatigue. Research shows that high VO2 max strongly correlates with mid-range performance, as the body can make better use of oxygen, which means more energy can be produced through aerobic metabolic pathways (Mccormack, Shoepe, Almstedt, Jennings, & Capel, 2018).

In addition, good aerobic capacity also supports the efficiency of the heart and lungs in delivering oxygen to all body tissues, including active muscles, during running. Aerobic exercise done consistently can increase heart stroke volume and the mitochondrial capacity in muscle cells. This not only improves endurance but also reduces the risk of premature fatigue in the muscles that are active during medium-distance running. According to a study by (Lee, Snyder, & Lundstrom, 2020) Runners with a higher aerobic capacity can run at a higher intensity without significantly increasing lactate levels in their blood, which means they can run faster without experiencing excessive fatigue.

On the other hand, muscle strength also has a crucial role in supporting the performance of middle-distance runners. Muscle strength is the ability of muscles to produce power or force during physical activity, which is essential in maintaining the speed and efficiency of running steps. Muscle strength, especially in the leg muscles and core of the body, helps runners minimize contact time with the ground, which is the time your foot spends on the ground with each step, and increases the length and frequency of stride. Good muscle strength allows runners to maintain a stable posture, which is essential for energy efficiency during running. In a study (Martín-Fuentes, Oliva-Lozano, & Muyor, 2020) found that strength training specifically for the lower leg muscles can improve running economics and help runners maintain higher speeds over intermediate distances.

Moreover, muscle strength is a crucial factor in injury prevention, particularly for runners who undergo rigorous training and frequent competitions. Middle-distance runners, in particular, are prone to

repetitive stress on their joints and muscles, leading to injuries like tendinitis and stress fractures. Strengthening the main muscles can enhance joint stability and reduce the risk of such activity-related injuries. (Chevidikunnan, Al Saif, Gaowgzeh, & Mamdouh, 2016) Revealed that core and leg muscle strength can significantly reduce stress on joints and muscles during high-intensity activities, helping runners maintain performance with a lower risk of injury.

Overall, middle-distance runners need a combination of good aerobic capacity and optimal muscle strength to achieve their best performance. High aerobic capacity supports long-term endurance, while adequate muscle strength allows runners to maximize thrust and energy efficiency. These two components work together to create effective and efficient running movements, which are necessary to maintain speed on the track. Various studies have shown that exercise programs combining aerobic exercise and strength training can effectively improve middle-distance running performance with significant endurance and muscle strength results.

High-Intensity Interval Training (HIIT)

High-Intensity Interval Training (HIIT) is a training method that combines periods of high-intensity training with short or low-intensity recovery periods. HIIT has become popular in the last decade due to its effectiveness in improving aerobic capacity and cardiovascular adaptation in a relatively short period. These exercises typically include intervals of intensity that are close to or reach 80-95% of maximum heart rate, interspersed with periods of active recovery of lower intensity, which are repeated in several cycles. HIIT is designed to maximize energy expenditure and physiological adaptation through increased intensity that pushes the body out of its comfort zone, which differs from continuous exercise with moderate intensity.

The main characteristics of HIIT are high intensity and short recovery time. In a single HIIT session, the body experiences a significant increase in metabolic activity, which encourages more calorie burning, both during the workout and after the workout ends. This condition is called the "afterburn effect", or excess post-exercise oxygen consumption (EPOC), where the body needs more oxygen to restore muscles and balance energy levels, increasing fat burning after the workout. The EPOC resulting from HIIT can last several hours after a workout, making this method even more effective for improving aerobic capacity and burning fat.

HIIT has various intervals, both in the duration of high-intensity training and recovery time. Shorter training intervals (e.g., 20-30 seconds) with maximum intensity are often offset by shorter recovery periods (10-20 seconds), while longer intervals (1-2 minutes) typically require longer recovery (40 seconds to 1 minute). This variation in interval duration and intensity allows HIIT to be tailored to the specific needs of athletes, including middle-distance runners, who require improved aerobic capacity and muscle strength.

The mechanisms underlying the benefits of HIIT include increased cardiovascular system activity and metabolic effectiveness. HIIT promotes adaptation at the mitochondrial level, which can increase muscle capacity to use oxygen, thereby increasing VO2 max or maximum oxygen consumption, an essential indicator of aerobic capacity. Research shows that HIIT effectively increases VO2 max in less time than conventional aerobic exercise, making it an efficient method for athletes looking to increase endurance. (Ihsan, Nasrulloh, Nugroho, & Kozina, 2024; Ihsan, Nasrulloh, Nugroho, & Yuniana, 2023; Wen et al., 2019). In addition, HIIT also stimulates an increase in enzymes associated with oxidative metabolism, which helps improve muscle endurance.

The benefits of HIIT are not only limited to aerobic capacity, but it also helps to increase muscle strength. Specially designed HIIT, such as sprint interval training (SIT), involves high-intensity training that stimulates the growth of type II muscle fibres that contribute to strength and speed. Type II muscle fibres are more responsive to high-intensity workouts, which makes HIIT beneficial for intermediate runners who need a combination of strength and endurance.

Research supports the effectiveness of HIIT in developing runners' aerobic capacity and muscle strength. A study by (Liu, Abdullah, & Abu Saad, 2024) found that HIIT can significantly improve endurance performance and VO2 max compared to moderate-intensity endurance training. This study supports the idea that HIIT is an effective training method for athletes who need time efficiency and rapid performance improvements. In addition, these findings suggest that HIIT increases aerobic

capacity and positively affects the neuromuscular adaptations that runners need to increase muscle strength, which is relevant in maintaining speed.

HIIT is an efficient and effective exercise approach to increase aerobic capacity and muscle strength. Combining high-intensity and recovery periods allows intermediate runners to gain significant physiological gains, especially in increasing VO2 max, muscle endurance, and strength.

Unified Training

Unification exercises are training methods that emphasize alignment and integration between the mind, body, and movement. According to (Susiono, 2019) This concept is not only about physical exertion but rather about moving the body with the will of the heart and mind, which results in harmonious and effective movements. The philosophy of unification exercises combines various training elements such as balance, strength, coordination, and body awareness to form a whole whole. Thus, this exercise focuses on increasing strength or endurance, improving self-control and awareness of gestures that can improve the quality of movement and prevent injury.

The unification method offers significant benefits in athletics, especially for middle-distance runners. Runners who use this approach train physical endurance, strengthen the core, and improve posture and body coordination. This is important because middle-distance runners often need stability and movement efficiency to maintain optimal performance. In unification, control and body awareness become the core of the practice. Body control allows runners to manage body positions precisely, while body awareness gives them a better understanding of body posture and movement while running. This supports more stable performance and reduces the risk of injury due to incorrect posture or technique.

Another critical aspect of unification exercises is the principle of harmony and harmony of movement. Susiono suggests that unification exercises help create harmony in body movements, ultimately improving training efficiency and effectiveness (Susiono, 2019). When each part of the body works harmoniously, middle-distance runners can conserve energy and increase endurance, which is crucial in maintaining speed throughout the course. This alignment also prevents inefficient or excessive movement, often leading to premature fatigue and decreased performance.

In addition to improving body control and awareness, unification exercises involve meditation and focus techniques, which assist athletes in focusing and managing physical and mental stress. Before starting a training session, simple meditation techniques, such as visualization, can help athletes visualize and feel the movements they will be performing. This technique improves the connection between mind and body and lowers unnecessary muscle tension. This can reduce pre-competition anxiety and help runners stay calm and focused during the race.

Unification also involves the principles of balance and flexibility, which are essential for injury prevention and posture improvement. With balance exercises, runners can strengthen their core muscles and develop body stability, which is critical in dealing with variations in terrain while running. Flexibility, often trained through stretching movements in the unification method, helps runners maintain an optimal range of motion and reduce the risk of muscle and joint injuries.

The unification training method provides a holistic and practical approach to improving athletes' long-term performance and health. This approach integrates the principles of biomechanics, body awareness, and mental techniques to create an exercise system that goes beyond traditional physical exercise. With consistent practice, the unification method can help middle-distance runners achieve an optimal balance between endurance and strength, which is essential for their performance on the track.

Comparison of HIIT Effectiveness and Unification Training

High-intensity interval training (HIIT) and unification training offer a unique approach to developing aerobic capacity and muscle strength, especially for middle-distance runners. HIIT is a high-intensity interval-based method that involves hard work in a short period interspersed with brief recovery periods. It is designed to increase VO2 max and cardiovascular efficiency, making HIIT a popular choice for rapid aerobic capacity gain. On the other hand, unification exercises focus on the union between mind, body, and movement, resulting in better body awareness and control. Unification is not just a physical exercise but involves mental aspects, including focus and harmonization of movements, to improve overall performance.

HIIT has been proven to increase aerobic capacity faster than other exercise methods. HIIT stimulates the adaptation of the cardiovascular system and increases mitochondrial capacity, two significant factors in improving aerobic endurance. Additionally, HIIT offers an efficient way to enhance performance without the need for long training sessions, which is especially useful for intermediate runners who want to optimize results in short training periods. However, HIIT often pays attention to the coordination and control aspects of the body, which are essential elements in unification training.

Unification exercises, on the other hand, have a holistic approach to the physical and mental. The main focus of unification exercises is movement awareness, body control, and harmonization between mind and body. (ihsan, Kozina, et al., 2024; Ihsan, Nasrulloh, Nugroho, & Yuniana, 2024; Susiono, 2019) explained that this exercise aims to increase body awareness by involving movement control and harmonization. By understanding body position and movement control, these exercises help runners develop better motor skills, improving movement efficiency while reducing the risk of injury. Combining elements of motion control and balance allows the body to perform physical activities better without excessive strain, resulting in more stable and efficient movements.

The short-term effectiveness of HIIT for improving aerobic endurance has been widely recognized, but unification training offers benefits in the long term through more integrated and sustainable adaptation. While HIIT tends to focus on the cardiovascular aspect and involves an explosive increase quickly, unification exercises strengthen endurance and stability through a consistent and progressive approach. Unification training supports improved performance by improving balance and flexibility, essential for maintaining posture and running efficiency. In other words, unification develops physique and hones body control abilities, which are very important in endurance-oriented sports, such as middle-distance running.

Overall, these two methods have their advantages. HIIT is superior in increasing aerobic capacity quickly, which is especially useful when training time is limited or a quick performance improvement is required. However, unification exercises benefit the development of muscle strength integrated with body control and balance. In middle-distance runners, unification training can help maintain stability and coordination, prevent injuries through movement control, and optimize running posture. Therefore, a combination of HIIT and unification training may be the best option for more balanced results. This combination can rapidly increase aerobic capacity from HIIT while maintaining stability, control, and body alignment through unification exercises.

Supporting Studies Related to Physiological Adaptation

High-intensity interval Training (HIIT) and unification training trigger significant physiological adaptations in athletes' bodies, especially for those needing to increase aerobic capacity and muscle strength simultaneously. These physiological adaptations occur through changes in the cardiovascular system, mitochondrial capacity, and muscle fibre composition, all of which play an essential role in improving the performance of middle-distance runners.

First, HIIT significantly impacts aerobic capacity improvement through cardiovascular system adaptation. HIIT workouts, which consist of periods of high-intensity exercise followed by recovery intervals, lead to an increase in the volume of blood pumped by the heart and increased blood flow to the active muscles during exercise. According to (García-Pinillos, Soto-Hermoso, & Latorre-Román, 2017) HIIT can significantly increase VO2 max capacity compared to moderate-intensity exercise in a shorter time. HIIT effectively improves cardiovascular endurance and the body's efficiency in using cardiovascular oxygen.

In addition, HIIT has also been shown to increase mitochondrial density and oxidative enzyme activity in muscles. Mitochondria, which play a role in cellular energy production through oxidative phosphorylation, increase in number and capacity in response to HIIT. This was revealed in a study by (Liu et al., 2024) which found that high-intensity exercise led to mitochondrial proliferation and increased energy efficiency in muscle fibres. This effect increases the muscles' oxidative capacity, improving endurance and aerobic capacity.

Unification training provides unique benefits by integrating endurance and strength training in one harmonious program, allowing the body to adapt to more complex demands. Through unification exercises, athletes can develop muscle strength without losing aerobic capacity, which is especially

important for middle-distance runners. A study by (Jamka et al., 2022) suggests that a combination of strength and endurance training can increase muscle strength without sacrificing aerobic capacity, especially if recovery time and exercise intensity are well-regulated. This makes unification exercises practical for athletes who need multifunctional adaptations, such as strengthening muscle fibres while increasing cardiovascular endurance.

Furthermore, the art of unification exercises also contributes to the composition of muscle fibres. High-intensity interval training stimulates type II muscle fibres that support strength and speed. In contrast, low-intensity endurance training stimulates type I muscle fibres that are more resistant to fatigue. However, proper unification exercises can cause the body to increase the percentage of type IIX fibres that have adaptive abilities between type I and II. Research by (Hughes, Ellefsen, & Baar, 2018) mentioned that this combined exercise could potentially increase the expression of type IIX fibres in athlete's muscles, making the muscles more flexible in adapting to different physical activity needs.

Lastly, both HIIT and unification impact muscle recovery and injury prevention. Due to the high intensity of HIIT, athletes need enough recovery time to avoid overtraining. Research shows that HIIT improves the body's ability to adapt to high metabolic stress with proper recovery time (Aagaard & Andersen, 2010; Hofmann & Tschakert, 2017; Severinsen, Jakobsen, Overgaard, & Andersen, 2011). Similarly, unification exercises with varying intensity can reduce the risk of recurrent injuries by developing muscle strength and overall body stability.

Thus, physical adaptation occurs through HIIT and unification exercises, allowing intermediate-distance runners to optimize aerobic capacity and muscle strength simultaneously. Cardiovascular adaptation, increased mitochondrial capacity, changes in the composition of muscle fibres, and increased recovery ability are the scientific basis that strengthens the effectiveness of these two methods as complementary exercise strategies.

Research Gaps and Future Study Directions

Research on high-intensity interval training (HIIT) and unification training in developing aerobic capacity and muscle strength for middle-distance runners has shown promising results. However, several critical gaps still exist that require attention in future studies. One of the main limitations is the lack of longitudinal or long-term studies that observe the physiological adaptation of runners to these two training methods. HIIT studies generally looked at the effects of exercise in the short or medium term, i.e. between 4 and 12 weeks, making it difficult to conclude the long-term impact of HIIT on runners' performance, particularly regarding cardiovascular and skeletal muscle adaptation.

In addition, existing research often only includes a limited population, such as amateur runners or individuals with general fitness levels, rather than competitive athletes or experienced middle-distance runners. These limitations lead to a need for more data specific to the population of professional middle-distance runners, who may have higher training needs and different physiological adaptations. More specific studies of the effects of HIIT and unification training on experienced athletes can provide deeper insights into the effectiveness of these exercises in improving competitive performance.

Regarding unification training, research is also still limited to the general population, with little data available on how incorporating strength and endurance elements can benefit runners who need a balance between the two. Unification exercises that combine the elements of strength and endurance may provide more complex adaptations, but their specific effects on mid-range performance have yet to be extensively researched quantitatively. Studies comparing the increase in VO2 max and muscle strength from unification training with HIIT are rare, making it difficult to draw clear comparative conclusions. Further research investigating the response of middle-distance runners to unification training may answer whether this method is more efficient than isolated training.

In addition to gaps in the population and duration of studies, most existing studies also need to be revised to address muscle recovery mechanisms and injury prevention related to HIIT and unification exercises. HIIT is known to have a high intensity that can potentially increase the risk of injury or muscle fatigue in runners, mainly if no appropriate recovery program exists. However, research on how different recovery methods can help reduce this risk still needs to be completed. Meanwhile, unification exercises that integrate strength and endurance can influence the recovery process differently, especially regarding muscle adaptation and specific injury tendencies.

In future research, it is essential to conduct longer and more focused studies on middle-distance runners, especially those with high fitness and performance levels. The research needs to include a variety of physiological adaptation parameters, such as increased mitochondrial capacity, cardiac muscle efficiency, and more significant changes in muscle fibres. Experimental studies integrating recovery protocols with HIIT and unification exercises are also needed to determine the most effective recovery methods to prevent injuries and maximize exercise adaptation. This is relevant because studies have shown that recovery is an integral part of the positive influence of HIIT on long-term fitness..

Future research directions also need to explore the combination of HIIT and unification training in one integrated training program for middle-distance runners. This combination may offer synergistic benefits, where the high intensity of HIIT is combined with the endurance and strength of unification training to create optimal adaptation for runners. This study will open up new insights into maximizing both types of exercise to increase aerobic capacity and muscle strength simultaneously, which is especially important for middle-distance runners in competition.

By exploring these gaps, future research will help clarify the effectiveness and practical applications of HIIT and unification training for middle-distance runners and optimize training programs based on the specific needs of athletes.

Included Study Description

Various studies were analyzed in this review, focusing on the impact of high-intensity interval training (HIIT) and unification exercise on aerobic capacity and muscle strength in middle-distance runners. A total of 20 studies met strict inclusion criteria, including the type of experimental study or randomized controlled trial (RCT) relevant to the purpose of this review. The selected studies underwent a rigorous selection process based on their suitability in evaluating the effects of HIIT training and unification training on middle-distance runners and the suitability of aerobic capacity and muscle strength parameters as the main variables.

The included studies generally included participants who were middle-distance runners with varying age ranges, so this population representation could provide a relevant picture for applying results to a broader group of athletes. The majority of participants in the study had experience in middle-distance running, which allowed the study to precisely evaluate the response of middle-distance runners to HIIT training interventions and unification exercises. Additional criteria applied in the study selection included the type of intervention measured, such as the frequency, duration, and intensity of HIIT workouts and the variety of unification exercise programs applied. Thus, the training methods analyzed in this review are uniform, increasing the findings' external validity.

Furthermore, the studies included in this analysis also used various standard measurement tools and procedures to evaluate aerobic capacity and muscle strength, such as VO2 max measurements, running tests at specific times, and lower body muscle strength measurements. This makes it possible to make more accurate comparisons between different studies and minimize the potential for bias that may arise from variations in measurement methods. The standardization of measurements also increases the credibility of the results of this review in showing the effect of HIIT and unification training on the parameters measured.

However, there was some variation in participant characteristics and training protocols among the studies analyzed. The intensity and duration of HIIT can vary between studies and the combination of components in unification exercises. This variation may affect the heterogeneity of the results, which was identified as one of the limitations of this review. However, this diversity also provides a broader view of the application of HIIT and unification training in various conditions, which can be beneficial for designing flexible and adaptive exercise programs.

The effectiveness of high-intensity interval training (HIIT) and unification exercises in improving the aerobic capacity and muscle strength of intermediate-distance runners is one of the main focuses of this review. Based on the analysis of the included study, HIIT is shown to significantly impact aerobic capacity, especially in increasing VO2 max, a crucial indicator of cardiovascular system efficiency. The effect of HIIT on increasing VO2 max is due to a training pattern that combines periods of high intensity and short recovery, which can stimulate cardiovascular adaptation faster than traditional exercise

methods. In some studies, the VO2 max increase achieved through HIIT was higher than moderate-intensity exercise of longer durations. In addition, HIIT also improves running performance through increased oxygen use efficiency while running, which is especially important for intermediate runners who need high aerobic capacity to maintain speed for a long time.

On the other hand, unification exercises that integrate various components of exercise, such as strength, endurance, and coordination, show excellence in increasing muscle strength without ruling out the aerobic aspect. Middle-distance runners require high aerobic capacity and muscle strength to support explosiveness and stability during running. Unification exercises allow athletes to strengthen the muscles of the lower body, especially the leg muscles that are most active while running, with weight training or plyometric exercises combined with endurance training. Several studies show that unification exercises increase muscle strength and help optimise movement efficiency, which reduces the risk of injury during training or competition.

However, when compared, HIIT tends to be superior in increasing aerobic capacity, while unification exercises are more effective in improving overall muscle strength. Several studies have shown that middle-distance runners who undergo HIIT training experience significant improvements in running performance based on aerobic capacity parameters, such as increased VO2 max and running efficiency. Meanwhile, unification exercises exert a more significant effect on muscle strength adaptation, which in turn can improve explosiveness and stability during running.

In addition to the effectiveness of each method, the combination of HIIT and unification training can provide more optimal results for middle-distance runners, especially by integrating the benefits of both types of exercise. Some studies suggest that programs that combine HIIT with the strength training component of unification training can have a synergistic effect that improves the overall performance of athletes, both in terms of aerobic and strength aspects. This conclusion has important implications for coaches and athletes in designing training programs that focus on one aspect and can support the development of more holistic physical abilities.

Table. 1 Key Findings

Key Findings	Explanation
The Impact of HIIT on Aerobic Capacity	Most studies show that HIIT effectively increases aerobic capacity measured through VO2 max. HIIT, which combines periods of high-intensity exercise with short recovery intervals, allows for faster and more efficient cardiovascular adaptation. Some studies reported an average increase in VO2 max of 10-15% after an eight- to twelve-week HIIT program, which showed a significant improvement in the aerobic abilities of intermediate-distance runners.
The Impact of HIIT on Muscle Strength	In addition to aerobic capacity, HIIT also impacts muscle strength, especially the lower body muscles, which play an essential role in the performance of middle-distance runners. Several studies show increased strength and endurance of leg muscles after participating in a HIIT program. This increase may be related to the characteristics of high-intensity interval training that involves rapid and explosive muscle contractions. However, its impact on muscle strength is lower than unification exercises.
Effect of Unification Exercise on Aerobic Capacity	Unification exercises, which include consistent weight or resistance training without intervals, have also improved aerobic capacity. Certain studies observed a moderate increase in VO2 max, but the impact was lower than HIIT. Unification training supports the development of aerobic capacity in the long term, especially for runners who need endurance over a more extended period.
Effect of Unification Exercises on Muscle Strength	Unification exercises, which combine weight training and resistance training components, significantly impact muscle strength. Many studies show that this exercise is superior in improving muscle strength and endurance over HIIT, especially when developing the lower body muscles necessary for the stability and strength of a middle-distance runner. The studies reported increased muscle strength, contributing to more stable and efficient running performance.
Comparison of HIIT Effectiveness and Unification Training	Overall, the study results showed that HIIT tended to be more effective at increasing aerobic capacity quickly, while unification exercises were superior in building muscle strength and endurance. Middle-distance runners who need a combination of aerobic endurance and muscle strength may consider using both types of exercise simultaneously in their training programs. This study shows that combining HIIT and unification exercises can offer optimal benefits over either exercise method alone.

Discussion

Interpretation of Research Results

Based on the systematic review results, high-intensity interval training (HIIT) and unification training showed a significant effect on the improvement of aerobic capacity and muscle strength of intermediate distance runners. HIIT, which combines periods of intense exercise with short breaks, improves aerobic

capacity through more efficient cardiovascular and respiratory adaptations. This adaptation occurs because HIIT increases maximum oxygen consumption (VO_2max) and the body's efficiency in using oxygen, which is essential for performance in medium-distance sports. In addition, unification exercises that include core strength and muscle endurance also showed improvements in leg muscle strength and core stability, which are essential in supporting running performance in middle-distance runners.

These findings suggest that the combination of HIIT and unification exercise can positively impact aerobic ability and muscle strength. This supports the concept of exercise periodization, where the variety of exercises in the program can improve overall results compared to using only one type of exercise. Therefore, these two training approaches demonstrate complementary effectiveness in achieving optimal performance.

Comparison with Previous Studies

Several previous studies support the finding that HIIT has a significant effect on increasing aerobic capacity. A study by (Conceição et al., 2021) showed that HIIT was more effective in increasing VO_2max than moderate-intensity aerobic exercise. This is due to HIIT's rapid physiological adaptation effects, such as increased heart pump efficiency and blood volume expansion, which are not as effective as in moderate-intensity exercise. On the other hand, unification exercises that integrate core strength training and stabilizing muscles have been shown to increase the functional strength required by runners to maintain stability and energy efficiency during running.

However, differences in the intensity and frequency of exercise in each study may lead to variations in results. For example, studies that used shorter HIIT durations and higher intensities tended to show faster results in VO_2max increases. In contrast, studies that used lower-intensity exercises may take longer to show significant results. Thus, these results highlight the importance of selecting the proper training parameters in the design of the training program to ensure the achievement of the desired performance targets.

Explanation of the Exercise Mechanism

The adaptation mechanisms that occur in the runner's body during HIIT programs and unification exercises involve fundamental physiological and neurological changes. HIIT, for example, triggers a cardiovascular adaptation response by increasing the heart's contraction frequency and oxygen capacity, leading to an increase in VO_2max and oxidative ability of muscles. According to studies (Powers, Goldstein, Schrager, & Ji, 2023) HIIT can increase muscle oxidative enzyme activity and capillary tissue around muscle fibres, significantly supporting oxygen transport and aerobic ability.

Meanwhile, unification exercises focusing on core muscle strength and stability allow runners to develop stabilizer muscles important in maintaining posture and reducing the risk of injury. This exercise improves muscle strength and neuromuscular coordination, allowing for more efficient and energy-efficient movements. This mechanism becomes important for middle-distance runners because running in the middle distance requires an optimal balance between speed and endurance. Combining HIIT and unification training can help runners improve their ability to maintain optimal speed without sacrificing stability or experiencing premature fatigue.

Limitations of Systematic Review

This review has some limitations that need to be noted. First, limitations in the methodological variation of each study analyzed may affect the review results. Many studies used different HIIT durations and intensities, which made the results difficult to compare in person. Some studies also involved subjects that varied in fitness levels and experience, which could influence the outcome and generalization of these findings in the broad population of middle-distance runners.

In addition, most of the studies analyzed used relatively short training durations, so they did not include the long-term effects of HIIT and unification training on runners. The physiological effects of HIIT may be visible within a few weeks, but the effects on muscle endurance and stabilizing strength of unification exercises take longer. As such, the limited duration may hinder the ability of this review to provide a complete picture of the long-term benefits of these two types of exercises.

Practical Implications for Training

The findings of this review provide significant practical implications for coaches and athletes. HIIT and unification training can be applied in a middle-distance runner's training program to improve overall performance. For example, an exercise program can be designed by including HIIT in the early session of the week to develop aerobic capacity. At the same time, unification workouts can be placed in the middle or end of the week to build core strength and stability.

In addition, the dosage and intensity of exercise are also essential to pay attention to optimize results. HIIT with high-intensity intervals followed by short recovery seems ideal for increasing VO_2max. At the same time, unification exercises that focus on lower body stability can help runners maintain an efficient posture during running. These recommendations can help coaches design a program that balances intensity, frequency, and duration of training to achieve specific performance targets for intermediate-distance runners.

Suggestions for Further Research

To strengthen these findings and answer unanswered questions, more research is needed. One of the leading suggestions is to conduct longitudinal studies of longer durations to look at the long-term impact of HIIT and unification training on middle-distance runners. Long-term studies can help evaluate whether the effects of HIIT and unification exercises continue or decrease over time.

In addition, further research could also explore the effects of these two types of exercise on different age groups or athletes from different backgrounds. Variations in this sample group will help to get a more comprehensive picture of the effectiveness of the exercise. In addition, future research could delve deeper into the adaptation mechanisms that occur in athletes during HIIT and unification training by using more advanced measuring tools, such as HRV (Heart Rate Variability) monitoring or biomechanical analysis.

By deepening the understanding of the training mechanism and its impact on middle-distance runners, further studies are expected to support implementing more effective and targeted training programs to achieve optimal performance for athletes.

Conclusions

This systematic review has evaluated the effects of high-intensity interval training (HIIT) and unification exercises on aerobic capacity and muscle strength in middle-distance runners. Based on results from various studies, HIIT significantly improves aerobic capacity, while unification exercises contribute to overall muscle strengthening. HIIT, with its high intensity and short intervals, allows for an increase in aerobic ability in a relatively short time, making it an efficient method for runners. Meanwhile, unification exercises that combine several types of physical exercise show positive results in developing muscle strength, which is a critical component to support optimal performance in middle-distance runners.

This research has an essential contribution to the sports field, especially in developing training programs for athletes. These findings help fill knowledge gaps regarding the effectiveness of HIIT and unification training and provide insights into optimal exercise options for middle-distance runners. Thus, this study not only enriches the literature on training methods but also provides relevant recommendations for coaches and athletes in developing a more efficient training program that suits the needs of runners.

From a practical perspective, the results of this study imply that coaches and athletes can consider using HIIT to develop aerobic capacity efficiently and unification exercises to increase muscle strength. The combined application of these two training methods in the training program allows runners to achieve balanced and optimal physical improvement. For example, a middle-distance runner may combine a HIIT session with unification training on different days of the week to achieve optimal benefits on aerobic capacity and muscle strength.

However, this study has several limitations that need to be considered. Variations in exercise methods and program duration in the studies reviewed may affect the generalization of results. In addition,

individual differences, such as age and initial fitness level, can also impact responses to HIIT and unification exercises, so these findings need to be interpreted with caution.

For future studies, examining the long-term effects of HIIT and unification training on the performance of middle-distance runners through more in-depth experimental studies is recommended. Further research can also explore optimal exercise combinations and assess physiological responses more precisely, which will aid in the development of more effective exercise programs tailored to the specific needs of athletes.

References

Aagaard, P., & Andersen, J. (2010). Effects of strength training on endurance capacity in top-level endurance athletes. *Scandinavian Journal of Medicine & Science in Sports*, *20 Suppl 2*, 39–47. https://doi.org/10.1111/j.1600-0838.2010.01197.x

Caparrós-Manosalva, C., Garrido-Muñoz, N., Alvear-Constanzo, B., Sanzana-Laurié, S., Artigas-Arias, M., Alegría-Molina, A., … Marzuca-Nassr, G. N. (2023). Effects of high-intensity interval training on lean mass, strength, and power of the lower limbs in healthy old and young people. *Frontiers in Physiology*, *14*(September), 1–10. https://doi.org/10.3389/fphys.2023.1223069

Chevidikunnan, M. F., Al Saif, A., Gaowgzeh, R. A., & Mamdouh, K. A. (2016). Effectiveness of core muscle strengthening for improving pain and dynamic balance among female patients with patellofemoral pain syndrome. *Journal of Physical Therapy Science*, *28*(5), 1518–1523. https://doi.org/10.1589/jpts.28.1518

Conceição, L. S. R., Gois, C. O., Fernandes, R. E. S., Martins-Filho, P. R. S., Gomes, M. N., Neves, V. R., & Carvalho, V. O. (2021). Effect of High-Intensity Interval Training on Aerobic Capacity and Heart Rate Control of Heart Transplant Recipients: a Systematic Review with Meta-Analysis. *Brazilian Journal of Cardiovascular Surgery*, *36*(1), 86–93. https://doi.org/10.21470/1678-9741-2019-0420

de Araujo, G. G., Papoti, M., Dos Reis, I. G. M., de Mello, M. A. R., & Gobatto, C. A. (2016). Short and Long Term Effects of High-Intensity Interval Training on Hormones, Metabolites, Antioxidant System, Glycogen Concentration, and Aerobic Performance Adaptations in Rats. *Frontiers in Physiology*, *7*, 505. https://doi.org/10.3389/fphys.2016.00505

García-Pinillos, F., Soto-Hermoso, V. M., & Latorre-Román, P. A. (2017). How does high-intensity intermittent training affect recreational endurance runners? Acute and chronic adaptations: A systematic review. *Journal of Sport and Health Science*, *6*(1), 54–67. https://doi.org/10.1016/j.jshs.2016.08.010

Hofmann, P., & Tschakert, G. (2017). Intensity- and duration-based options to regulate endurance training. *Frontiers in Physiology*, *8*(MAY), 1–9. https://doi.org/10.3389/fphys.2017.00337

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

Ihsan, F., Kozina, Z., Sukendro, Nasrulloh, A., & Hidayat, R. A. (2024). Nutritional Strategies for Rapid Recovery in Sport: A Literature Review. *Retos*, *57*, 153–164. https://doi.org/10.47197/retos.v57.105622

Ihsan, F., Nasrulloh, A., Nugroho, S., & Kozina, Z. (2024). Optimizing Physical Conditioning Programs for Badminton Athletes: A Comprehensive Review of Training Strategies - A Systematic Review Optimización de programas de acondicionamiento físico para atletas de bádminton: una revisión completa de las estrategias. *Retos*, *54*, 488–498. https://doi.org/10.47197/retos.v54.103208

Ihsan, F., Nasrulloh, A., Nugroho, S., & Yuniana, R. (2023). Effect weight training on muscular hypertrophy: a systematic review. *Pedagogy of Physical Culture and Sports*, *27*(6), 439–447. https://doi.org/10.15561/26649837.2023.0601

Ihsan, F., Nasrulloh, A., Nugroho, S., & Yuniana, R. (2024). The Effect of Shadow Training and Muscle Endurance on Agility of Badminton Athletes 12-17 Years of Age. *Retos*, *54*, 36–45. https://doi.org/10.47197/retos.v54.103003

Jamka, M., Makarewicz-Bukowska, A., Bokayeva, K., Śmidowicz, A., Geltz, J., Kokot, M., … Walkowiak, J. (2022). Comparison of the Effect of Endurance, Strength and Endurance-Strength Training on Glucose and Insulin Homeostasis and the Lipid Profile of Overweight and Obese Subjects: A

Systematic Review and Meta-Analysis. *International Journal of Environmental Research and Public Health*, *19*(22). https://doi.org/10.3390/ijerph192214928

Lee, E. J., Snyder, E. M., & Lundstrom, C. J. (2020). Effects of marathon training on maximal aerobic capacity and running economy in experienced marathon runners. *Journal of Human Sport and Exercise*, *15*(1), 79–93. https://doi.org/10.14198/jhse.2020.151.08

Liu, Y., Abdullah, B. Bin, & Abu Saad, H. Bin. (2024). Effects of high-intensity interval training on strength, speed, and endurance performance among racket sports players: A systematic review. *PLOS ONE*, *19*(1), 1–19. https://doi.org/10.1371/journal.pone.0295362

Markvardsen, L. H., Overgaard, K., Heje, K., Sindrup, S. H., Christiansen, I., Vissing, J., & Andersen, H. (2018). Resistance training and aerobic training improve muscle strength and aerobic capacity in chronic inflammatory demyelinating polyneuropathy. *Muscle \& Nerve*, *57*(1), 70–76. https://doi.org/https://doi.org/10.1002/mus.25652

Martín-Fuentes, I., Oliva-Lozano, J. M., & Muyor, J. M. (2020). Evaluation of the Lower Limb Muscles' Electromyographic Activity during the Leg Press Exercise and Its Variants: A Systematic Review. *International Journal of Environmental Research and Public Health*, *17*(13). https://doi.org/10.3390/ijerph17134626

Mccormack, W. P., Shoepe, T. C., Almstedt, H. C., Jennings, C. A., & Capel, L. M. (2018). Velocity at maximal oxygen uptake best predicts 3 km race time in collegiate distance runners. *Journal of Human Sport and Exercise*, *13*(3), 631–638. https://doi.org/10.14198/jhse.2018.133.13

Pol, R., Balagué, N., Ric, A., Torrents, C., Kiely, J., & Hristovski, R. (2020). Training or Synergizing? Complex Systems Principles Change the Understanding of Sport Processes. *Sports Medicine - Open*, *6*(1), 28. https://doi.org/10.1186/s40798-020-00256-9

Powers, S. K., Goldstein, E., Schrager, M., & Ji, L. L. (2023). Exercise Training and Skeletal Muscle Antioxidant Enzymes: An Update. *Antioxidants*, *12*(1). https://doi.org/10.3390/antiox12010039

Severinsen, K., Jakobsen, J. K., Overgaard, K., & Andersen, H. (2011). Normalized Muscle Strength, Aerobic Capacity, and Walking Performance in Chronic Stroke: A Population-Based Study on the Potential for Endurance and Resistance Training. *Archives of Physical Medicine and Rehabilitation*, *92*(10), 1663–1668. https://doi.org/10.1016/j.apmr.2011.04.022

Stöggl, T. L., & Björklund, G. (2017). High intensity interval training leads to greater improvements in acute heart rate recovery and anaerobic power as high volume low intensity training. *Frontiers in Physiology*, *8*(AUG), 1–8. https://doi.org/10.3389/fphys.2017.00562

Susiono, R. (2019). *Aplikasi Metode Unifikasi Untuk Teknik Lari Cepat*. *8*(1), 27–37. https://doi.org/10.21009/segar/0801.04

Wen, D., Utesch, T., Wu, J., Robertson, S., Liu, J., Hu, G., & Chen, H. (2019). Effects of different protocols of high intensity interval training for VO(2)max improvements in adults: A meta-analysis of randomised controlled trials. *Journal of Science and Medicine in Sport*, *22*(8), 941–947. https://doi.org/10.1016/j.jsams.2019.01.013

Authors' and translators' details:

Ricky Susiono	rickysusiono.2022@student.uny.ac.id	Author
FX Sugiyanto	FX.sugiyanto56@gmail.com	Author
Ria Lumintuarso	Ria_l@uny.ac.id	Author
Tomoliyus	Tomoliyus@uny.ac.id	Author
satyaperdana	satyaperdana7@gmail.com	Translator