Effect of sprint interval training (SIT) on cardiorespiratory and neuromuscular variables associated with performance: a systematic review

Efecto del entrenamiento por intervalos de sprint (SIT) sobre las variables cardiorrespiratorias y neuromusculares asociadas con el rendimiento: una revisión sistemática

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Abstract

Introduction: Sprint interval training (SIT) has become one of the most widely studied time-efficient training strategies for improving athletic performance. Nevertheless, evidence regarding its effects on specific cardiorespiratory and neuromuscular variables remains fragmented.
Objective: To examine the effects of SIT on cardiorespiratory and neuromuscular variables associated with sports performance through a systematic review of the recent literature.
Methodology: Twenty-one studies involving different athletic populations and SIT protocols were included. Outcomes comprised relative and absolute VO_2max, maximal aerobic speed (MAS), maximal and resting heart rate, countermovement jump (CMJ), sprint performance, repeated sprint ability (RSA), and peak power output (PPO).
Results: SIT improved several physiological and performance-related outcomes, particularly in recreational or moderately trained individuals. The most consistent adaptations were observed for VO_2max and PPO, while MAS also improved, especially when SIT was combined with sport-specific training. Evidence for RSA was limited. The magnitude of the adaptations appeared to depend on participant characteristics, intervention duration, training volume, and protocol specificity.
Conclusions: SIT is an effective and time-efficient strategy for improving key physiological variables associated with sports performance. However, its effects are not consistent across all outcomes or populations. Future studies should standardize SIT protocols, isolate the effects of SIT from concurrent training components, and evaluate its application in specific sports.

Keywords

Sprint interval training; neuromuscular performance; sports performance.

Resumen

Introducción: El entrenamiento por intervalos de sprint (SIT) se ha consolidado como una de las estrategias de entrenamiento más estudiadas por su eficiencia para mejorar el rendimiento deportivo. Sin embargo, la evidencia sobre sus efectos en variables cardiorrespiratorias y neuromusculares específicas continúa siendo limitada.
Objetivo: Examinar los efectos del SIT sobre las variables cardiorrespiratorias y neuromusculares asociadas con el rendimiento deportivo mediante una revisión sistemática de la literatura reciente.
Metodología: Se incluyeron 21 estudios con diferentes poblaciones deportivas y protocolos de SIT. Las variables evaluadas fueron el VO_2max relativo y absoluto, la velocidad aeróbica máxima (VAM), la frecuencia cardíaca máxima y en reposo, el salto con contramovimiento (CMJ), el rendimiento en sprint, la capacidad para realizar sprints repetidos (RSA) y la potencia pico (PPO).
Resultados: El SIT mejoró diversas variables fisiológicas y relacionadas con el rendimiento, especialmente en individuos recreativos o moderadamente entrenados. Las adaptaciones más consistentes se observaron en el VO_2max y la PPO, mientras que la VAM también mejoró, particularmente cuando el SIT se combinó con entrenamiento específico del deporte. La evidencia sobre la RSA fue limitada. La magnitud de las adaptaciones pareció depender de las características de los participantes, la duración de la intervención, el volumen de entrenamiento y la especificidad del protocolo.
Conclusiones: El SIT constituye una estrategia eficaz y eficiente en términos de tiempo para mejorar variables fisiológicas asociadas con el rendimiento deportivo. No obstante, sus efectos no son consistentes en todas las variables ni en todas las poblaciones. Futuros estudios deberían estandarizar los protocolos de SIT, aislar sus efectos de otros componentes del entrenamiento y evaluar su aplicación en disciplinas deportivas específicas.

Palabras clave

Entrenamiento por intervalos de sprint; rendimiento neuromuscular; rendimiento deportivo.

Introduction

Among the training strategies that have gained prominence in recent decades, Sprint Interval Training (SIT) stands out as a key tool for enhancing athletic performance (Weston et al., 2014). SIT is a form of interval training characterized by supramaximal high-intensity efforts, representing one of the most physiologically demanding forms of exercise (MacInnis & Gibala, 2017). It typically involves sprint bouts lasting between 10 and 30 seconds. Sprints shorter than 10 seconds are predominantly dependent on the phosphagen system and rapid glycolysis, without eliciting significant changes in mitochondrial enzyme activity. Conversely, sprint durations longer than 30 seconds tend to engage a substantially greater oxidative contribution to ATP resynthesis and are associated with a marked decline in exercise intensity (Sloth et al., 2013). SIT protocols frequently employ all-out supramaximal intensities and have emerged as a highly effective method for improving endurance, speed, and power across various team sports such as football, basketball, rugby, and among semi-professional athletes (Hall et al., 2023).

Recent research supports the effectiveness of SIT in enhancing athletic performance. One study investigated the impact of a SIT program consisting of three weekly sessions over seven weeks using a Wingate protocol on a cycle ergometer. The results demonstrated significant improvements in VO_2max among 12 participants, along with changes in the activity of glycolytic muscle enzymes (MacDougall et al., 1998). Additionally, repeated-sprint ability has been identified as an important component of performance in team sports, and SIT may represent a useful strategy to enhance this capacity (Castagna et al., 2007).

Research on SIT and its relationship with athletic performance continues to evolve (Atakan et al., 2022), with emerging perspectives broadening our understanding of this training modality (Boullosa et al., 2022). Some studies have examined the physiological mechanisms underlying the effects of SIT on performance, including changes in cardiovascular function, metabolic capacity, and neuromuscular adaptations. Notably, increases in mitochondrial content, capillary density, maximal stroke volume, maximal cardiac output, and total blood volume have been reported after six to seven weeks of SIT or high-intensity interval training (HIIT) (MacInnis & Gibala, 2017). Previous systematic reviews have reported positive effects of SIT on maximal oxygen uptake (VO_2max) and aerobic performance (Hall et al., 2023; Sloth et al., 2013), while more recent reviews have examined the effects of short sprint interval training (≤10 s) or the overall impact of SIT on physical performance (Boullosa et al., 2022). However, these reviews have generally focused on specific performance domains, particular SIT formats, or pooled performance outcomes. Consequently, there remains a need for a synthesis specifically examining the effects of SIT on individual cardiorespiratory and neuromuscular variables associated with sports performance, including VO_2max, maximal aerobic speed, heart rate responses, countermovement jump performance, repeated sprint ability, sprint performance, and peak power output.

This review aims to address the question: What is the effect of SIT on cardiorespiratory and neuromuscular variables associated with athletic performance? as well as other related inquiries, through a comprehensive evaluation of the existing scientific literature and the presentation of emerging perspectives from current research. Using a rigorous and multidimensional approach, this review seeks to deepen the understanding of SIT and its impact on sports performance, with the objective of providing valuable guidance for athletes, coaches, and sports professionals aiming to optimize training programs.

In addition, potential practical applications of SIT across various sports contexts will be explored, and recommendations for its effective implementation will be discussed. It is expected that this review will contribute to an improved understanding and application of SIT as a comprehensive strategy to enhance athletic performance across different sports disciplines. Accordingly, the present systematic review aimed to analyze the effects of SIT on cardiorespiratory and neuromuscular variables associated with athletic performance, including maximal oxygen uptake, maximal aerobic speed, heart rate-related variables, countermovement jump performance, sprint performance, repeated sprint ability, and peak power output.

Method

This study followed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines, as defined by the EQUATOR Network, as a pre-established protocol for conducting systematic reviews (Page et al., 2021). Additionally, it optimized the central methodology across all stages of the review process, including problem formulation, literature search, evaluation, analysis, and presentation of findings to systematize the review and strengthen its scientific rigor.

The objective was to determine the effect of SIT on cardiorespiratory and neuromuscular variables associated with performance through a systematic review of randomized controlled trials. As this review was not eligible for registration in PROSPERO due to its primary focus on athletic performance outcomes, the study protocol and methodological details were made publicly available through Figshare to ensure transparency and reduce the risk of duplication, under the following DOI: 10.6084/m9.figshare.24945003.

Eligibility Criteria

The inclusion criteria for this systematic review were as follows:

1. Randomized controlled trials (RCTs).
2. A minimum follow-up duration of six weeks.
3. Assessment of performance-related variables.
4. Explicit declaration of the use of SIT.
5. Peer-reviewed articles published between 2010 and 2024.
6. Publications written in English or Spanish.
7. Full-text availability.
8. Articles reporting performance changes resulting from SIT interventions.

Studies were excluded if they did not constitute original research (e.g., editorials, commentaries, dissertations), involved populations with underlying medical conditions, were not experimental in design, and/or presented methodological limitations. PubMed/MEDLINE and Scopus were selected as the primary databases to examine the available literature. Additionally, supplementary articles were identified through manual searches conducted on Google Scholar.

The search strategy was guided by the PRISMA guidelines for systematic reviews (Page et al., 2021). Initially, using the PICO framework, the following research question was defined: "Does Sprint Interval Training (SIT) affect cardiorespiratory and neuromuscular variables?" Searches were conducted in the selected databases using specific search algorithms designed to capture relevant articles for this review. The database search was carried out during the last week of March 2024.

The following search terms were used across all databases: "SIT AND performance," "Sprint Interval Training AND performance", "(SIT) OR (Sprint Interval Training) AND VO_2max," and "(SIT) OR (Sprint Interval Training) AND sprint." Study selection was conducted using the Rayyan.ai platform.

Searches were conducted in the following clinical trial registries to identify any ongoing trials during the development of this systematic review: ClinicalTrials.gov, Current Controlled Trials (www.served-trials.com), the Australian and New Zealand Clinical Trials Registry (www.actr.org.au), and the University Hospital Medical Information Network Clinical Trials Registry (www.umin.ac.jp/ctr).

Two authors (H.D.M. and J.D.C.) independently conducted searches across the selected databases. Studies that met the inclusion criteria were subsequently selected for analysis and synthesis. A data extraction table was developed to organize and compare key information, including citation/country, study type, study design, participant characteristics, objectives, methodology, results, and conclusions. Three authors (J.D.Q., J.D.A., and N.A.A.) were responsible for drafting and revising the manuscript. Any discrepancies were identified and resolved through discussion with a third author and, when necessary, with additional input from a fourth author (A.R.J. and C.A.G.).

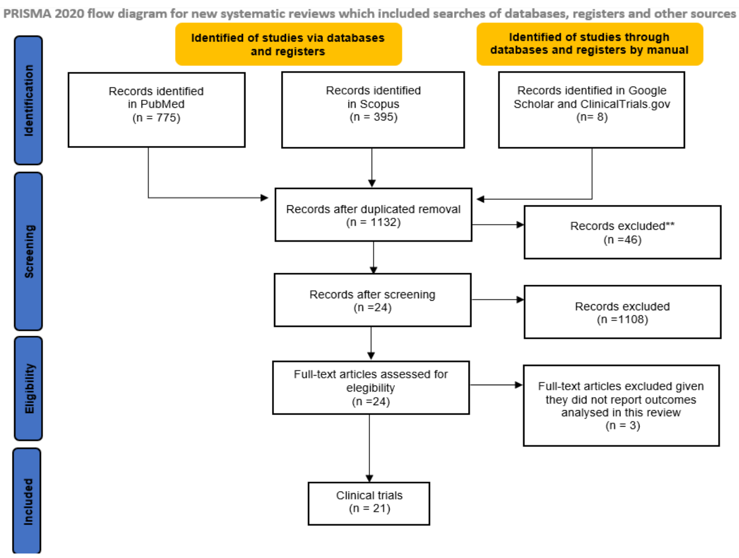
The risk of bias of the included studies was assessed using the Cochrane Risk of Bias tool for randomized controlled trials, which comprises seven methodological domains: random sequence generation, allocation concealment, blinding of participants and personnel, blinding of outcome assessment, incomplete outcome data, selective reporting, and other sources of bias. Each domain was independently rated by two reviewers and classified as low risk of bias, some concerns, or high risk of bias, in accordance with the guidance provided in the Cochrane Handbook for Systematic Reviews of Interventions. Discrepancies were resolved by consensus.

The domain-level judgments were graphically represented using the robvis package in R, which generates traffic-light plots and summary figures for risk-of-bias assessments. These visualizations were used exclusively to facilitate the presentation and interpretation of the methodological quality of the included studies.

Results

After a comprehensive literature search (with date and language filters applied; the initial number of retrieved records was not available in the dataset), 1,132 records remained after duplicate removal. Following title and abstract screening, 1,108 records were excluded, leaving 24 potentially eligible publications according to the predefined inclusion criteria. Subsequently, all 24 full-text articles were assessed for eligibility, and three studies were excluded because they did not report the outcomes analyzed in this review. Ultimately, 21 studies fulfilled the eligibility criteria and were included in the qualitative synthesis. Figure 1 presents the flow diagram of the literature selection process. The included studies evaluated the effects of SIT on a range of cardiorespiratory and neuromuscular performance variables, including VO_2max, MAS, peak power output PPO, RSA, CMJ performance, sprint performance, and heart rate-related outcomes. Overall, the findings suggest that SIT may induce favorable adaptations in several performance-related variables, although the magnitude and consistency of these effects varied according to participant characteristics, intervention protocols, and outcome measures. Detailed characteristics and results of the included studies are presented in Table 1.

Figure 1. PRISMA flow diagram. Excluded because of duplication across databases.



The methodological quality and risk of bias of the included clinical trials, assessed using the Cochrane Risk of Bias tool for randomized controlled trials, are presented in Figures 2 and 3. The domain-level judgments were displayed using the Risk-of-bias VISualization (robvis) tool. Figure 2 summarizes the proportion of studies classified as having low risk of bias, some concerns, or high risk of bias across each domain, whereas Figure 3 presents the risk-of-bias assessment for each individual study.

Figure 2. Summary of the risk-of-bias assessment across methodological domains of the included clinical trials. Judgments were derived from the Cochrane Risk of Bias tool for randomized controlled trials and graphically represented using the robvis tool. Green, yellow, and red indicate low risk of bias, some concerns, and high risk of bias, respectively.

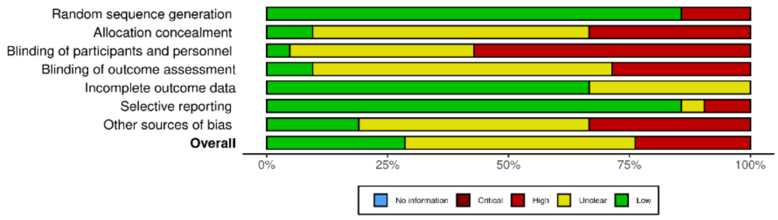


Figure 3. Risk-of-bias assessment of individual clinical trials. Judgments were derived from the Cochrane Risk of Bias tool for randomized controlled trials and graphically represented using the robvis tool. Green, yellow, and red indicate low risk of bias, some concerns, and high risk of bias, respectively.

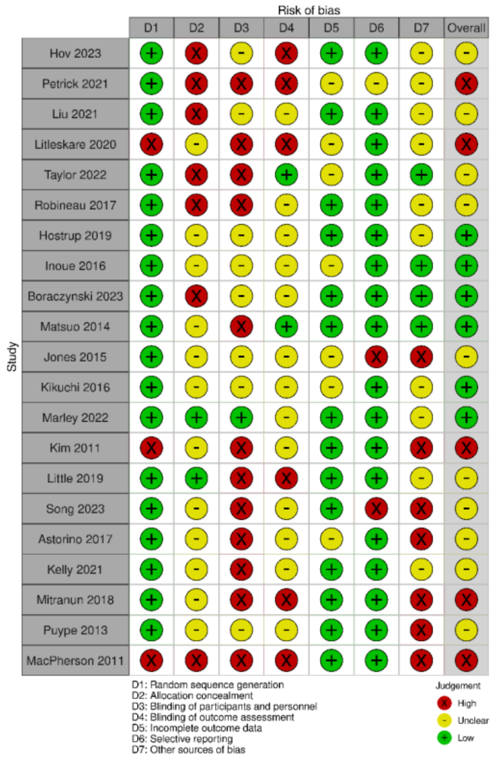


Table 1. Results table

Reference	N (F:M)	Characteristics	SIT					Assesed variable	Observed change
			Exercise(s)	Frequency (days·week-1)	Intensity (% VO_2max / % HRmax / % MAS / W)	Volume (sets × reps)	Duration (weeks)		
Hov et al. (2023)	48 0:10	23 ± 2 years 178 ± 5 cm 75,2 ± 6,5 kg 62,1 ± 4,8 VO_2max ($ml·kg^{-1}·min^{-1}$)	Treadmill HIIT	3	~95% MAS	(4 x 4 min) 3min active recovery (<70% HR max)	8	VO_2max ($ml·kg^{-1}·min^{-1}$) VO_2max ($ml·kg^{-0.75}·min^{-1}$), HRmax MAS 300 m Time Trial (s) 3000 m Time Trial (s)	6,05 %*** 5,87 %*** -2,01 %** 10,20 %*** -2,22 % -6,13 %***
	48 0:12	23 ± 2 years 180 ± 5 cm 75,2 ± 11,0 kg	Treadmill SIT		~150% MAS	8 x 20 s, 10 s passive recovery		VO_2max ($ml·kg^{-1}·min^{-1}$) VO_2max ($ml·kg^{-0.75}·min^{-1}$), HRmax	3,03 %*** 3,33 %*** -0,51 %

		64,0 ± 6,1 VO_2max (ml·kg^{-1}·min^{-1})						MAS 300 m Time Trial (s) 3000 m Time Trial (s)	4,31 %** -4,65 %** -4,48 %**
	48 0:9	24 ± 4 years 184 ± 6 cm 81,0 ± 8,1 kg 63,1 ± 5,3 VO_2max (ml·kg^{-1}·min^{-1})	Treadmill SIT		~175% MAS	(10 x 30 s) 3,5min active recovery (<70% HR máx)		VO_2max (ml·kg^{-1}·min^{-1}) VO_2max (ml·kg$^{-0.75}$·min^{-1}), HRmax MAS 300 m Time Trial (s) 3000 m Time Trial (s)	1,56 % 1,25 % -1,02 % 2,17 % -4,65 %** -2,30 %*
Petrick et al. (2021)	23 0:11	37,4 ± 15,1 years BMI 34 ± 3,4 kg·m	Cycle ergometer	5	Week 1-2: (56% ± 3% W_peak) Week 3-6: (58% ± 3% W_peak)	Week 1-2: 30 min at 114 ± 25 W Week 3-4: 35 min at 118 ± 25 W Week 5-6: 40 min at 118 ± 25 W	6	VO_2peak (L·min^{-1}) W_peak (W) VO_2peak (mL·kg body mass^{-1}·min^{-1}) VO_2peak (mL·kg lean mass^{-1}·min^{-1}) Resting HR	11,84 %* 16,26 %* 11,83 %* 11,53 %* -8,19 %
	23 0:12		Cycle ergometer SIT	3	Week 1-2: (168% ± 5% W_peak) Week 3-6: (173% ± 12% W_peak)	Week 1-2: 4 × 30 s at 350 ± 81 W /2 min at 50 W Week 3-4: 5 × 30 s at 359 ± 77 W /2 min at 50 W Week 5-6: 6 × 30 s at 359 ± 77 W /2 min at 50 W		VO_2peak (L·min^{-1}) W_peak (W) VO_2peak (mL·kg body mass^{-1}·min^{-1}) VO_2peak (mL·kg lean mass^{-1}·min^{-1}) Resting HR	5,73 %* 11,81 %* 5,31 %* 5,47 % -6,15 %*
Liu et al. (2021)	32 8:0	20,5 ± 1,4 years 168,5 ± 4,2 cm 62,6 ± 4,2 kg 9,5 ± 1,2 years 181,9 ± 8,9 HR max	SIT Cycling Training	2	> 90% HR max	Cycling: 5 × 1–2 min at 50 W, preparation for 30 s all-out effort with individualized load (0.075 kg/kg BW), 5 min recovery	8	VO_2max (ml·kg^{-1}·min^{-1})	8,00 %**
	32 0:8	20,0 ± 1,3 years 179,6 ± 3,6 cm 73,8 ± 6,9 kg 12,1 ± 2,2 years 190,7 ± 8,8 HR max	SIT - Specific Multiple Balls Training	1		Multi-ball: 2 × 8 reps (30 s), 5–8 min recovery		VO_2max (ml·kg^{-1}·min^{-1})	10,69 %**
	32 8:0	19.4 ± 1.5 years 168.2 ± 4.8 cm 61.3 ± 4.2 kg 9.8 ± 1.5 years 180.4 ± 8.5 HR max	Traditional Training	2	65–79% HR max	Runing: 40 min Fartlek		VO_2max (ml·kg^{-1}·min^{-1})	0,92 %
	32 0:8	20.0 ± 1.3 years 179.6 ± 3.6 cm 73.8 ± 6.9 kg 12.1 ± 2.2 years 190.7 ± 8.8 HR max	Traditional Multiple Ball Training	1		Multi-ball: 2 x 4 reps (1 min), 5 - 8 min recovery		VO_2max (ml·kg^{-1}·min^{-1})	3,29 %
Litleskare et al. (2020)	25 8:4	25 ± 1 years 23,6 ± 0,9 kg·m −2 BMI	CT-RV	3	70 - 80% HR max	30 - 60 min of running, increasing by +5 min/week	8	VO_2max (ml·kg^{-1}·min^{-1})	3,62 %*
	25 8:5	25 ± 1 years 24,0 ± 0,8 kg·m −2 BMI	Uphill sprint SIT		>85% HR max	5–10 × 30 s sprints, 3 min recovery If >7 sprints: 6 min mid- session recovery		VO_2max (ml·kg^{-1}·min^{-1})	5,25 %*
Taylor et al. (2022)	18 0:9	20,4 ± 1,0 years 23,5 kg·m -2 BMI	Flat SIT	2		6 × 30 m sprints / 30 s recovery; +1 sprint per week until week 7 (12 sprints in weeks 7–8)	8	10-m sprint 30-m sprint	-1,19 % -1,41 %*
	18 0:9	20,9 ± 1,0 years 23,7 kg·m- 2 BMI	6% Uphill SIT			6 × 30 m sprints / 30 s recovery; +1		10-m sprint 30-m sprint	-3,59 % -2,27 %*

						sprint per week until week 7 (12 sprints in weeks 7–8)			
Robineau et al. (2017)	30 0:11	27.5 ± 2.5 years 177.3 ± 5.6 cm 89.4 ± 14.2 kg	Strength-only training (CON)	2	Week 1-3: 70% 1RM Week 4-6: 80% 1RM Week 7-8: 90% 1RM	Weeks 1-3: CTE: 2 x 3 min / 30 s Main exercises: 3+3 x 10 reps / 2 min Complementary exercises: Plyometric and hamstring - 6+6 reps Weeks 4-6: CTE: 3 x 3 min / 30 s Main exercises: 3+3 x 6 reps / 3 min Complementary exercises: Plyometric and hamstring - 6+6 reps Weeks 7-8: CTE: 3 x 4 min / 30 s Main exercises: 3+3 x 3 reps / 3 min Complementary exercises: Plyometric and hamstring - 6+6 reps	8	CMJ VO_2peak (L·min⁻¹) MAS RSAmax (s)	7,10 % 0,40 % -0,60 % 0,00 %
	30 0:9	25.0 ± 3.7 years 180.1 ± 7.7 cm 86.2 ± 10.5 kg	Concurrent strength and short-interval training (INT)	2-2	Strength workload Weeks 1-3: 70% 1RM Weeks 4-6: 80% 1RM Weeks 7-8: 90% 1RM Short Interval: 30/30 s intervals: 30 s at 100% MAS + 30 s active recovery at 50% MAS.	Strength workload Weeks 1-3: CTE: 2 x 3 min / 30s Main exercises: 3+3 x 10 reps / 2 min Complementary exercises: Plyometric and hamstring - 6+6 reps Weeks 4-6: CTE: 3 x 3min / 30s Main exercises 3+3 x 6 reps / 3 min Complementary exercises Plyometric and hamstring - 6+6 reps Weeks 7-8: CTE: 3 x 4min / 30s		CMJ VO_2peak (L·min⁻¹) MAS RSAmax (s)	3,10 % 1,50 % 4,10 % 0,10 %

						Main exercises 3+3 x 3 rep / 3 min Complementary exercises Plyometric and hamstring - 6+6 reps Short Interval Weeks 1-3: 2 × 8 min of 30/30 s intervals Weeks 4-6: 2 × 10 min of 30/30 s intervals Weeks 7-8: 2 × 12 min of 30/30 s intervals			
	30 0:10	26.4 ± 3.0 years 179.7 ± 8.0 cm 89.3 ± 10.3 kg	Concurrent strength and sprint interval training (SIT)	2-2	Strength workload Weeks 1-3: 70% 1RM Weeks 4-6: 80% 1RM Weeks 7-8: 90% 1RM Sprint Interval all-out	Strength workload Weeks 1-3: CTE 2 x 3 min / 30s Main exercises: 3+3 x 10 reps / 2 min Complementary exercises: Plyometric and hamstring - 6+6 reps Weeks 4-6: CTE: 3 x 3min / 30s Main exercises: 3+3 x 6 reps / 3 min Complementary exercises: Plyometric and hamstring - 6+6 reps Weeks 7-8: CTE: 3 x 4 min / 30s Main exercises 3+3 x 3 reps / 3 min Complementary exercises: Plyometric and hamstring - 6+6 reps Sprint Interval Weeks 1-3: 4 × 30 s Weeks 4-6: 6 × 30 s Weeks 7-8: 8 × 30 s		CMJ VO_2peak ($L \cdot min^{-1}$) MAS RSAmax (s)	4,10 % 5,40 % 5,60 % -0,10 %
Hostrup et al. (2019)	20 0:12	22.8 ±2.2 years 1.78 ±0.05 m 75.1 ±6.4 kg 23.5 ±1.8 BMI (kg × (m2)−1)	Intense intermittent training: 10-20-30 concept	3	20 s at moderate speed 10 s at maximal sprint effort	2 (wk 1-4) to 3 (wk 5-10) sets x 5 reps (30 s of jogging) 20 s moderate speed and 10 s maximal sprint	10	30 m sprint time (s)	0,23 %

						/ 4 min recovery			
	20 0:8	24.9 ±5.4 years 1.81 ±0.05 m 76.5 ±8.0 kg 23.3 ±1.5 BMI (kg × (m2)−1)	Change of direction (45º-90º) SIT		Maximal sprint	2 (wk 1-4) to 3 (wk 5-10) sets x 6 reps (6 s / 54 s passive recovery) 4 min recovery between sets		30 m sprint time (s)	-0,93 %
Inoue et al. (2016)	16 0:7	34,0 ± 6,7 years 174,1 ± 2,7 cm 68,8 ± 2,8 kg 65,6 ± 5,6 VO 2máx (mL kg -1 min -1)	Cycling HIT	Weeks 1-5: 3 Week 6: 2	Maximal sustainable effort Recovery: active cycling at 100 rpm, RPE 10–15	1: 8 reps x 4 min / 4 min 2: 10 reps x 4 min / 4min 3: 3 reps x 4 min / 4 min 4: 7 reps x 6 min / 6min 5: 8 reps x 6 min / 6min 6: 2 reps x 4 min / 4min	6	PPO (W) PPO ($W·kg^{-1}$)	7,21 % 8,33 %
	16 0:9	30,6 ± 6,3 years 176,8 ± 6,7 cm 69,5 ± 6,8 kg 64,0 ± 3,2 VO 2máx (mL kg -1 min -1)	Cycling SIT		All out Recovery: active cycling at 100 rpm, RPE 10–15	1: 8 reps x 30 s / 4 min 2: 10 reps x 30 s / 4 min 3: 3 reps x 30 s / 4min 4: 10 reps x 30 s / 4min 5: 12 reps x 30 s / 4min 6: 2 reps x 30 s / 4 min		PPO (W) PPO ($W·kg^{-1}$)	4,90 % 6,52 %
Boraczyński et al. (2023)	25 0:12	24.3±5.16 years 181.0±4.37 cm 75.0±5.94 kg	SSG	Weeks 1-3: 2 Weeks 4-6: 3	85-90% HRmax	Phase 1 (2·wk-1): 5 x 3 min, 3 min active recovery (technical drills) Phase 2 (3·wk-1): 4 x 4 min, 3 min active recovery (technical drills)	6	CMJ T5m (s) T30m (s) WAnT PPO (W) WAnT PPO (W/kg) VO_2max ($ml·kg^{-1}·min^{-1}$)	2,90 % -2,10 % -1,50 % 3,00 % 2,90 % 5,20 %
	25 0:13	25.6±3.98 years 180.3±6.45 cm 75.4±6.15 kg	SIT		Maximal effort	Phase 1 (2·wk-1): 1 set of 10x45 s, 1 min active recovery Phase 2 (3·wk-1): 2 sets, 10x30 s, 30 s active recovery		CMJ T5m (s) T30m (s) WAnT PPO (W) WAnT PPO (W/kg) VO_2max ($ml·kg^{-1}·min^{-1}$)	3,50 % -2,20 % -2,40 % 4,50 % 5,50 % 2,60 %
Matsuo et al. (2014)	42 0:14	26,4 ± 6,5 years 170,9 ± 5,0 cm 62,4 ± 5,4 kg	Cycling SIT	Week 1: 4 Weeks 2-8: 5	30W, 60 rpm 120% VO_2max >85rpm 30W, 40-60 rpm	2min warm-up 7 x 30 s / 15 s (no rest at 7th) 3min cooldown 10 min total – 110 kcal	8 (12)	VO_2max ($ml·kg^{-1}·min^{-1}$) Resting HR	16.7% ± 11.6%* −7.3% ± 11.1%*
	42 0:14	27,2 ± 6,4 years 171,6 ± 4,9 cm 63,1 ±6,7 kg	Cycling HIAT		30W, 60 rpm 85-90% VO_2max 70-80 rpm 50% VO_2max 60 rpm 85-90% VO_2max 70-80 rpm 50% VO_2max 60 rpm	2min 3min 2min 3min 2min 3min 3min 18 minutes total - 180 kcal		VO_2max ($ml·kg^{-1}·min^{-1}$) Resting HR	22.5% ± 12.2%* −12.7% ± 12.2%*

					80-85% VO_2max 70-80 rpm 30 W, 40-60 rpm				
	42 0:14	25,9 ± 6,0 years 172,2 ± 3,4 cm 63,0 ± 7,2 kg	Cycling CAT		30 W, 60 rpm 60-65% VO_2max 60 rpm 30 W, 40-60 rpm	2min 40min 3min 45 minutes total - 360 kcal		VO_2max (ml·kg^{-1}·min $^{-1}$) Resting HR	10.0% ± 8.9%* −2.2% ± 13.3%
Jones et al. (2015)	21 6:0	20,6 ± 0,9 years 187 ± 0,6 cm 65,0 ± 4,3 kg	Wattbike Pro Cycling repeat SIT	1		Weeks 1-2: 8 x 60 s / 75 s – ar 45 ± 10 W Weeks 3-4: 10 x 60 s / 75 s – ar 45 ± 10 W Weeks 5-6: (12 x 60 s / 75 s – ar 45 ± 10 W	6	PPO (W) VIFT	12,67 % 2,90 %*
	21 15:0	21,4 ± 1,0 years 185 ± 4,1 cm 67,3 ± 2,1 kg	Normal Training CON	5-3		5 x field hockey practice and 3 x RT sessions / week	6	VIFT	0,37 %
Kikuchi et al. (2016)	12 0:6	20 ± 1.8 years 171.2 ± 4.9 cm 64.5 ± 4.7 kg	Muscle hypertrophy Resistance Training RT	3	80% + 5 1RM	3 s x 10-12 reps / 90 s rest intervals	8	VO_2max (ml·kg^{-1}·min $^{-1}$)	5,30 %
	12 0:6		PowerMaxV II Concurrent Sprint Interval Training CT		Maximal effort	4 x 30 s / 4 m 30s rest intervals		VO_2max (ml·kg^{-1}·min $^{-1}$)	18,57 %*
Marley et al. (2022)	27 0:27	25± 5 years 178 ± 7 cm 78 ± 10 kg	SIT on cycle ergometer + SIT on arm crank ergometer (upper-body kinetic chain)	2	LB: 8 × 10 s 8% BW / 30 s rest. 5 min rest UB: 8 × 10 s 5% BW / 30 s rest	LB: 8 × 10 s / 30 s rest. 5 min rest UB: 8 × 10 s / 30 s rest	6	SIT(d3) LB VO_2peak (ml·kg^{-1}·min $^{-1}$) UB VO_2peak (ml·kg^{-1}·min $^{-1}$) LB PPO (W.kg^{-1}) UB PPO (W.kg^{-1})	S 6,25 % 7,50 % 18,22 % 13,67 %
								SIT LB VO_2peak (ml·kg^{-1}·min $^{-1}$) UB VO_2peak (ml·kg^{-1}·min $^{-1}$) LB PPO (W.kg^{-1}) UB PPO (W.kg^{-1})	C 0,23 % -2,78 % 12,25 % 6,15 %
Kim et al. (2011)	29 0:29	SIT 20.00 ± 1.10 years 173.00 ± 6.05 cm 74.91 ± 7.73 kg 25.00 ± 1.99 BMI CON 19.94 ± 1.16 years 172.72 ± 7.17 cm 74.91 ± 7.73 kg 25.00 ± 1.99 BMI	SIT sprint in treadmill	4	Weeks 1-2: 80% MAS Weeks 3-8: 90% MAs	Weeks 1-2: 6x30 s / 4 Weeks 3-4: 8 x 3 s /4 Weeks 5-8: 10 x 30 s / 4	8	SIT VO_2max (ml·kg^{-1}·min $^{-1}$) HR max HR post PPO (W.kg^{-1}) Mean power (W.kg^{-1})	SIT 6,17 % -1,33 % -0,78 % 22,32 %
								CON VO_2max (ml·kg^{-1}·min $^{-1}$) HR max	CON 6,91 % -0,74 % 0,03 % 7,35 % 4,77 %

								HR post PPO (W.kg^{-1}) Mean power (W.kg^{-1})	
				3 x week 1 session / day	0.21 N·m/kg (standard load)	3 x 20 s sprints / 3 min recovery		SS VO_2max (ml·kg^{-1}·min^{-1}) VO2peak (L·min^{-1}) PPO (W)	SS 4,19 % 4,00 % 2,14 %
Little et al. (2019)	28 14:14 30 0:30	SS 22 years 7 : 5 70 ± 10 kg 23.5 ± 1.99 BMI 35.6 ± 11.4 VO_2max CON 21 years 7 : 9 71 ± 17 kg 24.1 ± 4.9 BMI 34.3 ± 7.6 VO_2max 25,2 ± 2,0 years BMI 24.28	Sprint on cycle ergometer SIT (short sprints)	2	SIT / SSIT progression: Week 1: 7 sprints at max intensity Week2: 8 sprints at max intensity Week 3: 9 sprints at max intensity Week 4: 10 sprints at max intensity Week 5: 10 sprints at max intensity Week6 10 sprints at max intensity	Wk 1: 3 × 7 × 15 s / 15 s Wk 2: 3 × 8 × 15 s / 15 s Wk 3: 3 × 9 × 15 s / 15 s Wk 4–6: 3 × 10 × 15 s / 15 s 3 min rest between sets	6 6	SIT 20-m sprint (s) VO_2max (ml·kg^{-1}·min^{-1})	SIT -2,97 % 4,66 %
Song et al. (2023)	30 0:30 71 34:37	25,2 ± 2,0 years BMI 24.28 HIIT + SIT 22.5 ± 5.8 years 23.0 BMI	SSIT: sprints with ball, passes, and dribbling CON: 2 x / week of basketball technical and tactical drills High- / low-volume HIIT + all-out SIT	2 3	SIT / SSIT progression: Week 1: 7 sprints at max intensity Week2: 8 sprints at max intensity Week 3: 9 sprints at max intensity Week 4: 10 sprints at max intensity Week 5: 10 sprints at max intensity Week6 10 sprints at max intensity Week 1: Session 1-3	Wk 1: 3 × 7 × 15 s / 15 s Wk 2: 3 × 8 × 15 s / 15 s Wk 3: 3 × 9 × 15 s / 15 s Wk 4–6: 3 × 10 × 15 s / 15 s 3 min rest between sets 8 reps x 30 s / 75 s recovery 9 reps x 60s / 75 s recovery 10 reps x 60s / 75 s recovery 8 reps x 30 s / 120 s recovery 5 reps x 150 s / 60 s recovery	6 6	SSIT 20-m sprint (s) VO_2max (ml·kg^{-1}·min^{-1}) CON 20-m sprint (s) VO_2max (ml·kg^{-1}·min^{-1}) PPO (W) VO_2max (ml·kg^{-1}·min^{-1}) VO2peak (L-min^{-1}) HR max	SSIT -4,32 % 5,67 % CON 0,26 % -0,21 % 8,70 % 8,70 % 10,00 % 1,60 %

					HIIT-SIT-PER at 90% PPO Week 2: Session 4-6 HIIT-SIT-PER at 100% PPO Week 3: Session 7-10 HIIT-SIT-PER at 110% PPO Week 4: Session 11-13 SIT 130% PPO HIIT 70% PPO PER 70% PPO Week 5: Session 14-16 SIT 140% PPO HIIT 75% PPO PER 140% PPO Week 6: Session 17-20 SIT 150% PPO HIIT 80% PPO PER 100% PPO	6 reps x 150 s / 60 s recovery 10 reps x 30 s / 120 s recovery 6 reps x 150 s / 60 s recovery 10 rep x 30 s / 120 s recovery 12 reps x 30 s / 120 s recovery 7 reps x 150 s / 60 s recovery 8 reps x 60 s / 75 s recovery			
Astorino et al. (2017)	71 34:37 25 0:25	HIIT +HIIT 21.9±1.9 years 22.5 BMI	High- / low-volume HIIT + all-out SIT ET: continuous treadmill running at 75% SIT: maximal-intensity sprints with short intra-set and long inter-set recovery	3 3	Week 1: Session 1-3 HIIT-SIT-PER at 90% PPO Week 2: Session 4-6 HIIT-SIT-PER at 100% PPO Week 3: Session 7-10 HIIT-SIT-PER at 110% PPO Week 4: Session 11-13 SIT 130% PPO HIIT 70% PPO PER 70% PPO Week 5:	8 reps x 30 s / 75 s recovery 9 reps x 60s / 75 s recovery 10 reps x 60s / 75 s recovery 8 reps x 30 s / 120 s recovery 5 reps x 150 s / 60 s recovery 6 reps x 150 s / 60 s recovery 10 reps x 30 s / 120 s recovery 6 reps x 150 s / 60 s recovery	6 6	PPO (W) VO₂max (ml·kg⁻¹·min ⁻¹) VO2peak (L-min⁻¹) HR max	9,40 % 7,80 % 6,50 % 0,50 %
		HIIT + PER 23.1±5.5years; 23.8 BMI						PPO (W) VO₂max (ml·kg⁻¹·min ⁻¹) VO₂peak (L-min⁻¹) HR max	8,00 % 10,40 % 10,00 % 0,00 %
		CON 25.8±5.8 years; 24.3 BMI						PPO (W) VO₂max (ml·kg⁻¹·min ⁻¹) VO₂peak (L-min⁻¹) HR max	0,40 % -0,50 % 0,00 % 0,00 %
		25,9 ± 3,8 years. 24.5 BMI						ET HR max vVO₂max (km·h⁻¹)	ET -2,07 % 10,46 %

					Session 14-16 SIT 140% PPO HIIT 75% PPO PER 140% PPO Week 6: Session 17-20 SIT 150% PPO HIIT 80% PPO PER 100% PPO ET: Weeks 1-2: 40 min at 75% Week 3-6: 50 min at 75%	10 rep x 30 s / 120 s recovery 12 reps x 30 s / 120 s recovery 7 reps x 150 s / 60 s recovery 8 reps x 60 s / 75 s recovery ET 1 sets x 40 min			
Kelly et al. (2021)	25 0:25	25,9 ± 3,8 years. 24.5 BMI	ET: continuous treadmill running at 75%.	3	SIT (all-out, 3–4 sets)	SIT Weeks 1-2: 4 X 100 m x 3 sets / 3 s recovery Weeks 3-6: 4 X 100 m x 4 sets / 3 s recovery	6	SIT HR max vVO_2max ($km \cdot h^{-1}$)	SIT -2,60 % 6,58 %
Mitranun (2018)	45 0:45	n = 15 20.5 ± 1.0years. 23.6 BMI	SIT rowing protocol CON (No intervention)	3	5 s all-out rowing CON	SIT (10 × 30 s all-out cycling sprints / 30 s recovery) FIT (10 functional exercises × 30 s / 30 s recovery)	4	CON Resting HR CMJ	CON -3,40 % 3,30 %
Mitranun (2018) (cont.)	45 0:45 29 0:29	SIT n = 15 20.2 ± 0.9 years. 23.6 BMI	SIT (cycle ergometer sprints)		SIT 10 x 30 s / 30 s recovery	CON (no intervention)	10	SIT Resting HR CMJ	SIT -1,40 % -2,30 %
		FIT n = 15 20.6 ± 1.0years. 23.7 BMI	FIT (Lunge with medicine ball, squat jump with medicine ball, Burpee, Three cone agility, jump squat twist with medicine ball, side jump, lunge twist with medicine ball, depth jump, knee tuck jump, pattern-X on 3-by-3 grid)	3 3	FIT 10 x 30 s / 30 s recovery (10 exercises)	SIT (10 × 30 s all-out cycling sprints / 30 s recovery) FIT (10 functional exercises × 30 s / 30 s recovery) GRUPO NOR&HYP Week 1: 4 x 30 s sprint / 4 m 30 s recovery Week 2: 5 x 30 s sprint / 4 m 30 s recovery Week 3: 6 x 20 s sprint 4 m 30 s recovery Week 4: 7 x 30		FIT Resting HR CMJ	FIT -1,40 % 6,20 %
		CON n = 10 27.9±2.0 years. 24.6 BMI	CON (No intervention)		CON (NR) NOR & HYP: first and last sprint of each session performed at maximal power, remaining	s sprint / 4 m 30 s recovery Week 5: 8 x 30 s sprint 4 m 30 s recovery Week 9: 9 x 30 s sprint / 4 m 30 s recovery	6	CON NOR: VO_2max ($ml \cdot kg^{-1} \cdot min^{-1}$) HYP: VO_2max ($ml \cdot kg^{-1} \cdot min^{-1}$)	CON -1,30 % -7,00 %

					sprints at 80% of the mean power output measured in the initial sprint.				
Puype et al. (2013)	29 0:29 20 (8:12)	NOR n = 9 25.1±1.9 years. 23.2 BMI	NOR (sprint on cycle ergometer)	3 3	CON (NR) NOR & HYP: first and last sprint of each session performed at maximal power, remaining sprints at 80% of the mean power output measured in the initial sprint. SIT (all-out sprints).	GRUPO NOR&HYP Week 1: 4 x 30 s sprint / 4 m 30 s recovery Week 2: 5 x 30 s sprint / 4 m 30 s recovery Week 3: 6 x 20 s sprint 4 m 30 s recovery Week 4: 7 x 30 s sprint / 4 m 30 s recovery Week 5: 8 x 30 s sprint 4 m 30 s recovery Week 9: 9 x 30 s sprint / 4 m 30 s recovery SIT Weeks 1-2: 4 x 30 s / 4 min recovery Weeks 3-4: 5 x 30 s / 4 min recovery Weeks 5-6: 6 x 30 s / 4 min recovery	6 6	NOR NOR: VO_2max (ml·kg⁻¹·min⁻¹) HYP: VO_2max (ml·kg⁻¹·min⁻¹)	NOR 5,50 % -2,20 %
		HYP n = 10 23.8±1.6 years. 23.4 BMI	HYP (sprint on cycle ergometer under normobaric hypoxia; FiO_2 = 14.5%)					HYP NOR: VO_2max (ml·kg⁻¹·min⁻¹) HYP: VO_2max (ml·kg⁻¹·min⁻¹)	HYP 6,90 % -0,40 %
		SIT n = 10 24 ±3.3 years 25,2 BMI	SIT (all-out sprints)					VO_2max (ml·kg⁻¹·min⁻¹) VO_2max (L·min⁻¹)	10,30 % 6,10 %
Macpherson et al. (2011)	20 (8:12)	ET n = 10 22.8 ± 3.1 years 22,4 BMI	ET (continuous running)	3	ET at 65% VO_2 max	ET Weeks 1-2: 30 min Weeks 3-4: 45 min Weeks 5-6: 60 min	6	VO_2max (ml·kg⁻¹·min⁻¹) VO_2max (L·min⁻¹)	11,10 % 3,50 %

Note: ar: active recovery; BMI: body mass index; BW: body weight; CAT: cycling combined aerobic training; CMJ: countermovement jump; CON: control group; CT: continuous training; CTE: circuit training exercise; ET: endurance training; FIT: functional high-intensity interval training; HIAT: cycling high-intensity aerobic training; HIIT: high-intensity interval training; HR max: maximum heart rate; HYP: hypoxia; LB: lower body; MAS: maximal aerobic speed; NR: not reported; NOR: normoxia; PER: passive exercise recovery; PPO (W): peak power output (watts); PR: passive rest; rpm: revolutions per minute; RSA max: repeated sprint ability maximum; RT: resistance training; CT-RV: Continuous moderate-intensity running on varied terrain; SIT: sprint interval training; SS: sprint snacks; SSG: small-sided games; SSIT: sport-specific sprint interval training; UB: upper body; vVO_2max: velocity at maximal oxygen uptake; VIFT: final velocity in the 30–15 intermittent fitness test; VO_2peak: peak oxygen consumption; VO_2max: maximal oxygen uptake; WAnT: Wingate anaerobic test; Wpeak: peak power output; wk: week. All values in the "Observed change" column are expressed as percentage change from baseline and rounded to two decimal places. Statistical significance of the within-group change: * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$; values without an asterisk did not reach statistical significance or significance was not reported in the source study.

Discussion

The aim of the present study was to examine, through a review of the existing literature, the effects of SIT on cardiorespiratory and neuromuscular variables associated with athletic performance. A total of 21 studies were analyzed, investigating outcomes such as relative and absolute VO_2max, MAS, resting and maximal heart rate, CMJ, RSA, and peak power output.

While the findings demonstrated significant improvements in several physiological and performance-related variables, the effects of SIT cannot be generalized uniformly across all contexts. The magnitude of the impact varied depending on the characteristics of the study population, the duration of the intervention, and primarily on the type of variable assessed—whether cardiorespiratory or neuromuscular. In certain conditions, the benefits were more pronounced in untrained or recreational participants, whereas in highly trained athletes, the effects were more modest or specific. Additionally, SIT proved to be more effective for some performance metrics, while in others it showed no significant differences over alternative training methods. Therefore, the conclusions must be interpreted with these contextual considerations in mind, which are discussed in detail below.

Cardiorespiratory variables

Regarding maximal oxygen uptake, five studies explicitly assessed the effects of SIT on this variable, either in its relative or absolute form. Among these, four reported relative VO_2max (Hov et al., 2023; Litleskare et al., 2020; Liu et al., 2021; Macpherson et al., 2011), while only one presented absolute VO_2max values (Robineau et al., 2017). Maximal oxygen consumption was typically measured through incremental tests to exhaustion conducted on a cycle ergometer, with gas exchange analyzed via metabolic systems. Some studies complemented these assessments with functional tests or indirect estimates such as MAS or time to exhaustion.

The findings were heterogeneous. Liu et al. (2021), in a study involving badminton players, observed a significant and clinically meaningful increase in both relative and absolute VO_2max. In male participants, VO_2max rose from 56.8 ± 7.0 to 63.6 ± 4.7 ml·kg^{-1}·min^{-1} ($g = 1.14$), and in female participants, from 42.5 ± 2.9 to 46.2 ± 3.0 ml·kg^{-1}·min^{-1} ($g = 1.28$). Similarly, Litleskare et al. (2020), reported a 5.5% improvement (from 50.5 ± 1.6 to 53.3 ± 1.5 ml·kg^{-1}·min^{-1}; $p < 0.01$), also suggesting a functionally relevant adaptation. Robineau et al. (2017) documented a 5.4% increase in absolute VO_2max, from 4079 ± 289 to 4301 ± 326 ml·min^{-1}, with a moderate effect size ($d = 0.64$).

Other studies reported more modest improvements. Hov et al. (2023) compared different training protocols and found no significant differences in VO_2max in the SIT groups, while significant improvements were observed in the group performing longer intervals (4 × 4 minutes). Finally, Macpherson et al. (2011) reported no significant changes following a SIT protocol and suggested that the observed adaptations in VO_2max were primarily peripheral rather than central—unlike continuous training, which elicited greater effects on maximal cardiac output.

These findings suggest that SIT can elicit relevant improvements in maximal oxygen uptake, particularly in young individuals with moderate fitness levels or those involved in intermittent sports. In studies reporting effect sizes, moderate to large magnitudes were observed, indicating not only statistical significance but also clinical relevance. For instance, Liu et al. (2021) reported $g = 1.14$ and 1.28, and Robineau et al. (2017) reported $d = 0.64$. In contrast, other studies, such as Hov et al. (2023) and Macpherson et al. (2011) found no clear differences across conditions. This variability of results suggests that the effectiveness of SIT on VO_2max depends on several factors, including protocol duration, weekly frequency, participant characteristics, and the type of assessment used.

Regarding to maximal aerobic speed, two studies explicitly assessed the effects of SIT on MAS (Hov et al., 2023; Robineau et al., 2017). This variable was measured using incremental treadmill protocols to exhaustion and progressive field tests such as the VAM-EVAL, which are commonly used in intermittent sports contexts. In the study by Hov et al. (2023), two SIT protocols were compared in trained runners. The group that performed eight 20-second sprints at 150% of MAS, three times per week for eight weeks, showed a significant increase in MAS, rising from 13.3 ± 1.4 to 13.9 ± 1.1 km/h ($p < 0.01$). In contrast, the group that performed ten 30-second sprints at 175% of MAS did not show significant improvements (from 13.1 ± 1.4 to 13.4 ± 1.3 km/h; $p = 0.13$). This difference in outcomes suggest that the effects of SIT on MAS may depend on effort duration, relative intensity, and tolerance to training volume, even within a homogeneous population.

Robineau et al. (2017), on the other hand, implemented a combined SIT and resistance training protocol in elite rugby seven players using the VAM-EVAL progressive field test. After eight weeks of intervention, they reported a 5.6% increase in MAS, although no statistical significance or effect size was provided. Since the intervention included both sprint and resistance training, it is not possible to attribute the observed improvements only to the SIT component. Nonetheless, the specificity of the sport and the test used underscore the relevance of MAS as a variable responsive to combined high-intensity stimuli. These findings suggest that SIT can lead to improvements in MAS; however, the effects are not universally consistent. The characteristics of the training protocol, participant profile, and evaluation method appear to be key factors influencing the magnitude of adaptation. While notable improvements have been observed in moderately trained individuals and athletes participating in intermittent sports, other contexts have yielded more modest or non-significant responses. These data highlight the importance of considering MAS as a sensitive but context- and design-dependent outcome when applying SIT protocols.

As for heart rate-related variables (Resting HR and HRmax), evidence regarding heart rate-related variables was more limited and less consistent than that observed for VO_2max, MAS, or PPO. While several studies reported reductions in resting heart rate following SIT interventions, changes in HRmax were generally small, inconsistent, or absent (Kim et al., 2011; Petrick et al., 2021). These findings are not unexpected, as resting heart rate is more responsive to training-induced cardiovascular adaptations, including enhanced autonomic regulation and increased stroke volume, whereas HRmax is largely influenced by age and intrinsic cardiac characteristics. Therefore, improvements in cardiorespiratory fitness following SIT appear to be more strongly reflected by changes in variables such as VO_2max and MAS than by alterations in maximal heart rate.

Neuromuscular variables

The CMJ is commonly used as a marker of neuromuscular performance, particularly in contexts aiming to assess rapid force production and acute or chronic fatigue. In this review, three studies evaluated the effects of SIT on CMJ performance (Boraczyński et al., 2023; Mitranun, 2018; Robineau et al., 2017). Of these, two reported improvements following the intervention. Robineau et al. (2017) found a 4.1% increase in CMJ in a group that combined SIT with resistance training. However, due to the concurrent design of the intervention, it is not possible to attribute the improvement only to SIT, as the resistance training component likely contributed to this gain. Similarly, Boraczyński et al. (2023) observed a 3.5% increase in CMJ in professional soccer players who performed SIT exclusively, providing more direct evidence that SIT can improve neuromuscular performance in trained populations.

In contrast, Mitranun (2018) reported a slight decrease in CMJ performance (−2.3%) following a SIT protocol using a cycle ergometer. This negative outcome may be associated with the mode of exercise, the total training volume, or the training background of the participants. Although all studies used contact platforms to assess vertical jump performance, there were notable differences in participant characteristics, SIT modalities (e.g., running, cycling, sport-specific drills), program duration, and sport context. These factors can substantially influence both the magnitude and direction of training adaptations. Based on these findings, current evidence suggests that SIT may lead to modest improvements in CMJ, particularly when applied in a modality-specific manner or combined with complementary training stimuli. However, neutral or even negative effects may occur, especially when the exercise mode diverges from the neuromuscular demands of the jumping task. Therefore, the effects of SIT on CMJ performance should not be generalized hastily and must be interpreted within the context of sport-specific demands, training protocol dosage and specificity.

Concerning sprint performance. four studies were identified that examined the effects of SIT on sprint performance, all drawn from the included articles (Hostrup et al., 2019; Boraczyński et al., 2023; Song et al., 2023; Taylor et al., 2022). Despite this, the findings were mixed and do not allow for a definitive conclusion regarding the consistent efficacy of SIT in improving sprint performance.

Only the study by Taylor et al. (2022) reported statistically significant improvements in 10- and 30-meter sprint performance among field hockey players following a progressive protocol involving both flat and uphill sprints, with reductions in sprint time of up to −3.59%. This suggests a potential performance gain when SIT is tailored to sport-specific demands. In contrast, the remaining studies reported either modest or non-significant effects. For instance, Hostrup et al. (2019), despite implementing SIT involving maximal efforts and change-of-direction drills in football players, observed only a marginal reduction of −0.93% in 30-meter sprint time, which did not reach statistical significance. Similarly, Boraczyński et al. (2023) reported improvements in sprint performance, with reductions of 2.2% and 2.4% in 5-m and 30-m sprint times, respectively. Song et al. (2023) found a reduction of −2.97% in 20-meter sprint time; however, no further information was provided regarding its statistical significance or practical relevance.

These discrepancies may be explained by methodological factors such as the testing environment (e.g., field-based vs. ergometer), technical specificity of the training protocol, intervention duration, and participant profile. Assessing sprint performance in recreational runners using treadmill or cycle-based tests is substantially different from testing trained athletes using movement patterns representative of their sport. Thus, while SIT may serve as a useful training tool, its effectiveness for improving sprint performance appears highly dependent on the specificity of the protocol and the sporting context. Interventions that incorporate sport-specific technical elements—executed under realistic game or competition conditions—demonstrate greater transfer potential. In this regard, it is recommended that sprint training programs adopt a design logic that aligns with the neuromuscular orientation of the sprint movement, the competitive environment, and the tactical demands of the sport being practiced. Consistent with this reasoning, Wu (2025) reported that an integrated model combining strength, speed and endurance work produced greater improvements in 100-m and 400-m sprint times than traditional isolated approaches, reinforcing the relevance of multicomponent designs when sprint performance is the target outcome.

In the repeated sprint ability, among the studies included in this review, only one study explicitly assessed the effects of SIT on repeated sprint ability (Robineau et al., 2017). That trial involved rugby seven players allocated to three training modalities: isolated resistance training, concurrent training with submaximal running intervals, and concurrent training incorporating SIT. The group that combined resistance training with sprint-based intervals showed the most favourable changes in RSA; nevertheless, because the design was concurrent, the strength component may also have contributed to the observed adaptations, so the improvement cannot be attributed to the SIT stimulus alone. Given that RSA was evaluated in a single trial, the evidence on this variable remains preliminary and must be interpreted with caution.

In this trial, RSA was assessed using a repeated sprint test conducted under sport-specific conditions, likely facilitating the transfer of training adaptations. This methodological specificity aligns with previous evidence suggesting that the effectiveness of SIT on RSA is highly dependent on the application context and the degree of similarity between the training stimulus and the competitive demands. Thus, although current evidence is limited, SIT—especially when integrated into training designs that reflect the characteristics of intermittent sports—appears to be a promising strategy to improve RSA performance. Nevertheless, further research with controlled designs, standardized assessment protocols, and larger sample sizes is warranted to better determine the scope and consistency of these adaptations.

Positive effects on peak power output following SIT interventions were identified in several studies, including Jones et al. (2015), Inoue et al. (2016), Astorino et al. (2017), Marley et al. (2022), Kim et al. (2011), and Boraczyński et al. (2023). Reported improvements ranged from approximately 2.1% to 12.7%, depending on the SIT modality, intervention duration, and participant characteristics. For instance, Jones et al. (2015) observed a 12.67% increase in PPO measured via cycle ergometry, suggesting a substantial impact after six weeks of repeated sprint training. Similarly, Astorino et al. (2017) reported an improvement of approximately 8.7% following a protocol that combined SIT with interval training, indicating a potential synergistic effect between the two approaches. Additionally, Marley et al. (2022) examined the effects of SIT in combination with vitamin D_3 supplementation, also reporting increases in PPO; however, the mixed nature of the intervention makes it difficult to attribute the observed effects uniquely to SIT. Likewise, Little et al. (2019) reported significant improvements in peak power output after six weeks of SIT, with increases of approximately 14–15 W during the incremental exercise test, further supporting the effectiveness of low volume sprint-based interventions for enhancing maximal power production.

All studies employed maximal resistance cycling protocols, either on leg or arm cycle ergometers, to assess PPO, ensuring a certain degree of methodological consistency. Nevertheless, some studies, such as Marley et al. (2022), incorporated complementary approaches, which may introduce variability in the outcomes. Despite this, the overall effects on PPO were consistent across trained and recreational populations. This body of evidence supports the efficacy of SIT as a strategy to enhance maximal power output, particularly when implemented at high intensities and with adequate training volume.

However, it is important to note that variability in session frequency, sprint duration, and recovery intervals across studies limits the ability to define a universally optimal dosage for all populations. Overall, the findings of the present review are generally consistent with previous systematic reviews examining the effects of SIT on performance related outcomes. Sloth et al. (2013) reported that SIT is an effective strategy for improving aerobic capacity and exercise performance, particularly through increases in VO_2max and adaptations associated with high intensity exercise tolerance. Equally, Hall et al. (2023) highlighted the potential of SIT to enhance physiological and performance outcomes across different athletic populations. The findings of the present review support these observations, as improvements were identified in variables such as VO_2max, MAS, PPO, RSA, and sprint performance. However, unlike previous reviews that primarily focused on aerobic fitness or broader performance outcomes, the present review provides a variable specific synthesis of both cardiorespiratory and neuromuscular adaptations, allowing a more detailed understanding of the responses associated with SIT across different performance domains. Beyond laboratory settings, Lasso-Quilindo et al. (2024) also observed improvements in physical fitness and competitive performance in middle-distance para-athletes following a high-intensity interval programme, indicating that these adaptations are attainable in applied training contexts as well.

One of the main limitations of this review was the difficulty in isolating the specific effects of SIT, as several studies combined SIT with resistance training or other complementary stimuli (Marley et al., 2022; Robineau et al., 2017). This methodological overlap restricts the ability to attribute observed improvements solely to SIT. Moreover, contradictory findings were noted in variables such as CMJ and RSA, where some studies reported performance gains (Boraczyński et al., 2023; Taylor et al., 2022), while others found neutral or even negative effects (Mitranun, 2018). These inconsistencies underscore the influence of methodological design, sample characteristics, and intervention duration on the outcomes.

Another critical limitation was the small sample size in most of the included studies, which may lead to an overestimation of the reported effects (Inoue et al., 2016; Macpherson et al., 2011; Marley et al., 2022; Robineau et al., 2017; Taylor et al., 2022). In addition, a lack of conceptual clarity was identified regarding the differentiation between SIT protocols and short-duration HIIT, generating ambiguity in both practical application and the interpretation of results.

Based on these findings, future research should aim to:

- Design interventions with larger sample sizes to enhance external validity of the results.
- Clearly report the number of weeks and training sessions implemented, applying a minimum threshold (e.g., at least 4 weeks and 8 sessions) to ensure the detection of meaningful adaptations.
- Compare protocols involving different sprint durations (e.g., <10, 10, 30 seconds) and recovery intervals, documenting their specific effects on neuromuscular and cardiorespiratory variables.
- Isolate the pure effects of SIT, avoiding concurrent training stimuli (e.g., resistance training), particularly when evaluating sensitive outcomes such as CMJ.
- Explore sport-specific SIT interventions to determine whether tailoring protocols to the tactical and physiological demands of a given sport yields greater transfer in performance measures such as sprint speed and RSA.

Finally, future studies should contribute to a clearer conceptual delimitation between SIT and short-duration HIIT, by standardizing protocols and establishing operational criteria that distinguish their respective applications, physiological adaptations, and performance outcomes in sport-specific contexts.

Conclusions

This systematic review concludes that SIT is an effective training method to enhance both cardiorespiratory and neuromuscular performance variables associated with athletic performance. The majority of studies demonstrated significant improvements, and from a practical standpoint, SIT appears to be a time-efficient strategy. Compared to other training modalities such as HIIT and moderate-intensity continuous training (MICT), SIT may produce similar or even superior results with a lower overall training volume.

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References

Astorino, T. A., Edmunds, R. M., Clark, A., King, L., Gallant, R. A., Namm, S., Fischer, A., & Wood, K. M. (2017). High-intensity interval training increases cardiac output and VO_2max. *Medicine & Science in Sports & Exercise, 49*(2), 265–273. https://doi.org/10.1249/MSS.0000000000001099

Atakan, M. M., Guzel, Y., Shrestha, N., Kosar, S. N., Grgic, J., Astorino, T. A., Turnagol, H. H., & Pedisic, Z. (2022). Effects of high-intensity interval training (HIIT) and sprint interval training (SIT) on fat oxidation during exercise: A systematic review and meta-analysis. *British Journal of Sports Medicine, 56*(17), 988–996. https://doi.org/10.1136/bjsports-2021-105181

Boraczyński, M. T., Laskin, J. J., Gajewski, J., Podstawski, R. S., Brodnicki, M. A., & Boraczyński, T. W. (2023). Effects of two low-volume high-intensity interval training protocols in professional soccer: Sprint interval training versus small-sided games. *The Journal of Sports Medicine and Physical Fitness, 63*(1), 23–33. https://doi.org/10.23736/S0022-4707.22.13589-9

Boullosa, D., Dragutinovic, B., Feuerbacher, J. F., Benítez-Flores, S., Coyle, E. F., & Schumann, M. (2022). Effects of short sprint interval training on aerobic and anaerobic indices: A systematic review and meta-analysis. *Scandinavian Journal of Medicine & Science in Sports, 32*(5), 810–820. https://doi.org/10.1111/sms.14133

Castagna, C., Manzi, V., D'Ottavio, S., Annino, G., Padua, E., & Bishop, D. (2007). Relation between maximal aerobic power and the ability to repeat sprints in young basketball players. *Journal of Strength and Conditioning Research, 21*(4), 1172–1176. https://doi.org/10.1519/R-20376.1

Hall, A. J., Aspe, R. R., Craig, T. P., Kavaliauskas, M., Babraj, J., & Swinton, P. A. (2023). The effects of sprint interval training on physical performance: A systematic review and meta-analysis. *Journal of Strength and Conditioning Research, 37*(2), 457–481. https://doi.org/10.1519/JSC.0000000000004257

Hostrup, M., Gunnarsson, T. P., Fiorenza, M., Mørch, K., Onslev, J., Pedersen, K. M., & Bangsbo, J. (2019). In-season adaptations to intense intermittent training and sprint interval training in sub-elite football players. *Scandinavian Journal of Medicine & Science in Sports, 29*(5), 669–677. https://doi.org/10.1111/sms.13395

Hov, H., Wang, E., Lim, Y. R., Trane, G., Hemmingsen, M., Hoff, J., & Helgerud, J. (2023). Aerobic high-intensity intervals are superior to improve $\dot{V}O_2$max compared with sprint intervals in well-trained men. *Scandinavian Journal of Medicine & Science in Sports, 33*(2), 146–159. https://doi.org/10.1111/sms.14251

Inoue, A., Impellizzeri, F. M., Pires, F. O., Pompeu, F. A., Deslandes, A. C., & Santos, T. M. (2016). Effects of sprint versus high-intensity aerobic interval training on cross-country mountain biking performance: A randomized controlled trial. *PLoS ONE, 11*(1), e0145298. https://doi.org/10.1371/journal.pone.0145298

Jones, B., Hamilton, D. K., & Cooper, C. E. (2015). Muscle oxygen changes following sprint interval cycling training in elite field hockey players. *PLoS ONE, 10*(3), e0120338. https://doi.org/10.1371/journal.pone.0120338

Kelly, D. T., Cregg, C. J., O'Connor, P. L., Cullen, B. D., & Moyna, N. M. (2021). Physiological and performance responses of sprint interval training and endurance training in Gaelic football players. *European Journal of Applied Physiology, 121*(8), 2265–2275. https://doi.org/10.1007/s00421-021-04699-0

Kikuchi, N., Yoshida, S., Okuyama, M., & Nakazato, K. (2016). The effect of high-intensity interval cycling sprints subsequent to arm-curl exercise on upper-body muscle strength and hypertrophy. *Journal of Strength and Conditioning Research, 30*(8), 2318–2323. https://doi.org/10.1519/JSC.0000000000001315

Kim, J., Lee, N., Trilk, J., Kim, E.-J., Kim, S.-Y., Lee, M., & Cho, H.-C. (2011). Effects of sprint interval training on elite judoists. *International Journal of Sports Medicine, 32*(12), 929–934. https://doi.org/10.1055/s-0031-1283183

Lasso-Quilindo, C. A., Chalapud-Narváez, L. M., Medina-López, J. E., & García-Mantilla, E. D. (2024). Efectos del HIIT sobre la condición física y el rendimiento deportivo en corredores de media distancia de 800 y 1500 m de para atletismo: Un estudio de caso. *Retos, 56*, 707–717. https://doi.org/10.47197/retos.v56.102365

Litleskare, S., Enoksen, E., Sandvei, M., Støen, L., Stensrud, T., Johansen, E., & Jensen, J. (2020). Sprint interval running and continuous running produce training specific adaptations, despite a similar improvement of aerobic endurance capacity—A randomized trial of healthy adults. *International Journal of Environmental Research and Public Health, 17*(11), 3865. https://doi.org/10.3390/ijerph17113865

Little, J. P., Langley, J., Lee, M., Myette-Côté, E., Jackson, G., Durrer, C., Gibala, M. J., & Jung, M. E. (2019). Sprint exercise snacks: A novel approach to increase aerobic fitness. *European Journal of Applied Physiology, 119*(5), 1203–1212. https://doi.org/10.1007/s00421-019-04110-z

Liu, H., Leng, B., Li, Q., Liu, Y., Bao, D., & Cui, Y. (2021). The effect of eight-week sprint interval training on aerobic performance of elite badminton players. *International Journal of Environmental Research and Public Health, 18*(2), 638. https://doi.org/10.3390/ijerph18020638

MacDougall, J. D., Hicks, A. L., MacDonald, J. R., McKelvie, R. S., Green, H. J., & Smith, K. M. (1998). Muscle performance and enzymatic adaptations to sprint interval training. *Journal of Applied Physiology, 84*(6), 2138–2142. https://doi.org/10.1152/jappl.1998.84.6.2138

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

Macpherson, R. E. K., Hazell, T. J., Olver, T. D., Paterson, D. H., & Lemon, P. W. R. (2011). Run sprint interval training improves aerobic performance but not maximal cardiac output. *Medicine & Science in Sports & Exercise, 43*(1), 115–122. https://doi.org/10.1249/MSS.0b013e3181e5eacd

Marley, A., Grant, M. C., & Babraj, J. (2022). Vitamin D3 supplementation combined with sprint interval training improves aerobic and anaerobic exercise performance over sprint interval training alone in recreational combat sport athletes. *Science & Sports, 37*(3), 217.e1–217.e10. https://doi.org/10.1016/j.scispo.2021.07.004

Matsuo, T., Saotome, K., Seino, S., Shimojo, N., Matsushita, A., Iemitsu, M., Ohshima, H., Tanaka, K., & Mukai, C. (2014). Effects of a low-volume aerobic-type interval exercise on $\dot{V}O_2$max and cardiac mass. *Medicine & Science in Sports & Exercise, 46*(1), 42–50. https://doi.org/10.1249/MSS.0b013e3182a38da8

Mitranun, W. (2018). Supramaximal vs functional high-intensity interval training effects on macrovascular reactivity in young male athletes. *Songklanakarin Journal of Science and Technology, 40*(3), 710–717. https://doi.org/10.14456/sjst-psu.2018.88

Page, M. J., McKenzie, J. E., Bossuyt, P. M., Boutron, I., Hoffmann, T. C., Mulrow, C. D., Shamseer, L., Tetzlaff, J. M., Akl, E. A., Brennan, S. E., Chou, R., Glanville, J., Grimshaw, J. M., Hróbjartsson, A., Lalu, M. M., Li, T., Loder, E. W., Mayo-Wilson, E., McDonald, S., … Moher, D. (2021). The PRISMA 2020 statement: An updated guideline for reporting systematic reviews. *BMJ, 372*, n71. https://doi.org/10.1136/bmj.n71

Petrick, H. L., King, T. J., Pignanelli, C., Vanderlinde, T. E., Cohen, J. N., Holloway, G. P., & Burr, J. F. (2021). Endurance and sprint training improve glycemia and $\dot{V}O_2$peak but only frequent endurance benefits blood pressure and lipidemia. *Medicine & Science in Sports & Exercise, 53*(6), 1194–1205. https://doi.org/10.1249/MSS.0000000000002582

Puype, J., Van Proeyen, K., Raymackers, J.-M., Deldicque, L., & Hespel, P. (2013). Sprint interval training in hypoxia stimulates glycolytic enzyme activity. *Medicine & Science in Sports & Exercise, 45*(11), 2166–2174. https://doi.org/10.1249/MSS.0b013e31829734ae

Robineau, J., Lacome, M., Piscione, J., Bigard, X., & Babault, N. (2017). Concurrent training in rugby sevens: Effects of high-intensity interval exercises. *International Journal of Sports Physiology and Performance, 12*(3), 336–344. https://doi.org/10.1123/ijspp.2015-0370

Sloth, M., Sloth, D., Overgaard, K., & Dalgas, U. (2013). Effects of sprint interval training on VO_2max and aerobic exercise performance: A systematic review and meta-analysis. *Scandinavian Journal of Medicine & Science in Sports, 23*(6), e341–e352. https://doi.org/10.1111/sms.12092
Song, T., Jilikeha, & Deng, Y. (2023). Physiological and biochemical adaptations to a sport-specific sprint interval training in male basketball athletes. *Journal of Sports Science and Medicine, 22*(4), 605–613. https://doi.org/10.52082/jssm.2023.605
Taylor, L., & Jakeman, J. R. (2022). The impact of a repeated sprint training program on performance measures in male field hockey players. *Journal of Strength and Conditioning Research, 36*(7), 1984–1988. https://doi.org/10.1519/JSC.0000000000004000
Weston, M., Taylor, K. L., Batterham, A. M., & Hopkins, W. G. (2014). Effects of low-volume high-intensity interval training (HIT) on fitness in adults: A meta-analysis of controlled and non-controlled trials. *Sports Medicine, 44*(7), 1005–1017. https://doi.org/10.1007/s40279-014-0180-z
Wu, Y. (2025). Integrating strength, speed, and endurance: A comprehensive training model for 100m and 400m sprints. *Retos, 67*, 1200–1210. https://doi.org/10.47197/retos.v67.114886

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