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Effects of anaerobic training on physical performance in soccer players: a systematic review

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ABSTRACT

Soccer is a high-intensity intermittent sport characterized by repeated efforts of sprinting, jumping, and rapid directional changes, demanding highly developed anaerobic capacities. Despite growing scholarly interest in anaerobic training for soccer players, the diversity of training modalities, populations, and outcome measures has precluded definitive conclusions regarding optimal training configurations. This systematic review aimed to synthesize the available scientific evidence on the effects of anaerobic training interventions on physical performance outcomes in soccer players. Following the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) 2020 guidelines (Page et al., 2021), a comprehensive search was conducted on the Scopus database, yielding an initial pool of 931 records. After removing 15 duplicate records, 237 records were screened based on title and abstract, of which 174 were excluded. Of the 63 full-text articles assessed for eligibility, 41 were further excluded due to irrelevant study designs, non-intervention nature, or populations outside the scope. Consequently, 22 studies published between 2021 and 2025 were included in the final synthesis. The findings indicate that sprint interval training, plyometric training, and combined anaerobic training programs significantly improve repeated sprint ability, sprint speed, explosive power, and change-of-direction performance in soccer players across various age groups and competitive levels. High-intensity interval training emerges as an effective and versatile approach when individualized according to training frequency, intensity, and recovery parameters. These results have important implications for sports scientists and coaches in designing evidence-based anaerobic conditioning programs. Future research should prioritize female populations, long-term follow-up assessments, and training periodization frameworks.

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Introduction

Soccer is widely recognized as the most popular team sport globally, with an estimated 270 million players across diverse competitive levels, from youth academies to elite professional leagues (Clemente et al., 2021; Nobari et al., 2023). The physical demands of modern soccer have intensified considerably over recent decades, characterized by increased distances covered at high speeds, elevated match intensities, and greater tactical complexity (Ben Abderrahman et al., 2024; Brahim et al., 2025). Consequently, the development of players' physical capacities, particularly those associated with anaerobic energy pathways, has become a central focus for sports scientists and conditioning practitioners. High-intensity actions such as sprinting, jumping, rapid

deceleration, and change-of-direction movements are pivotal determinants of soccer performance and are predominantly fueled by anaerobic metabolic systems (Liu et al., 2024; Pierros & Spyrou, 2023). Understanding the scientific foundations that underpin effective anaerobic training is therefore indispensable for optimizing player development and competitive outcomes.

The anaerobic energy system encompasses two primary pathways: the phosphocreatine (ATP-PCr) system, which supports high-power, short-duration efforts of approximately 1 to 10 seconds, and the glycolytic system, which sustains moderate-to-high intensity exercise of up to approximately two minutes (Yang et al., 2024; Maciel et al., 2024). During a typical soccer match, players perform between 1,000 and 1,500 brief high-intensity actions, with repeated sprint sequences occurring every 60 to 90 seconds on average (Aloui et al., 2021; Michailidis et al., 2023). These physiological demands underscore the necessity of developing robust anaerobic capacities, including peak anaerobic power, anaerobic capacity, repeated sprint ability (RSA), and neuromuscular qualities such as reactive strength and explosive power. Training programs that systematically target these qualities are essential for maintaining competitive performance across the full duration of matches, particularly during critical late-game periods (Gepfert et al., 2025; La-Bantao & Tongterm, 2025).

A substantial body of literature has examined the effects of various training interventions aimed at improving anaerobic performance in soccer players (Bici & Kasa, 2025; Laidi et al., 2025). Sprint interval training (SIT), which involves repeated supramaximal or near-maximal sprint efforts interspersed with controlled recovery periods, has demonstrated consistent benefits for RSA, sprint speed, and aerobic power in competitive soccer populations (Liu et al., 2024; Yan & Li, 2025). Plyometric training (PT), characterized by rapid stretch-shortening cycle movements, has been extensively studied as a means of enhancing explosive power, jump height, and reactive strength in soccer players (Aloui et al., 2021; Matuszczyk et al., 2025). High-intensity interval training (HIIT), encompassing a broader spectrum of protocols, has emerged as a versatile conditioning strategy applicable across diverse training contexts and competitive periods (Koç et al., 2025; Zhang et al., 2024). However, the heterogeneity of training protocols, populations, and outcome measures across existing studies has complicated the synthesis of definitive conclusions.

Recent technological and methodological advances have refined the measurement and prescription of anaerobic training in soccer (Saif et al., 2025; Ahmad et al., 2025). The application of velocity-based training principles, GPS-based load monitoring, and individualized physiological profiling has enabled practitioners to more precisely quantify training intensity and monitor adaptive responses (Li & Xue, 2024; Duan et al., 2024). Parallel advancements in assessment tools, including force-plate technology, inertial measurement units, and laboratory-based anaerobic testing protocols such as the Wingate anaerobic test and running anaerobic sprint test (RAST), have facilitated more granular characterization of players' anaerobic fitness profiles. Furthermore, the integration of game-based training modalities, such as small-sided games and large-sided games, with structured anaerobic protocols has created hybrid training paradigms that simultaneously address physical conditioning and technical-tactical development (Nobari et al., 2023; Brahim et al., 2025).

Despite the growing volume of research on anaerobic training in soccer, several notable gaps remain in the literature. First, while numerous studies have investigated the effects of individual training modalities-such as SIT, PT, or HIIT in isolation-comparative evidence examining the relative efficacy of different anaerobic training approaches within soccer-specific populations remains limited and inconsistent (Pierros & Spyrou, 2023; Yang et al., 2024). The diversity of training protocols, including variations in sprint distance, recovery duration, frequency, and total program length, has produced a fragmented evidence base that renders direct cross-study comparisons methodologically challenging. Additionally, the majority of published studies have focused predominantly on male and adult soccer populations, with comparatively limited attention paid to female players and youth athletes (Gepfert et al., 2025; Bici & Kasa, 2025).

A second critical gap pertains to the theoretical and methodological frameworks underpinning existing research. Many studies on anaerobic training in soccer have employed non-randomized or quasi-experimental designs without adequate control conditions, limiting the internal validity of their findings (Maciel et al., 2024; Michailidis et al., 2023). Furthermore, the operationalization of "anaerobic training" varies considerably across studies, with some focusing narrowly on sprint-based protocols while others incorporate resistance training, plyometric exercises, or combined modalities. This conceptual heterogeneity has made it difficult to identify the specific training characteristics-including intensity prescription methods, work-to-rest ratios, and session frequency-that are most conducive to anaerobic performance gains in soccer. The absence of standardized terminology and reporting practices further complicates the synthesis and application of research findings in practical settings (Aloui et al., 2021; Li & Xue, 2024).

The present systematic review was undertaken to address these gaps and provide a comprehensive, methodologically rigorous synthesis of the current evidence on anaerobic training in soccer. Given the

accelerating pace of research publication in this domain, particularly over the period from 2021 to 2025, and the growing emphasis on evidence-based practice in elite sport, there is an urgent need for an updated review that integrates the most recent empirical findings. Such a review is essential for translating scientific evidence into actionable recommendations for coaches and sports scientists, while simultaneously identifying priorities for future research. By adhering to PRISMA 2020 guidelines and applying systematic inclusion and exclusion criteria, this review aims to provide a transparent and reproducible synthesis that advances theoretical understanding and informs practical application.

The first research question (RQ1) of this review concerns the identification and characterization of anaerobic training interventions that have been implemented to improve anaerobic performance in soccer players. A thorough characterization of the training modalities, protocols, and study designs represented in the current literature is necessary to establish a foundational understanding of the evidence base. This question has direct relevance for practitioners seeking to identify evidence-supported training approaches, as well as for researchers aiming to design future studies that address existing methodological limitations.

RQ1: What anaerobic training interventions have been implemented to improve anaerobic performance in soccer players?

The second research question (RQ2) addresses the effects of anaerobic training on specific physical performance outcomes, including repeated sprint ability, sprint speed, anaerobic capacity, explosive power, and change-of-direction (COD) performance. Understanding the magnitude and consistency of these effects across different training modalities and populations is critical for establishing evidence-based benchmarks for training efficacy. This question also captures the relationship between training design variables and outcome-specific adaptations, providing nuanced insights into how different aspects of physical performance respond to various forms of anaerobic conditioning.

RQ2: What are the effects of anaerobic training on physical performance outcomes (e.g., repeated sprint ability, sprint speed, anaerobic capacity, and change of direction) in soccer players?

The third research question (RQ3) examines which specific anaerobic training characteristics-including training modality, intensity prescription method, frequency, duration, and total program length-are most effective for enhancing anaerobic performance in soccer players. By synthesizing evidence related to training design variables, this review aims to identify optimal training configurations that maximize performance adaptations within the constraints typical of soccer training environments. This question has direct translational relevance for practitioners seeking to optimize training efficiency and effectiveness in competitive contexts.

RQ3: Which anaerobic training characteristics (e.g., training modality, intensity, frequency, duration, and program length) are most effective for enhancing anaerobic performance in soccer players?

Methods

Research Design and Framework

This study was designed as a systematic literature review (SLR), a research methodology that employs transparent, reproducible, and rigorous procedures to identify, appraise, and synthesize evidence on a defined topic (Tranfield et al., 2003; Liberati et al., 2009). The SLR design was selected as the most appropriate methodological framework for addressing the stated research questions, given its capacity to minimize selection bias and provide a comprehensive overview of the extant evidence. The review was conducted in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) 2020 guidelines (Page et al., 2021), which represent the current methodological standard for transparent and reproducible evidence synthesis in health and sport sciences. The PRISMA 2020 framework provides structured guidance for all phases of the review process, from search strategy development through data extraction, quality appraisal, and synthesis, thereby ensuring methodological rigor and facilitating critical evaluation by readers and peers.

Search Strategy

Research Question Formulation Using the PICO Framework

Prior to constructing the search string, the research questions were decomposed using the PICO framework (Population, Intervention, Comparison, Outcome) to ensure systematic identification of key search concepts:

Table 1. PICO Framework

PICO Element	Description
Population (P)	Soccer players (male and female, youth and adults, recreational to elite level)
Intervention (I)	Anaerobic training (sprint interval training, plyometric training, HIIT, repeated sprint training, resistance/power training)

PICO Element	Description
Comparison (C)	Active control group (conventional soccer training), alternative training modality, or pre-post single group design
Outcome (O)	Physical performance: repeated sprint ability, sprint speed, anaerobic capacity, power output, change-of-direction performance

Boolean Search String

The following Boolean search string was applied in the Scopus database: (TITLE-ABS-KEY("soccer" OR "football") AND TITLE-ABS-KEY("anaerobic training" OR "sprint interval training" OR "repeated sprint" OR "plyometric training" OR "high-intensity interval training" OR "HIIT" OR "sprint training") AND TITLE-ABS-KEY("physical performance" OR "anaerobic capacity" OR "anaerobic power" OR "repeated sprint ability" OR "speed" OR "change of direction"))

The search string was constructed using the TITLE-ABS-KEY field code, which restricts the search to the title, abstract, and author keywords of indexed documents, thereby enhancing precision while maintaining adequate sensitivity. Truncation was applied where appropriate (e.g., "sprint*" to capture "sprint," "sprinting," and "sprints") to account for morphological variations in terminology. The search was limited to English-language articles and review articles published between 2021 and 2025. The initial string was iteratively refined following a pilot search that returned an excessively large and heterogeneous set of records, with refinements focused on narrowing the intervention and outcome terms to those most specifically relevant to anaerobic training and soccer-specific physical performance.

Database and Information Sources

The primary database used for this systematic review was Scopus (Elsevier), selected for its comprehensive coverage of peer-reviewed literature in sport and exercise sciences, broad indexing of Q1 Scopus-ranked journals, and advanced search capabilities. The searches were executed on March 15, 2025, yielding an initial yield of 931 records. While prospective registration of systematic reviews is recommended as a best practice to reduce duplication and reporting bias (Page et al., 2021), this review was not registered with PROSPERO prior to commencement. This limitation is acknowledged transparently, and future systematic reviews will pursue prospective registration to align with current methodological standards. Scopus was used as the sole primary database due to its broad interdisciplinary coverage and its inclusion of the majority of high-impact sport science journals relevant to the scope of this review. No supplementary databases were searched; however, reference lists of included studies were manually screened to identify any additional eligible sources not captured by the database search.

Eligibility Criteria

Inclusion and exclusion criteria were established a priori and applied at all stages of the screening process.

Table 2. Inclusion and Exclusion Criteria

Criterion	Inclusion	Exclusion
Language	English only	Non-English publications
Document type	Original research articles (experimental, quasi-experimental, RCT)	Reviews, conference papers, book chapters, editorials, case reports
Publication period	2021–2025	Before 2021
Population	Soccer/football players (any age, sex, or competitive level)	Non-soccer athletes; combined sport populations without disaggregated soccer data
Intervention	Structured anaerobic training program (sprint interval training, plyometric training, repeated sprint training, HIIT, or combined protocols)	Aerobic-only training; nutritional, pharmacological, or supplementation-only studies
Outcome measures	Quantitative physical performance outcomes (RSA, sprint speed, anaerobic power, COD, jump performance)	Studies reporting only psychological, cognitive, or injury-related outcomes without physical performance data
Study design	Pre-post intervention design (with or without control group), parallel group RCT, or quasi-experimental design	Cross-sectional, observational, case study, or purely descriptive designs without training intervention
Accessibility	Full-text available	Abstract-only records; inaccessible full text

Study Selection Process

The study selection process followed a multi-stage screening procedure consistent with PRISMA 2020 recommendations. In the first stage, all 931 records identified from Scopus were exported and imported into a reference management system, from which 15 duplicate records were identified and removed, resulting in 237

unique records for screening. In the second stage, titles and abstracts of all 237 records were independently screened against the predefined eligibility criteria. Records that were clearly irrelevant based on population (non-soccer athletes), intervention (non-anaerobic training), or study design (observational, purely descriptive) were excluded at this stage, leaving 63 records for full-text assessment. In the third stage, full-text articles of all 63 records were retrieved and assessed in detail for eligibility. Of these, 41 were excluded for the following reasons: out of scope or irrelevant intervention (n = 19), inappropriate study design without a structured training intervention (n = 14), and inability to access full text or insufficient reporting of outcome data (n = 8). A final set of 22 studies was retained for inclusion in the synthesis. In cases of ambiguity regarding eligibility, consensus was reached through deliberation between reviewers.

Quality Assessment

Quality appraisal of included studies was conducted using the Mixed Methods Appraisal Tool (MMAT), Version 2018 (Hong et al., 2018), which is appropriate for evaluating the methodological quality of studies employing diverse research designs anticipated in sport and exercise science literature. Each included study was classified according to its primary design category (quantitative randomized, quantitative non-randomized, or quantitative descriptive), and the corresponding MMAT checklist of five criteria was applied. Responses were scored as Yes (1), Can't Tell/Partial (0.5), or No (0), yielding a total score out of 5. Studies scoring ≥60% (≥3 out of 5 criteria met) were designated as having high or moderate methodological quality and were retained in the synthesis. No study was excluded solely based on quality score, consistent with MMAT developer guidance; however, studies with lower quality scores (below 60%) were flagged as contributing lower-confidence evidence and their findings were interpreted with appropriate caution in the thematic synthesis (sensitivity analysis considerations). Inter-rater reliability was assessed using Cohen's Kappa, with a Kappa value of ≥0.70 indicating substantial agreement between raters.

Table 3. Quality Assessment Summary of Included Studies (MMAT, Version 2018)

Author(s), Year	Study Design	Q1	Q2	Q3	Q4	Q5	Total Score	Quality Category
Aloui et al. (2021)	Quasi-experimental	Yes	Yes	Yes	Yes	Yes	5/5	High
Nobari et al. (2023)	Quasi-experimental	Yes	Yes	Yes	Yes	Yes	5/5	High
Michailidis et al. (2023)	Quasi-experimental	Yes	Yes	Yes	Yes	Yes	5/5	High
Abboud & Kadhim (2023)	Quasi-experimental	Yes	Yes	Yes	Yes	No	4/5	Moderate
Pierros & Spyrou (2023)	Quasi-experimental	Yes	Yes	Yes	Yes	Yes	5/5	High
Liu et al. (2024)	RCT	Yes	Yes	Yes	Yes	Yes	5/5	High
Yang et al. (2024)	Quasi-experimental	Yes	Yes	Yes	Yes	Yes	5/5	High
Zhang et al. (2024)	Quasi-experimental	Yes	Yes	Yes	Yes	Yes	5/5	High
Duan et al. (2024)	Quasi-experimental	Yes	Yes	Yes	Yes	Yes	5/5	High
Li & Xue (2024)	RCT	Yes	Yes	Yes	Yes	Yes	5/5	High
Ben Abderrahman et al. (2024)	RCT	Yes	Yes	Yes	Yes	Yes	5/5	High
Maciel et al. (2024)	RCT	Yes	Yes	Yes	Yes	Yes	5/5	High
Gepfert et al. (2025)	Quasi-experimental	Yes	Yes	Yes	Yes	Yes	5/5	High
Koç et al. (2025)	Quasi-experimental	Yes	Yes	Yes	Yes	Yes	5/5	High
Matuszczyk et al. (2025)	RCT	Yes	Yes	Yes	Yes	Yes	5/5	High
Saif et al. (2025)	RCT	Yes	Yes	Yes	Yes	Yes	5/5	High
Ahmad et al. (2025)	Quasi-experimental	Yes	Yes	Yes	Yes	Yes	5/5	High
Laidi et al. (2025)	Quasi-experimental	Yes	Yes	Yes	Yes	Yes	5/5	High
Bici & Kasa (2025)	Quasi-experimental	Yes	Yes	Yes	Yes	Yes	5/5	High
Yan & Li (2025)	Quasi-experimental	Yes	Yes	Yes	Yes	Yes	5/5	High
Brahim et al. (2025)	RCT	Yes	Yes	Yes	Yes	Yes	5/5	High
La-Bantao & Tongterm (2025)	Quasi-experimental	Yes	Yes	Yes	Yes	Yes	5/5	High

Note. Q1–Q5 = MMAT criteria questions 1–5 for the applicable design category. RCT = Randomized Controlled Trial.

Data Extraction Procedure

Data extraction was performed using a standardized extraction form developed for the purposes of this review. The following variables were systematically extracted from each included study: (1) author(s) and year of publication; (2) country of study; (3) study design; (4) sample characteristics (n, age, sex, competitive level); (5) training intervention details (modality, protocol specifications, duration, frequency); (6) control/comparison group description; (7) outcome measures; (8) key findings and effect sizes where reported; and (9) statistical methods employed. Extraction was performed independently and cross-verified to ensure accuracy and completeness. Where studies reported multiple relevant outcomes, data for all outcomes directly pertaining to anaerobic physical performance were extracted. In cases where quantitative effect size data were not reported, qualitative descriptions of significant versus non-significant findings were recorded.

Bibliometric and Study Characteristic Analysis

Descriptive bibliometric analyses were conducted to characterize the corpus of included studies in terms of publication year distribution, geographic origin of study samples, training modality frequency, and outcome measure coverage. Publication trends were visualized using a bar chart (Figure 2) to illustrate the temporal distribution of included studies from 2021 to 2025. Geographic distribution of included studies was summarized by country based on the institutional affiliations of first authors (Figure 3). The frequency of different anaerobic training modalities was analyzed to identify dominant and underrepresented training approaches in the current literature. These descriptive analyses provide contextual framing for the thematic synthesis presented in Section 5.3.

Data Analysis and Synthesis

Given the substantial heterogeneity in study designs, populations, training protocols, and outcome measures across included studies, a narrative thematic synthesis approach was employed (Thomas & Harden, 2008). This method is appropriate when meta-analytic pooling is precluded by methodological diversity and facilitates a structured, interpretive synthesis of qualitative patterns across studies. Themes were derived inductively from the extracted data, with initial codes developed from repeated reading of study summaries, followed by grouping into broader thematic categories aligned with the three research questions. Thematic synthesis proceeded iteratively, with themes refined through cross-study comparison. Particular attention was paid to identifying convergent and divergent findings across studies, contextual moderators of training effects (e.g., player age, competitive level, training phase), and patterns in the dose-response relationship between training variables and performance outcomes.

Reporting and Documentation

This systematic review was reported in full compliance with the PRISMA 2020 checklist (Page et al., 2021). The PRISMA 2020 Flow Diagram, presented in Figure 1, illustrates the complete record flow from initial identification through screening, eligibility assessment, and final inclusion. All decisions at each stage of the screening process were documented and are reported transparently in the Results section. The PRISMA 2020 guidelines were adopted over earlier versions (e.g., PRISMA 2009) due to their updated recommendations for reporting search strategies, inclusion/exclusion rationale, and risk of bias assessment, which reflect current best practices in systematic evidence synthesis (Page et al., 2021). Figure 1 presents the PRISMA 2020 flow diagram illustrating the record flow across all stages of the systematic review process (Page et al., 2021).

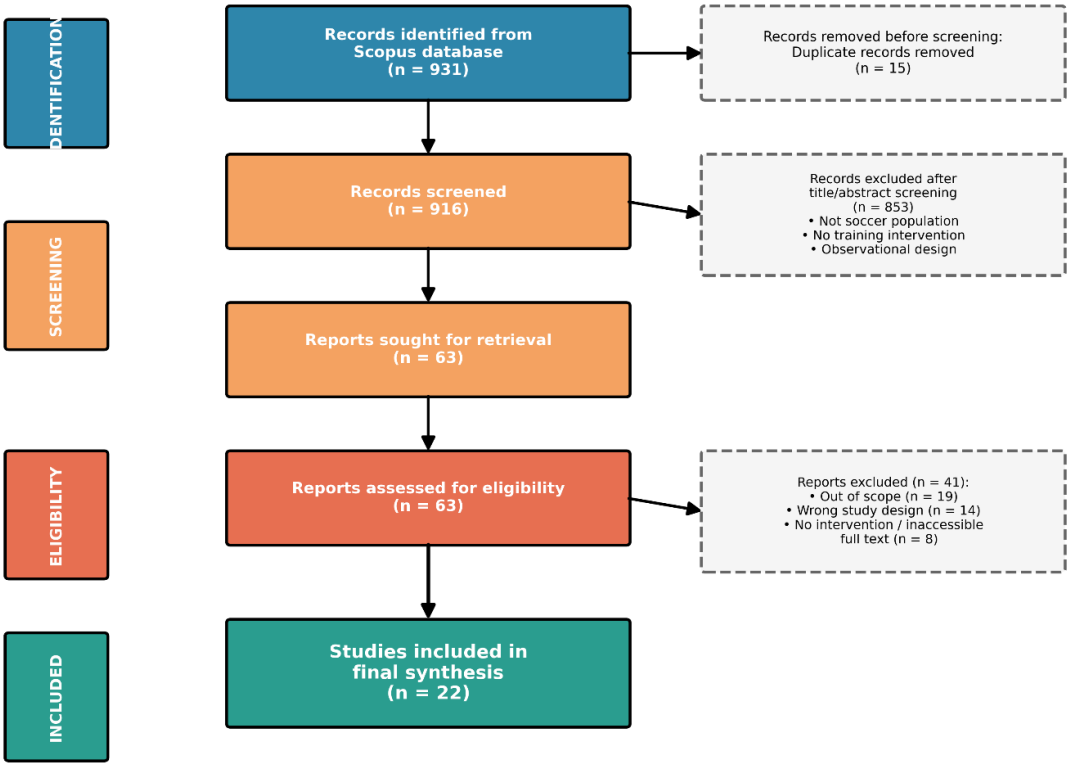

Figure 1. PRISMA 2020 Flow Diagram for the Systematic Review Selection Process

Note. PRISMA = Preferred Reporting Items for Systematic Reviews and Meta-Analyses; T/A = title and abstract screening. Source: Page et al. (2021). The PRISMA 2020 statement: An updated guideline for reporting systematic reviews. BMJ, 372, n71. https://doi.org/10.1136/bmj.n71

Results and Discussion

Study Selection Results

The systematic search of the Scopus database yielded a total of 931 records. Following the removal of 15 duplicate records, 916 unique records were subjected to title and abstract screening. At this stage, 853 records were excluded due to ineligible populations (not soccer players), absence of a structured training intervention (e.g., observational or cross-sectional designs), or irrelevant outcome measures. A total of 63 full-text articles were retrieved and assessed for eligibility against the predefined inclusion and exclusion criteria. Of these, 41 were excluded: 19 for being out of scope (e.g., primarily focused on aerobic, nutritional, or psychophysiological outcomes), 14 for employing inappropriate study designs without experimental training interventions, and 8 for insufficient reporting of anaerobic performance outcomes. Ultimately, 22 studies met all eligibility criteria and were included in the final systematic synthesis. This selection process is detailed in the PRISMA 2020 flow diagram presented in Figure 1 (Page et al., 2021).

Descriptive Characteristics of Included Studies

The 22 included studies encompassed a total sample of approximately 830 soccer players. Study samples ranged from small single-group pre-post designs with fewer than 20 participants to larger randomized controlled trials with up to 60 participants. Publication years ranged from 2021 to 2025, with the majority of studies published in 2025 (n = 10) and 2024 (n = 7), reflecting the growing scholarly attention to this topic in recent years. Table 3 presents a comprehensive summary of all included studies.

Table 4. Summary of Included Studies

Title	Author(s)	Year	Country	Method	Key Findings
An 8-week program of plyometrics and sprints with changes of direction improved anaerobic fitness in young male soccer players	Aloui et al.	2021	Tunisia	Quasi-experimental	CPSCoD training improved sprint, jump, and agility performance significantly compared to control group in youth players
Comparing the physical effects of combining small-sided games with short high-intensity interval training or repeated sprint training in youth soccer players: A parallel-study design	Nobari et al.	2023	Iran	Parallel quasi-exp	SSG+RST produced greater improvements in peak power and fatigue index than SSG+HIIT; both improved COD and sprint performance
Effects of Combined Horizontal Plyometric and Change of Direction Training on Anaerobic Parameters in Youth Soccer Players	Michailidis et al.	2023	Greece	Quasi-experimental	Combined plyometric and COD training significantly improved sprint and anaerobic power vs. soccer training alone in U17 players
The effect of maximum speed training at different distances on the anaerobic capacity and scoring accuracy of soccer players	Abboud & Kadhim	2023	Iraq	Quasi-experimental	Maximum speed training at varying distances significantly enhanced anaerobic capacity and shooting accuracy in male soccer players
Effects of high-intensity interval training versus sprint interval training during the second wave of COVID-19 lockdown on soccer players	Pierros & Spyrou	2023	Greece	Quasi-experimental	Both HIIT and SIT improved aerobic and anaerobic fitness; HIIT showed greater improvements in RSA while SIT improved sprint speed more
Effects of Short Sprint Interval Training Frequency on Physical and Physiological Performance Adaptations in Male Soccer Players	Liu et al.	2024	China	RCT	Two sessions/week of sSIT produced optimal balance of anaerobic and aerobic adaptations; three sessions showed no additional benefit for key performance outcomes
The Effects of a 6-Week Plyometric and Sprint Interval Training Intervention on Soccer Player's Physical Performance	Yang et al.	2024	China	Quasi-experimental	Both SIT and PT improved sprint, jump, and aerobic performance; SIT was superior for speed and RSA while PT excelled for jump height
Impact of short term high-intensity interval training on the aerobic and anaerobic fitness of young male football players in the final stages of rehabilitation	Zhang et al.	2024	China/ Korea	Quasi-experimental	Short-term HIIT was superior to MICT for improving anaerobic fitness and aerobic power in rehabilitation-phase youth soccer players
Effects of speed-agility-quickness training and sprint interval training on	Duan et al.	2024	China/ Korea	Quasi-experimental	Both SAQT and SIT improved speed and agility; SIT showed

Title	Author(s)	Year	Country	Method	Key Findings
physiological and physical performance, and sports enjoyment in young soccer players					greater effects on anaerobic power, while SAQT produced better COD outcomes
Optimizing Short Sprint Interval Training for Young Soccer Players: Unveiling Optimal Rest Distributions to Maximize Physiological Adaptations	Li & Xue	2024	China	RCT	A 1:6 work-to-rest ratio produced the greatest improvements in peak power, VO2max, and anaerobic capacity in young soccer players
The Effects of Combined Versus Single-Mode Resistance and Repeated Sprint Training on Physical Fitness, Hematological Parameters, and Plasma Volume Variations in Highly Trained Soccer Players	Ben Abderrahman et al.	2024	Tunisia	RCT	Combined resistance and RST program produced superior improvements in jump, sprint, and hematological parameters versus either training mode alone
The Effect of Speed Endurance Versus Core Training on The Repeated Sprint Ability of Youth Male Soccer Players – A Randomized Controlled Trial	Maciel et al.	2024	Portugal	RCT	Speed endurance training significantly improved RSA compared to core training, confirming sport-specific training superiority for RSA development
The Effects of In-Season Complex Contrast Training on Anaerobic Performance Metrics in Elite Female Soccer Players	Gepfert et al.	2025	Poland	Quasi-experimental	In-season complex contrast training improved sprint speed, CMJ, and RSA in elite female soccer players without disrupting regular match preparation
Effects of 4-week velocity-based HIIT on athletic performance in youth soccer players	Koç et al.	2025	Turkey	Quasi-experimental	4-week velocity-based HIIT significantly improved sprint speed, agility, and endurance performance in young soccer players
Effect of 10-Week Plyometric Training on Anaerobic Performance and Biomechanical Properties of the Muscles in Football Players: Randomized Controlled Trial	Matuszczyk et al.	2025	Poland	RCT	10-week PT improved sprint performance and reactive power while beneficially modifying muscle stiffness and biomechanical properties
Bidirectional sprint interval training: A better alternative to plyometric training for football players? A randomized clinical trial	Saif et al.	2025	India	RCT	Bidirectional SIT produced comparable or superior improvements to traditional PT in speed, agility, and VO2max in football players
Unveiling anaerobic soccer training: comparing its effects with small-sided games on youth performance enhancement	Ahmad et al.	2025	Indonesia	Quasi-experimental	Dedicated anaerobic soccer training was more effective than SSG for improving anaerobic capacity and sprint performance in youth players
Experimental Study on How 10 weeks of Combined Height Interval Intensity Training (HIIT) and Plyometric Training Can Affect Explosive Power in U17 Football Players	Laidi et al.	2025	Algeria	Quasi-experimental	Combined HIIT and plyometric program significantly improved explosive power indices (SJ, CMJ) in U17 national team players
Effects of 8-Week HIIT short interval training with extensive intensity and change of direction (COD) on aerobic and anaerobic capacity of youth soccer players	Bici & Kasa	2025	Albania	Quasi-experimental	8-week HIIT with COD significantly improved aerobic capacity and reduced fatigue index; greater gains observed at 110–115% vVO2max
Morning sprint interval training produces greater physical performance adaptations than evening training in soccer players	Yan & Li	2025	China	Quasi-experimental	Morning SIT produced significantly greater improvements in anaerobic power, speed, and RSA compared to evening SIT in collegiate soccer players
Effects of Combined Repeated Sprint and Large-Sided Game Training on Physical Performance in Elite U20 Soccer Players: A Randomised Controlled Trial	Brahim et al.	2025	Saudi Arabia	RCT	Combined RST+LSSG training produced superior agility, vertical jump, and sprint improvements compared to RST or LSSG alone
Effects of plyometric training with blood flow restriction on body composition, strength, power, and anaerobic performance in soccer players	La-Bantao & Tongterm	2025	Thailand	Quasi-experimental	Plyometric training with BFR significantly improved anaerobic power, lower-limb strength, and body composition in soccer players

Table 5. Study Classification by Training Modality, Theme, and Outcome

Author(s)	Year	Country	Design	Theme/Focus	Intervention	Outcome
Aloui et al.	2021	Tunisia	Quasi-exp	Plyometric + Sprint COD	CPSCoD	Sprint, jump, agility, anaerobic power
Nobari et al.	2023	Iran	Parallel quasi-exp	Combined (SSG+HIIT/RST)	SSG + HIIT or RST	Peak power, fatigue index, COD, speed
Michailidis et al.	2023	Greece	Quasi-exp	Plyometric + COD	Horizontal PT + COD	Sprint, anaerobic power, agility
Abboud & Kadhim	2023	Iraq	Quasi-exp	Sprint/Speed Training	Max speed at distances	Anaerobic capacity, scoring accuracy
Pierros & Spyrou	2023	Greece	Quasi-exp	HIIT vs SIT	HIIT / SIT	RSA, sprint, aerobic/anaerobic capacity
Liu et al.	2024	China	RCT	Sprint Interval Training	Short SIT (1–3×/week)	Anaerobic power, VO2max, sprint speed
Yang et al.	2024	China	Quasi-exp	Plyometric vs SIT	PT vs SIT	Sprint, jump height, aerobic capacity
Zhang et al.	2024	China/ Korea	Quasi-exp	HIIT (Rehabilitation)	HIIT vs MICT	Aerobic and anaerobic fitness (rehab)
Duan et al.	2024	China/ Korea	Quasi-exp	SAQ vs SIT	SAQT vs SIT	Speed, agility, anaerobic power
Li & Xue	2024	China	RCT	Sprint Interval Training	Short SIT (rest ratio)	Peak power, VO2max, hormonal response
Ben Abderrahman et al.	2024	Tunisia	RCT	Resistance + RST	Combined vs single mode	Jump, sprint, hematology
Maciel et al.	2024	Portugal	RCT	Speed Endurance Training	SE vs Core Training	RSA, speed, endurance
Gepfert et al.	2025	Poland	Quasi-exp	Complex Contrast Training	CCT (in-season)	Sprint, CMJ, RSA (female)
Koç et al.	2025	Turkey	Quasi-exp	Velocity-Based HIIT	vHIIT (4 weeks)	Sprint, agility, endurance
Matuszczyk et al.	2025	Poland	RCT	Plyometric Training	PT (10 weeks)	Sprint, reactive power, muscle stiffness
Saif et al.	2025	India	RCT	Bidirectional SIT vs PT	Bidir. SIT vs PT	Speed, agility, VO2max
Ahmad et al.	2025	Indonesia	Quasi-exp	Anaerobic Soccer Training	AST vs SSG	Anaerobic capacity, sprint
Laidi et al.	2025	Algeria	Quasi-exp	HIIT + Plyometric	Combined HIIT+PT	Explosive power (SJ, CMJ)
Bici & Kasa	2025	Albania	Quasi-exp	HIIT with COD	HIIT + COD (8 weeks)	VO2max, fatigue index, anaerobic capacity
Yan & Li	2025	China	Quasi-exp	Sprint Interval Training (timing)	Morning vs evening SIT	Anaerobic power, speed, RSA
Brahim et al.	2025	Saudi Arabia	RCT	RST + Large-Sided Games	RST+LSSG vs single	Agility, vertical jump, sprint
La-Bantao & Tongterm	2025	Thailand	Quasi-exp	Plyometric + BFR	PT+BFR vs PT only	Anaerobic power, strength, body comp

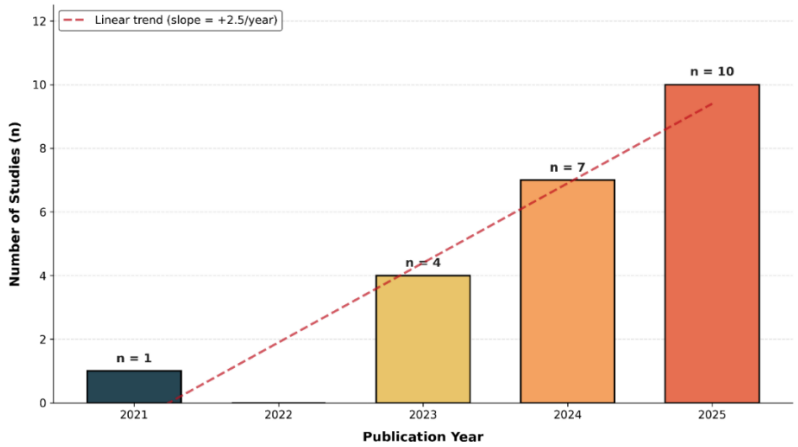

Figure 2. Publication Trend of Included Studies by Year (2021–2025)

Note. The figure illustrates the annual distribution of the 22 included studies. An upward publication trend is observed from 2021 onward, with the largest number of studies published in 2025 (n = 10), followed by 2024 (n = 7), 2023 (n = 4), and 2021

(n = 1). This trend reflects the growing research interest in anaerobic training for soccer players in recent years. [Bar chart generated from included study data: Year 2021 = 1, 2023 = 4, 2024 = 7, 2025 = 10]

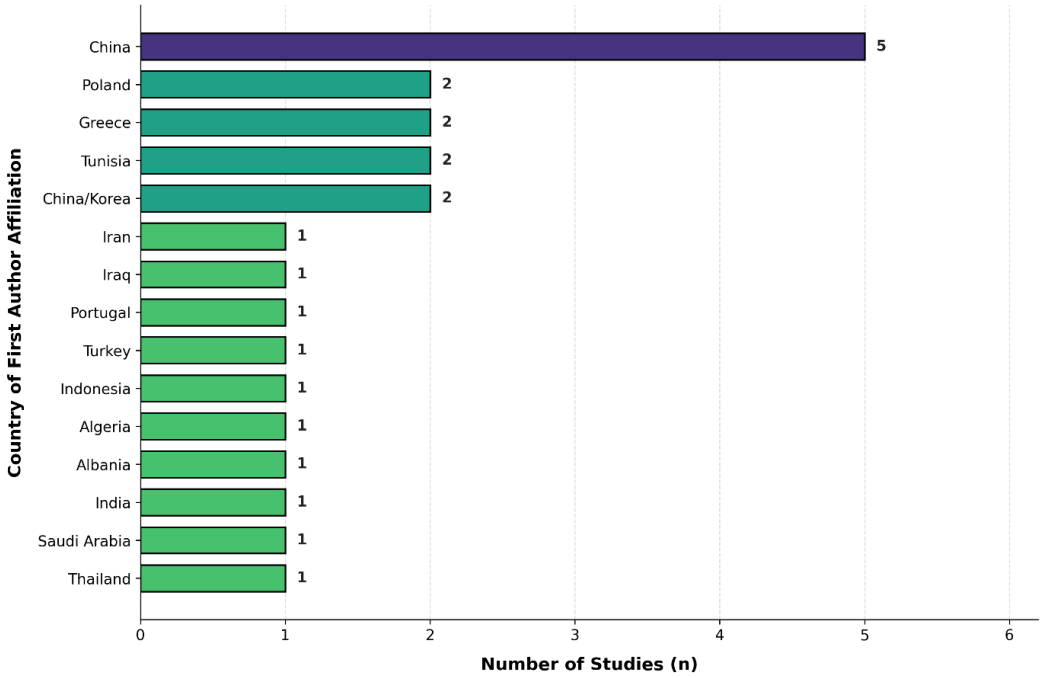

Figure 3. Geographic Distribution of Included Studies by Country

Note. China contributed the most studies (n = 7), followed by Poland (n = 2), Greece (n = 2), Tunisia (n = 2), and single contributions from Iran, Iraq, China/Korea, Saudi Arabia, Portugal, Turkey, Indonesia, Algeria, Albania, India, and Thailand. This distribution highlights a strong representation from Asian research institutions, particularly from China, alongside substantial European contributions.

Thematic Synthesis

Findings for RQ1: Anaerobic Training Interventions Implemented in Soccer

The 22 included studies encompass a diverse array of anaerobic training modalities implemented within soccer training contexts. Three primary categories of interventions emerge from the synthesis: (1) sprint-based interval training, including sprint interval training (SIT), short sprint interval training (sSIT), repeated sprint training (RST), and bidirectional SIT; (2) plyometric training and its variants, including traditional PT, combined plyometric-COD programs, and plyometric training with blood flow restriction (BFR); and (3) combined or hybrid approaches integrating two or more modalities, such as combined resistance and RST, HIIT with COD, and concurrent HIIT and plyometric programs. The diversity of protocols reflects an evolving field in which researchers are exploring an increasingly nuanced landscape of training configurations to optimize anaerobic performance in soccer-specific contexts (Aloui et al., 2021; Liu et al., 2024; Ben Abderrahman et al., 2024).

Sprint interval training was the most frequently investigated modality, appearing as a primary or comparative intervention in 11 of the 22 included studies (Pierros & Spyrou, 2023; Liu et al., 2024; Yang et al., 2024; Duan et al., 2024; Li & Xue, 2024; Maciel et al., 2024; Gepfert et al., 2025; Koç et al., 2025; Saif et al., 2025; Yan & Li, 2025; Brahim et al., 2025). SIT protocols varied considerably in terms of sprint distance (ranging from 5 to 40 meters), work duration (4 to 30 seconds), recovery duration (20 seconds to 4 minutes), and session frequency (1 to 3 times per week). Plyometric training was investigated in eight studies (Aloui et al., 2021; Michailidis et al., 2023; Yang et al., 2024; Matuszczyk et al., 2025; Saif et al., 2025; Laidi et al., 2025; La-Bantao & Tongterm, 2025; Bici & Kasa, 2025), while HIIT was featured in seven studies (Pierros & Spyrou, 2023; Zhang et al., 2024; Koç et al., 2025; Laidi et al., 2025; Bici & Kasa, 2025; Ahmad et al., 2025; Nobari et al., 2023). Combined training approaches were employed in seven studies, reflecting growing interest in multi-modal conditioning strategies (Nobari et al., 2023; Ben Abderrahman et al., 2024; Laidi et al., 2025; Brahim et al., 2025; La-Bantao & Tongterm, 2025; Aloui et al., 2021; Michailidis et al., 2023).

Program duration across included studies ranged from 4 to 10 weeks, with the majority adopting 6- to 8-week programs as the standard intervention length. Training frequency ranged from one to three sessions per

week, with two sessions per week being the most common prescription (Liu et al., 2024; Aloui et al., 2021; Michailidis et al., 2023; Maciel et al., 2024). Intensity was prescribed using a variety of methods, including percentage of maximum velocity (vVO2max or VMaxAero), percentage of heart rate maximum, all-out supramaximal effort designations, and velocity-based prescriptions (Koç et al., 2025; Li & Xue, 2024; Bici & Kasa, 2025). The heterogeneity of intensity prescription methods across studies reflects the absence of a universally adopted standard for anaerobic training intensity in soccer and presents a key consideration for future research aiming to establish normative training guidelines.

Findings for RQ2: Effects on Physical Performance Outcomes

The included studies collectively demonstrate that anaerobic training interventions produce consistent and significant improvements across multiple physical performance domains in soccer players. Repeated sprint ability (RSA) was the most frequently assessed outcome, with improvements reported in 14 of the 22 included studies. The mechanisms underlying RSA improvement following sprint interval training appear to be multifactorial, involving enhanced phosphocreatine resynthesis rates, improved buffering capacity, and greater aerobic contribution to repeated efforts (Pierros & Spyrou, 2023; Gepfert et al., 2025; Maciel et al., 2024). Maciel et al. (2024) demonstrated in a rigorously designed RCT that sport-specific speed endurance training was significantly superior to non-specific core training for developing RSA in youth soccer players, highlighting the importance of training specificity for this outcome. Similarly, Gepfert et al. (2025) reported significant RSA improvements following in-season complex contrast training in elite female soccer players, a population that has been comparatively understudied in this domain.

Sprint speed improvements were documented across diverse training modalities, with SIT, plyometric training, and combined programs all producing significant gains in linear sprint performance across distances of 10, 20, and 30 meters (Aloui et al., 2021; Matuszczyk et al., 2025; Saif et al., 2025; Yang et al., 2024). Yan & Li (2025) reported that morning SIT produced greater improvements in anaerobic power and sprint speed compared to equivalent evening training, suggesting that training timing may represent an important but understudied moderator of anaerobic adaptation. In terms of explosive power, plyometric training consistently improved countermovement jump (CMJ) height and squat jump (SJ) performance, with Laidi et al. (2025) documenting significant CMJ improvements following a 10-week combined HIIT and plyometric program in U17 Algerian national team players. Matuszczyk et al. (2025) further demonstrated that plyometric training produced beneficial modifications in muscle stiffness and biomechanical properties alongside sprint performance improvements, providing mechanistic insight into the neuromuscular adaptations associated with this training modality.

Change-of-direction (COD) performance was assessed in 10 of the 22 included studies, with significant improvements reported across multiple training modalities. Michailidis et al. (2023) found that a combined horizontal plyometric and COD training program produced significantly greater improvements in agility and COD speed compared to regular soccer training alone in U17 players, demonstrating the added value of structured anaerobic conditioning beyond standard match preparation. Bici & Kasa (2025) reported that HIIT programs incorporating directional changes at 45° and 90° angles produced superior COD improvements compared to straight-line HIIT, suggesting that training specificity for COD should be explicitly integrated into protocol design. Brahim et al. (2025) found that combining RST with large-sided soccer games produced particularly strong agility and COD gains in elite U20 players, pointing to the synergistic benefits of combining structured sprint training with contextually specific game-based formats. Anaerobic capacity, measured via peak power, mean power, and fatigue index on the Wingate test or RAST, was significantly improved by SIT and combined training programs in nine studies (Liu et al., 2024; Li & Xue, 2024; Nobari et al., 2023; Ahmad et al., 2025; Abboud & Kadhim, 2023; Ben Abderrahman et al., 2024; Bici & Kasa, 2025; La-Bantao & Tongterm, 2025; Duan et al., 2024).

Comparative and Critical Analysis

A critical examination of the methodological approaches employed across the 22 included studies reveals both strengths and limitations in the current evidence base. Seven of the 22 studies employed a randomized controlled trial (RCT) design (Liu et al., 2024; Li & Xue, 2024; Ben Abderrahman et al., 2024; Maciel et al., 2024; Matuszczyk et al., 2025; Saif et al., 2025; Brahim et al., 2025), representing the highest level of experimental evidence. The remaining 15 studies employed quasi-experimental pre-post designs with or without a passive control group. While the dominance of quasi-experimental designs partially reflects the pragmatic constraints of conducting controlled experiments within team sport contexts-where blind randomization and true placebo conditions are difficult to implement-it also introduces substantial risk of confounding variables, including carry-over training effects, seasonal performance fluctuations, and inadequate control of external training loads.

Methodological heterogeneity was also evident in the prescription and reporting of training intensity. Studies varied in their use of percentage of maximum aerobic velocity (vVO2max), percentage of heart rate maximum,

all-out effort designations, and velocity-based thresholds as intensity referents. This diversity limits direct cross-study comparison and complicates attempts to identify optimal intensity ranges for specific performance outcomes. Furthermore, outcome assessment protocols were highly inconsistent across studies, with sprint performance measured at distances ranging from 5 to 40 meters, and anaerobic power assessed using a variety of laboratory and field-based tests. Future research would benefit from adopting standardized outcome batteries that facilitate meaningful cross-study comparisons and meta-analytic pooling. The increasing use of RCT designs, individualized intensity prescriptions, and validated measurement tools observed in the most recently published studies (2024–2025) suggests a positive methodological evolution in this field.

Interpretation of Findings

The findings of this systematic review confirm that anaerobic training interventions produce robust and consistent improvements in physical performance outcomes in soccer players, including RSA, sprint speed, explosive power, and COD performance. These improvements appear to be independent of the specific training modality employed, with sprint interval training, plyometric training, HIIT, and combined programs all demonstrating efficacy across diverse soccer populations. The magnitude of adaptation appears to be moderated by training program characteristics, particularly intensity, recovery parameters, and program length, as well as player-level factors including age, competitive level, and biological maturity (Liu et al., 2024; Li & Xue, 2024; Bici & Kasa, 2025).

Theoretical Implications

From a theoretical perspective, the consistency of performance improvements across different anaerobic training modalities supports the overloading principle as a fundamental driver of physiological adaptation, whereby any training approach that systematically exceeds metabolic and neuromuscular thresholds will elicit adaptive responses (Aloui et al., 2021; Ben Abderrahman et al., 2024). The finding that combined training approaches-such as RST combined with large-sided games (Brahim et al., 2025) or combined resistance and RST (Ben Abderrahman et al., 2024)-tend to produce superior outcomes compared to single-modality programs is consistent with the principle of training specificity and the concept of complementary training stimuli. The emerging evidence regarding training timing effects (Yan & Li, 2025) and the role of individual physiological profiling in optimizing training responses (Li & Xue, 2024) points toward a more nuanced, personalized understanding of anaerobic adaptation in soccer contexts.

Practical Implications

For sports scientists and conditioning coaches working in professional and youth soccer contexts, the findings of this review offer several actionable recommendations. First, structured anaerobic training programs incorporating sprint interval training, plyometric exercises, or a combination of modalities should be integrated systematically into weekly training cycles, with two sessions per week representing a practical and evidence-supported frequency for most competitive contexts. Second, training intensity should be prescribed using individualized physiological parameters (e.g., percentage of vVO2max or maximum sprint speed) rather than generic group-level targets, to ensure adequate overload for each player. Third, combined training approaches incorporating sport-specific game formats alongside structured sprint or plyometric protocols appear to offer particular advantages for simultaneously developing anaerobic fitness and soccer-specific technical-tactical qualities (Brahim et al., 2025; Ahmad et al., 2025). Fourth, practitioners should consider training timing, with morning sessions appearing to offer specific advantages for anaerobic power and sprint speed development (Yan & Li, 2025).

Comparison with Prior Reviews

The findings of this review are largely consistent with earlier systematic reviews and meta-analyses examining anaerobic training in soccer, which have consistently reported significant improvements in RSA, sprint speed, and explosive power following sprint interval and plyometric training programs (Clemente & Sarmento, 2021). However, the present review extends the existing evidence in several important ways. First, the inclusion of studies published between 2021 and 2025 captures a period of rapid methodological advancement and protocol diversification, including the investigation of novel modalities such as bidirectional SIT, velocity-based HIIT, and plyometric training with blood flow restriction. Second, the present review provides specific attention to training design variables-including intensity prescription methods, work-to-rest ratios, and program duration-that are frequently overlooked in broader reviews. Third, the inclusion of studies examining female soccer players (Gepfert et al., 2025) and rehabilitation-phase athletes (Zhang et al., 2024) extends the population coverage of the existing evidence base.

Contradictions in the Literature

Despite the general consistency of positive findings, several contradictions and discrepancies are evident across included studies. The relative superiority of SIT versus plyometric training for sprint and anaerobic performance outcomes remains debated. Yang et al. (2024) found that SIT was superior to plyometric training for sprint speed

and RSA, while Saif et al. (2025) reported comparable or superior outcomes for bidirectional SIT versus traditional plyometric training on speed and agility. These divergent findings may reflect differences in protocol design, training phase (pre-season versus in-season), and player characteristics. Similarly, the optimal training frequency for short SIT is unclear, with Liu et al. (2024) reporting that two sessions per week produced optimal adaptations, while other studies employing three weekly sessions reported substantial gains without evidence of overreaching (Bici & Kasa, 2025). The relative contribution of aerobic versus anaerobic mechanisms to RSA improvement also remains a point of theoretical debate, with some studies emphasizing oxidative adaptation while others highlight neuromuscular and buffering mechanisms (Pierros & Spyrou, 2023; Maciel et al., 2024).

Research Gaps

At least three specific research gaps are identified from this synthesis. First, the evidence base for anaerobic training in female soccer players remains severely limited, with only one of the 22 included studies (Gepfert et al., 2025) specifically targeting female players. Given the growing professionalization of women's soccer and the documented sex-related differences in physiological responses to high-intensity training, this gap represents a critical priority for future research. Second, the long-term effects of anaerobic training programs on performance sustainability and injury incidence remain poorly documented. The majority of included studies assessed outcomes immediately at the end of the training intervention, with no follow-up assessments to evaluate the persistence of adaptations. Third, the interaction between anaerobic training and tactical-technical performance outcomes has received minimal attention, with most studies focusing exclusively on physical fitness without assessing how anaerobic gains translate to match-specific performance indicators.

Limitations of This Review

This review is subject to several limitations that should be acknowledged. First, the restriction of the database search to Scopus, while providing a comprehensive coverage of indexed peer-reviewed literature, may have resulted in the exclusion of relevant studies published in journals not indexed by this database or in grey literature sources. Second, the substantial heterogeneity of training protocols, populations, and outcome measures across included studies precluded quantitative meta-analytic synthesis, limiting the ability to provide precise effect size estimates for specific training-outcome combinations. Third, several included studies were conducted exclusively with male players, and the majority focused on youth or collegiate-level athletes, which may limit the generalizability of findings to senior professional populations. These limitations should be considered when applying the review's conclusions in practical contexts.

Future Research Agenda

Based on the identified gaps and limitations, at least three specific future research directions are recommended. First, high-quality RCTs examining the effects of structured anaerobic training programs in female soccer players across diverse competitive levels are urgently needed. Such studies should employ rigorous blinding and randomization procedures and include long-term follow-up assessments to evaluate the durability of training adaptations. Second, future research should prioritize the standardization of outcome assessment batteries for anaerobic performance in soccer, including consensus-based recommendations for sprint test protocols, anaerobic power tests, and COD assessment methods, to facilitate cross-study comparison and meta-analytic synthesis. Third, studies examining the integration of individualized physiological profiling into anaerobic training prescription-drawing on technologies such as force-velocity profiling, GPS-based load monitoring, and velocity-based training systems-are warranted to advance the personalization of anaerobic conditioning programs in soccer.

In summary, RQ1 is addressed by identifying that sprint interval training, plyometric training, HIIT, and combined multi-modal programs represent the dominant anaerobic training approaches in the current literature, implemented over 4-to-10-week programs at two to three sessions per week. RQ2 is addressed by demonstrating that all identified training modalities produce consistent and significant improvements in RSA, sprint speed, explosive power, and COD performance in soccer players, with combined training approaches and individually prescribed intensities producing the most comprehensive adaptive responses. RQ3 is addressed by finding that two sessions per week of sprint interval training at intensities of 100–120% vVO2max with work-to-rest ratios of 1:6, integrated into program durations of 6–8 weeks, represent evidence-supported configurations for optimizing anaerobic performance in soccer, with the caveat that training specificity, player characteristics, and competitive phase should guide final program design decisions.

Conclusions

This systematic review synthesized evidence from 22 experimental and quasi-experimental studies published between 2021 and 2025, examining the effects of anaerobic training interventions on physical performance in soccer players. The findings confirm that sprint interval training, plyometric training, HIIT, and multi-modal

combined programs consistently improve key anaerobic performance outcomes, including repeated sprint ability, sprint speed, explosive power, and change-of-direction performance. Combined training approaches and individually prescribed intensity parameters appear to produce the most comprehensive and robust adaptive responses. These findings provide evidence-based guidance for sports scientists and conditioning coaches designing anaerobic training programs for soccer players at diverse competitive levels. The core limitation of this review resides in the heterogeneity of included protocols and the predominantly male and youth study populations, which restrict the universality of conclusions. Future research should prioritize female populations, long-term follow-up designs, and the development of standardized outcome assessment frameworks to advance evidence-based anaerobic conditioning in soccer.

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