EFFECTS OF SAQ, HIIT, AND SSG TRAINING ON SPRINT AND COD PERFORMANCE IN SOCCER PLAYERS: A PAIRWISE AND NETWORK META-ANALYSIS

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Abstract:

The objective was to systematically compare the effects of speed, agility, and quickness (SAQ) training, high-intensity interval training (HIIT), and small-sided games (SSG) training on sprint and change of direction (COD) performance in soccer players through pairwise and network meta-analyses. A comprehensive search of five electronic databases (PubMed, Web of Science, Embase, Cochrane, and EBSCO) was conducted during June 2025 to identify controlled trials involving SAQ, HIIT, or SSG training interventions. Studies meeting predefined eligibility criteria underwent pairwise meta-analysis (PMA) to calculate standardized mean differences (SMDs) against control conditions, and network meta-analysis (NMA) to estimate comparative efficacy across all three modalities. Surface under the cumulative ranking (SUCRA) values were computed to establish an intervention hierarchy. Twenty-three studies involving 914 participants were included. Pairwise meta-analysis (PMA) results showed that, compared with the control groups, only SAQ training significantly improved sprint (SMD = –1.23, 95% CI: –1.85 to –0.60, p<.001) and COD performance (SMD = –1.09, 95% CI: –1.69 to –0.48, p<.001). In network meta-analysis (NMA), SAQ ranked highest for sprint performance (SUCRA = 98.2%), followed by conventional training (CT) (57.0%), HIIT (36.7%), and SSG (8.1%). For COD performance, HIIT (SUCRA = 67.3%) ranked highest, followed by SSG (65.9%), SAQ (63.1%) and CT (3.7%). SAQ training demonstrated the most robust enhancement of sprint speed among the examined modalities. Although direct comparisons indicated benefits of SAQ for COD performance, its superiority was not confirmed in the network analysis, likely due to limited head-to-head data and study heterogeneity. A training strategy centered on SAQ, with supplemental HIIT and SSG components, is therefore recommended to optimize both sprint and COD adaptations in soccer players.

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Keywords: *football, SAQ, HIIT, SSG, meta-analysis*

Introduction

Soccer imposes substantial demands on athletes' multifaceted physical capacities. Beyond proficiency in technical skills, players must exhibit adequate strength, power, speed, agility, flexibility, and endurance to perform effectively during match scenarios (Bloomfield, Polman, O'Donoghue, & McNaughton, 2007; Elghoul, et al., 2022; Gorostiaga, et al., 2004; Helgerud, Engen, Wisloff, & Hoff, 2001; Krustrup, Mohr, Ellingsgaard, & Bangsbo, 2005; Nemčić & Calleja-González, 2021). Among these physical attributes, high-speed movement ability, namely sprinting and change of direction (COD) speed (Sporis, Jukic, Ostojic, & Milanovic, 2009; Stølen, Chamari, Castagna, & Wisløff, 2005), is considered the most decisive factor influencing in-game performance and competitive success (R. Hammami, Makhlouf, Chtara, Padulo, & Chaouachi, 2015). Development of these abilities is complicated due to the intricate interplay of physiological and biomechanical factors that underpin each movement (Little & Williams, 2005). Several investigators have proposed that sprint and COD skills constitute separate motor abilities with limited cross-transfer, thereby necessitating distinct, targeted training regimens for each (Young, McDowell, & Scarlett, 2001). As a result, considerable time and effort are typically devoted to enhancing both sprint and COD performance, highlighting the need for integrated conditioning strategies capable of concurrently improving these critical attributes in soccer athletes.

In modern soccer conditioning systems, high-intensity interval training (HIIT) and small-sided games (SSG) are two widely adopted training methods. HIIT comprises brief, maximal effort bouts interspersed with recovery intervals, targeting enhancement of phosphagen system capacity and maximal sprint output (Clemente, Ramirez-Campillo, Nakamura, & Sarmento, 2021b; Gökkurt & Kivrak, 2021; Stankovic, Djordjevic, Trajkovic, & Milanovic, 2023). Although several studies have reported positive effects of HIIT on COD performance (Stankovic, et al., 2023; Wen, Song, Yang, & Xu, 2024), its repetitive, linear movement patterns poorly mirror the multifaceted demands of rapid directional transitions and real-time tactical decision-making inherent to match play, prompting debate over its true efficacy for COD enhancement (Engel, Ackermann, Chtourou, & Sperlich, 2018; G. Yang, Chen, Qi, Zhang, & Men, 2024). In contrast, SSG is more game-representative and supports the development of players' in-game responsiveness. This format elicits high intensity efforts while concurrently refining perceptual-decision-making and tactical awareness (Hill-Haas, Dawson, Impellizzeri, & Coutts, 2011), and has been shown to elevate the frequency of both sprints and directional changes in match equivalent scenarios (Chaouachi, et al., 2014; Dello Iacono, Beato, & Unnithan, 2021; A. Hammami, Gabbett, Slimani, & Bouhlel, 2018; Yüksel, et al., 2023). Nevertheless, the magnitude of sprint and COD improvements achieved via SSG appears highly contingent upon modifiable factors such as game rules, player count, and playing area (Radziminski, Rompa, Barnat, Dargiewicz, & Jastrzebski, 2013; Young & Rogers, 2014). Moreover, studies have shown no significant difference between SSG and HIIT in improving sprint performance (Clemente, et al., 2021a), further highlighting the need to optimize current training approaches for enhancing high-speed movement capacity in soccer players.

Speed, agility, and quickness (SAQ) training has gained increasing attention as an integrated approach aimed at comprehensively enhancing sprint performance, agility, and COD speed in athletes (Chandrakumar & Ramesh, 2015; Pearson, 2013). SAQ protocols are engineered to mirror the biomechanical demands of soccer specific maneuvers, thereby facilitating optimal recruitment of prime movers and enhancing movement economy during competitive play (Jovanovic, Sporis, Omrcen, & Fiorentini, 2011). Unlike HIIT or SSG, which may lack systematic progression in multidirectional drills, SAQ presents a highly structured framework that specifically targets deceleration-acceleration and directional change sequences. Tasks such as the 505 test or T Test are rehearsed in a controlled, repetitive fashion, reinforcing neuromuscular coordination and ingraining standardized movement patterns under varied velocities and angles. Empirical investigations have reported significant gains in both sprint and COD metrics following SAQ interventions (Lee, Lee, & Ahn, 2024; Polman, Walsh, Bloomfield, & Nesti, 2004), and meta-analytic syntheses corroborate its robust efficacy and transferability across team sport cohorts (Sun, et al., 2025, 2025; Uysal, Korkmaz, Sen, Thapa, & Pojskic, 2025). Therefore, SAQ may serve as a valuable complement to HIIT and SSG, potentially overcoming their limitations in improving sprint and COD abilities and enhancing the overall effectiveness of training interventions during both preseason preparation and in-season maintenance phases. Despite these promising outcomes, direct comparisons among SAQ, HIIT, and SSG within a single analytic framework remain scarce, underscoring the need for rigorous, evidence-based evaluations to rank their relative impact on high-speed movement capabilities.

Based on this background, the aim of the present study was to systematically compare the effects of SAQ, HIIT, and SSG training methods on sprint and COD performance in soccer players, so as to determine the relative advantages and applicability of each approach in enhancing athletic performance. The specific objectives were: (1) to evaluate whether these three training methods produce significantly greater improvements in sprint and COD performance compared to conventional training; (2) to examine differences in effectiveness among the three interventions; and (3) to explore whether the findings could inform the development of more targeted and effective conditioning strategies to optimize sprint and COD performance in match scenarios, thereby improving overall competitive performance. To achieve these objectives, both pairwise meta-analysis (PMA) and network meta-analysis (NMA) were employed to comprehensively synthesize direct and indirect evidence from existing literature. Specifically, PMA was employed to quantify the isolated effects of each intervention versus control conditions, whereas NMA facilitated direct and indirect comparisons among SAQ, HIIT, and SSG, yielding probabilistic rankings of their relative performance enhancing efficacy. These results aim to inform evidence-based guidelines for coaches and strength-and-conditioning specialists, thereby optimizing training programme design to elevate soccer specific physical capacities and competitive potential.

Methods

The present review was performed in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses–Network Meta-Analyses (PRISMA–NMA) guidelines (Hutton, et al., 2015; Page, et al., 2021), with PROSPERO registration (CRD42024583586).

Search strategy

All databases, including Web of Science, PubMed, Embase, Cochrane Central Register of Controlled Trials, and EBSCO, were searched from their inception to May 2025. Boolean operators ("AND" and "OR") were employed to combine subject terms with free-text terms in formulating the literature search strategy. Using PubMed as an example, the specific search strategy is shown in Table 1.

Table 1. Searching strategy for the study inclusion

Steps	Searching command	Field
#1	"SAQ"	Title OR Abstract
#2	"Speed, Agility, Quickness"	Title OR Abstract
#3	"HIIT"	Title OR Abstract
#4	"High-Intensity Interval Training"	Title OR Abstract
#5	"SSG"	Title OR Abstract
#6	"Small-Sided Games"	Title OR Abstract
#7	#1 OR #2 OR #3 OR #4 OR #5 OR #6	
#8	"Sprint"	Title OR Abstract
#9	"COD"	Title OR Abstract
#10	"change of direction"	Title OR Abstract
#11	#8 OR #9 OR #10	
#12	"football player"	Title OR Abstract
#13	"soccer player"	Title OR Abstract
#14	"soccer athlete"	Title OR Abstract
#15	"football athlete"	Title OR Abstract
#15	#12 OR #13 OR #14 OR #15	
#16	#7 AND #11 AND #16	

Study selection

Duplicate entries were eliminated using EndNote X9. Titles and abstracts were independently screened by two reviewers (F.L. and L.L.) to identify studies meeting preliminary inclusion criteria, followed by full□text assessment of selected articles by the same reviewers. Discrepancies were resolved by consensus or, when necessary, by consultation with the third expert. Inclusion criteria comprised: (1) controlled trials featuring at least one intervention arm employing SAQ, HIIT, or SSG training (single□arm designs were excluded); (2) participation of healthy soccer players engaged in routine training; (3) reporting of at least one relevant outcome measure (sprint performance or COD ability); and (4) publication in English. Exclusion criteria comprised inaccessible full texts, review articles, conference abstracts, duplicate publications, animal studies, and dissertations; investigations of acute exercise effects; and studies with incomplete outcome data when author contact failed to secure missing information. When multiple publications from the same trial reported overlapping outcomes, only the most recently published article was retained.

Data extraction

Data extraction was independently performed by two reviewers (F.L. and L.L.) using a customized data extraction form based on the Cochrane Handbook (Higgins & Green, 2008). The form included the following items: (1) study characteristics (first author, year of publication, and study design); (2) participant characteristics (sample size, mean age, sex, and athletic level); (3) intervention details (type, frequency, and duration); and (4) outcome measures. When relevant statistical data were not fully reported, the means and standard deviations were estimated based on sample size, median, range, and p-values, in accordance with the Cochrane Handbook (Higgins & Green, 2008).

Study quality

The risk of bias and methodological quality were assessed using the TESTEX scale (Smart, et al., 2015), a 15-point (12-item) tool specifically developed for evaluating exercise training trials. Two independent reviewers (F.L. and L.L.) evaluated all the selected studies, with any discrepancies resolved through discussion and consensus.

Data synthesis and analysis

Pairwise meta-analyses were performed separately for SAQ, HIIT, and SSG versus control conditions. Postintervention outcomes were synthesized in Review Manager 5.4 using standardized mean differences (SMDs) with 95 % confidence intervals. SMDs were interpreted according to Cohen's criteria, with values of 0.2, 0.5, and 0.8 representing small, moderate, and large effects, respectively (Cohen, 1988). Between-study heterogeneity was evaluated via Cochran's Q test and the I^2 statistic. Following Cochrane guidelines (Higgins & Green, 2008), if I^2 was less than or equal to 40%, heterogeneity was considered acceptable and a fixed-effects model was applied; otherwise, a random-effects model was used. Publication bias was evaluated both qualitatively and quantitatively using funnel plots and Egger's test. A p-value of <.1 was considered indicative of significant publication bias (Eng, Kramer, Zinman, & Retnakaran, 2014). For all other statistical tests, a p-value of <.05 was considered statistically significant.

Subsequently, NMA was undertaken within a frequentist framework using Stata 18.0 (Shim, Yoon, Shin, & Bae, 2017), integrating direct comparisons from head-to-head trials with indirect evidence via a common comparator. A network diagram was generated wherein nodes represent interventions and connecting edges denote one or more randomized controlled trials comparing the linked modalities (Bhatnagar, Lakshmi, & Jeyashree, 2014). Node size was proportional to the number of participants allocated to each intervention, and edge thickness reflected the number of studies informing each direct comparison. To accommodate clinical and methodological heterogeneity, a random-effects model was adopted, yielding more conservative confidence intervals (Shim, et al., 2017). Post-intervention endpoint data were synthesized to derive SMDs with 95 % confidence intervals for continuous outcomes (Panagiotou, 2015), with SMD magnitudes classified as small (SMD < 0.40), moderate (SMD = 0.40–0.70), or large (SMD > 0.70) according to Cochrane recommendations (Higgins & Green, 2008). To rank the effectiveness of exercise interventions, surface under the cumulative ranking curve (SUCRA) values and mean ranks were used. SUCRA provides an estimate of the cumulative probability that treatment ranks among the top *i* best treatments. For each treatment *j* out of n competing interventions, SUCRA was calculated as: $SUCRA_j = (\sum_{i=1}^{n-1} cum_{j,i}) / (n-1)$ (Salanti, Ades, & Ioannidis, 2011). A SUCRA value of 100% indicates that the intervention is certainly the most effective, whereas a value of 0% indicates it is certainly the least effective (Salanti, et al., 2011). Higher SUCRA values reflect better relative performance of the intervention within the network. To assess inconsistency in the network, both global and local approaches were employed. Global inconsistency was tested using the design-by-treatment interaction model, while local inconsistency was assessed using the loop-specific approach (Shim, Kim, Lee, & Rücker, 2019).

Results

Description of the included studies

Following duplicate removal, 424 unique records were retrieved. Title and abstract screening identified 69 articles for full-text evaluation. Application of the predefined eligibility criteria yielded 23 studies (2004-2024) comprising 914 participants. Of these, seven trials assessed SAQ training, twelve evaluated HIIT, and thirteen examined SSG interventions; twenty-two studies featured two-arm comparisons, while seven employed three-arm designs. Detailed study characteristics are provided in Supplementary Table 2, and the PRISMA flow of study selection is depicted in Fig. 1.

Risk of bias

As revealed in the TESTEX-based assessment in Table 3, the included trials demonstrated overall moderate methodological quality, with most studies scoring between 7-9 points. Despite adequate reporting on participant eligibility and group similarity at baseline, consistent deficiencies were noted in randomization reporting, allocation concealment, and blinding of assessors. Additionally, the lack of intention-to-treat analysis and control group activity monitoring were widespread limitations. Notably,

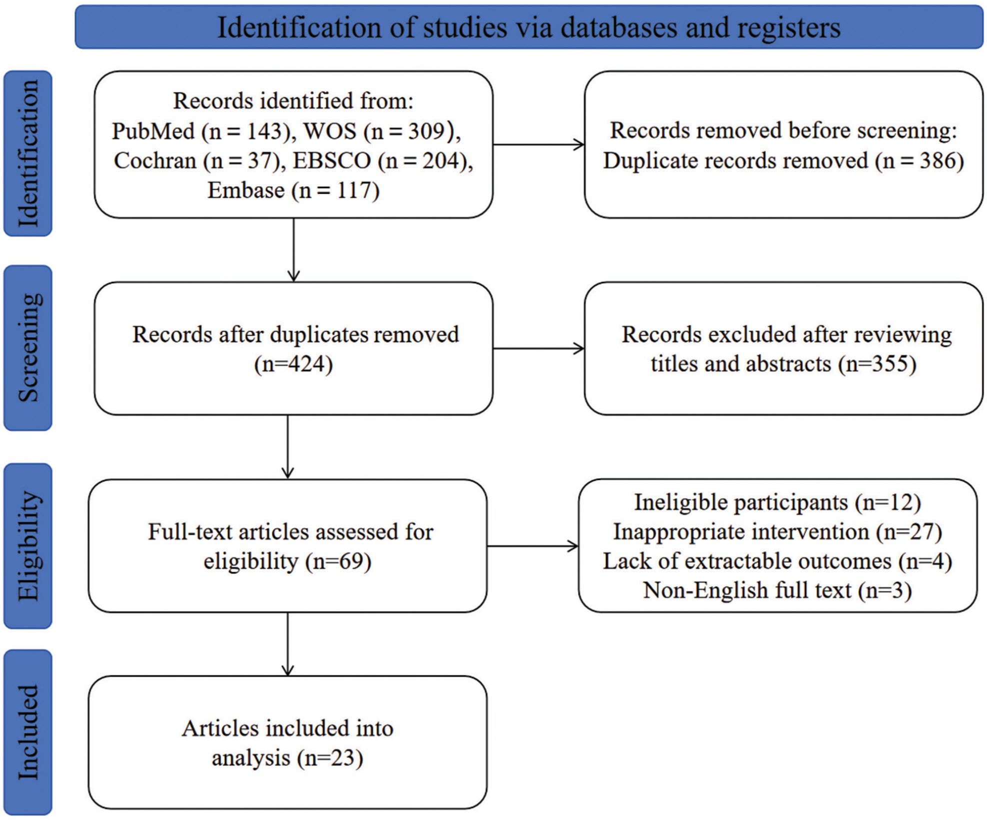


Fig. 1. Flow chart of literature search and study selection.

Table 2. Basic characteristics of the included studies

Author and year	Number	Age	Subject	Intervention	Outcome	Period	Frequency	Training years
Jovanovic, et al., 2011	100	SAQ:19; CT:19	Youth league men's soccer player	SAQ; CT	SP	8 weeks	3 times/week	> 7 years
Lee, et al., 2024	19	18.89±0.8	U-20 women's footballer	SAQ; CT	SP; COD	8 weeks	3 times/week	> 5 years
Milanović, et al., 2013	132	About 19	U-19 men's soccer player	SAQ; CT	COD	12 weeks	4 times/week	> 8 years
Milanovic, et al., 2014	132	18.5±0.4	U-19 men's soccer player	SAQ; CT	SP	12 weeks	4 times/week	> 8 years
Polman, et al., 2004	36	21.2±3.1	Elite women's footballer	SAQ; CT	SP; COD	12 weeks	NR	NR
Trecroci, et al., 2016>	35	SAQ:10.5±0.3; CT:10.7±0.21	Sub-elite junior men's soccer player	SAQ; CT	SP; COD	12 weeks	2 times/week	3.41 ± 0.55
Trecroci, et al., 2022	21	SAQ:9.7±0.4; CT:9.5±0.6	Junior male soccer player	SAQ; SSG	SP; COD	3 weeks	3 times/week	NR
Boraczyński, et al., 2023	25	HIIT:25.6±3.98; SSG:25.6±3.98	National first division team male professional footballer	HIIT; SSG	SP	6 weeks	15 times in total	HIIT:15.4±1.46; SSG:17.3±2.38
Dello Iacono, et al., 2021	20	SSG:18.7±0.6; CT:18.5±0.6	U-19 men's soccer player	SSG; CT	SP; COD	8 weeks	2 times/week	> 6 years
He, et al., 2024	52	W:18.2±0.8;M:18.7±0.9	Under-19 football players at the regional level	HIIT; SSG	SP; COD	8 weeks	2 times/week	M:4.1±0.8; W:5.2±0.7
Wen, et al., 2024	48	SSG:17.2±1.2; HIIT:17.1±0.8; CT:17.0±1.1	Young women's footballer	HIIT; SSG; CT	COD	8 weeks	2 times/week	> 2 years
Chaouachi et al., 2014	24	14.2±0.9	National first division team male professional footballer	SSG; CT	SP; COD	6 weeks	3 times/week	NR
Clemente, et al., 2022	40	HIIT:16.6±0.5; SSG:16.3±0.5	Regional league young men's soccer player	HIIT; SSG	SP; COD	4 weeks	3 times/week	HIIT:4.7 ± 0.4; SSG:4.5 ± 0.6
Hill-Haas, et al., 2009	19	14.6±0.9	College football player	SSG; CT	SP	7 weeks	2 times/week	NR
Young & Rogers, 2014	25	SSG: 17.5±0.8; CT:17.3±0.5	U-18 men's footballer	SSG; CT	COD	7 weeks	2 times/week	NR
Arslan, et al. 2020	20	HIIT:14.1±0.6; SSG:14.4±0.5	Young male footballer	HIIT; SSG	SP; COD	5 weeks	2 times/week	> 3 years
Gökkurt, et al., 2021	22	HIIT:18.36±0.51; CT:17.55±0.69	U-18 men's footballer	HIIT; CT	SP; COD	8 weeks	3 times/week	NR
Nayıroğlu, et al., 2022	24	HIIT:18.8 ± 2.7; SSG:18.5 ± 2.1	Young women's soccer player	HIIT; SSG	SP; COD	8 weeks	3 times/week	NR
Liu, et al., 2024	29	HIIT:17.5±0.5; SSG:17.6±0.6	Junior male soccer player	HIIT; SSG	SP	3 weeks	5-6 times in total	4.7±0.7
Sperlich, et al., 2011	17	13.5±0.4	Premier league youth footballer	HIIT; CT	SP	5 weeks	3-4 times/week	> 3 years
G. Yang, et al., 2024	20	HIIT:22.4±1.6; CT:22.2±1.9	Male college soccer player	HIIT; CT	SP; COD	6 weeks	3 times/week	HIIT:7.6±2.1; CT:6.4±3.2
Ouertatani, et al., 2022	24	HIIT:16.8±0.5; SSG:16.6±0.6	Elite junior male soccer player	HIIT; SSG	COD	6 weeks	2 times/week	NR
Wang & Zhang, 2023	30	HIIT:19.76±0.4; CT:19.72±0.6	Male college soccer player	HIIT; CT	SP	6 weeks	4 times/week	NR

Note. SP: sprint; COD: change of direction; SAQ: speed, agility and quickness; HIIT: high-intensity interval training; SSG: small-sided games; CT: contrast training; NR: not reported.

studies attaining higher scores more consistently reported exercise intensity and energy expenditure measures as well as statistical comparisons between groups, elements considered essential for rigorous evaluation of exercise interventions.

Pairwise analyses

Sprint

Pairwise meta-analysis indicated distinct effects of the exercise modalities on sprint performance (Fig. 2). SAQ training produced a pronounced enhancement in sprint outcomes (SMD = –1.23, 95% CI: –1.85 to –0.60, p<.001), whereas HIIT and SSG failed to reach statistical significance (HIIT: SMD = 0.07, 95% CI: –0.49 to 0.64, p=.22; SSG: SMD = 0.27, 95% CI: –0.04 to 0.57, p=.09), although SSG exhibited a modest favorable trend. Considerable heterogeneity was observed among the SAQ and HIIT subgroups (I^2 = 93% and 76%, respectively), implying notable methodological or clinical variation across the included trials. Owing to the small number of trials within each intervention category (n < 10), formal evaluation of publication bias was not feasible; nonetheless, the possibility of reporting bias merits careful attention in subsequent investigations.

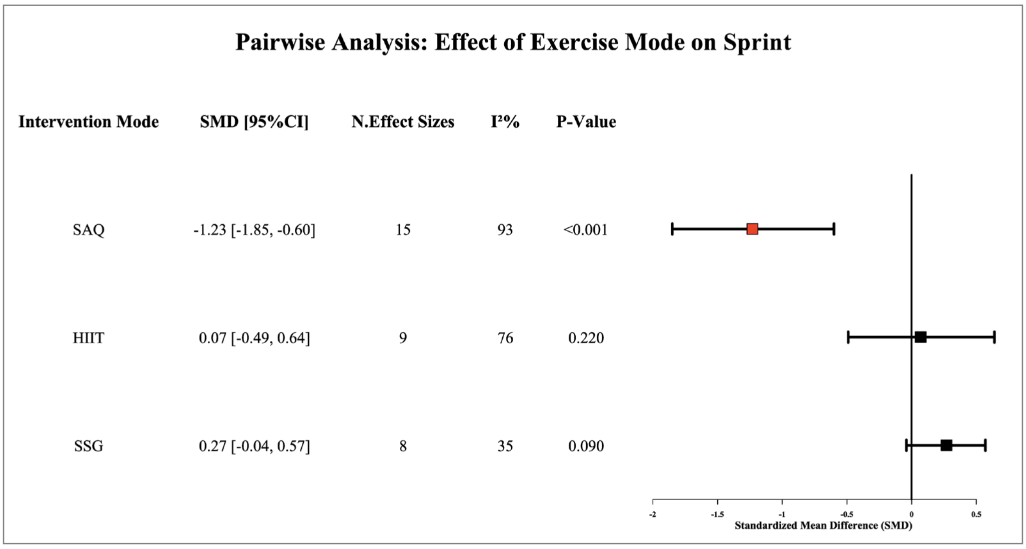
COD

Pairwise meta-analysis results (Fig. 3) indicated that the effects of the three exercise intervention modalities on COD performance varied. SAQ significantly improved COD performance (SMD = –1.09, 95% CI: –1.69 to –0.48, p<.001), with a highly significant effect size. In contrast, HIIT and SSG did not yield statistically significant effects (HIIT: SMD = –2.34, 95% CI: –5.00 to 0.53, p=.22; SSG: SMD = –1.18, 95% CI: –3.00 to 0.29, p=.23). Substantial heterogeneity was detected across all intervention comparisons (SAQ: I^2 = 78%; HIIT: I^2 = 90%; SSG: I^2 = 78%), indicating methodological variation or participants' diversity among the included trials. Formal assessment of publication bias was not possible due to the limited number of studies per intervention (n < 10), but the potential for reporting bias should be acknowledged in interpreting these results.

Table 3. Risk of bias TESTEX scoring

Study name	1	2	3	4	5	6	7	8	9	10	11	12	Overall
Jovanovic, et al., 2011	YES	NO	NO	YES	NO	YES(2)	NO	YES(2)	NO	NO	YES	YES	8
Lee, et al., 2024	YES	NO	NO	YES	NO	YES(2)	NO	YES(2)	YES	NO	YES	YES	9
Milanović, et al., 2013	YES	NO	NO	YES	NO	YES(2)	NO	YES(2)	NO	NO	YES	YES	8
Milanovic, et al., 2014	YES	NO	NO	YES	NO	YES(2)	NO	YES(2)	YES	NO	YES	YES	9
Polman, et al., 2004	YES	NO	NO	YES	NO	YES(2)	NO	YES(2)	NO	NO	YES	NO	8
Trecroci, et al., 2016>	YES	NO	NO	YES	NO	YES(2)	NO	YES(2)	YES	NO	NO	YES	8
Trecroci, et al., 2022	YES	NO	NO	YES	NO	YES(2)	NO	YES(2)	YES	NO	NO	YES	8
Boraczyński, et al., 2023	YES	NO	NO	YES	NO	YES(2)	NO	YES(2)	YES	NO	YES	YES	9
Dello Iacono, et al., 2021	YES	NO	NO	YES	NO	YES(2)	NO	YES(2)	YES	NO	YES	YES	9
He, et al., 2024	YES	NO	NO	YES	NO	YES(2)	NO	YES(2)	YES	NO	YES	YES	9
Wen, et al., 2024	YES	NO	NO	YES	NO	YES(2)	NO	YES(2)	YES	NO	YES	YES	9
Chaouachi, et al., 2014	YES	NO	NO	YES	NO	YES(2)	NO	YES(2)	NO	NO	NO	YES	7
Clemente, et al., 2022	YES	NO	NO	YES	NO	YES(2)	NO	YES(2)	YES	NO	YES	YES	9
Hill-Haas, et al., 2009	YES	NO	NO	YES	NO	YES(2)	NO	YES(2)	YES	NO	YES	YES	9
Young & Rogers, 2014	YES	NO	NO	YES	NO	YES(2)	NO	YES(2)	YES	NO	NO	YES	8
Arslan, et al., 2020	YES	NO	NO	YES	NO	YES(2)	NO	YES(2)	YES	NO	YES	YES	9
Gökkurt, et al., 2021	YES	NO	NO	YES	NO	YES(2)	NO	YES(2)	NO	NO	NO	YES	7
Nayıroğlu, et al., 2022	YES	NO	NO	YES	NO	YES(2)	NO	YES(2)	YES	NO	YES	YES	9
Liu, et al., 2024	YES	NO	NO	YES	NO	YES(2)	NO	YES(2)	YES	NO	YES	YES	9
Sperlich, et al., 2011	YES	NO	NO	YES	NO	YES(2)	NO	YES(2)	YES	NO	YES	YES	9
G. Yang, et al., 2024	YES	NO	NO	YES	NO	YES(2)	NO	YES(2)	YES	NO	NO	YES	8
Ouertatani, et al., 2022	YES	NO	NO	YES	NO	YES(2)	NO	YES(2)	YES	NO	NO	YES	8
Wang & Zhang, 2023	YES	NO	NO	YES	NO	YES(2)	NO	YES(2)	NO	NO	NO	YES	7

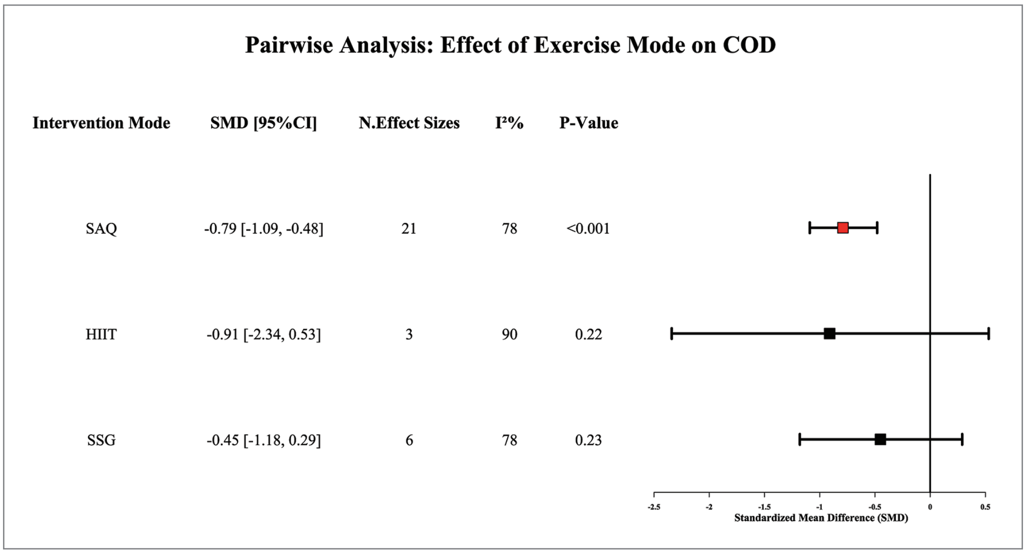
Note. 1: Eligibility criteria specified; 2: Randomization specified; 3: Allocation concealment; 4: Groups similar at baseline; 5: Assessors blinded; 6: Outcome measures assessed >85% of participants completed final assessment; 7: Intention to treat analysis; 8: Between-group statistical comparisons reported; 9: Point estimates reported; 10: Activity monitoring in control group; 11:Relative exercise intensity review; 12: Exercise volume & energy expended.



Pairwise Analysis: Effect of Exercise Mode on Sprint

Intervention Mode	SMD [95%CI]	N.Effect Sizes	I²%	P-Value
SAQ	-1.23 [-1.85, -0.60]	15	93	<0.001
HIIT	0.07 [-0.49, 0.64]	9	76	0.220
SSG	0.27 [-0.04, 0.57]	8	35	0.090

Fig. 2. Forest plot on sprint performance.



Pairwise Analysis: Effect of Exercise Mode on COD

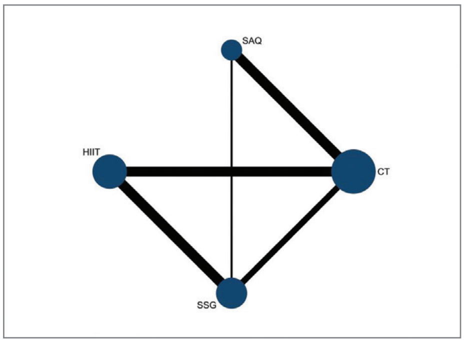
Intervention Mode	SMD [95%CI]	N.Effect Sizes	I²%	P-Value
SAQ	-0.79 [-1.09, -0.48]	21	78	<0.001
HIIT	-0.91 [-2.34, 0.53]	3	90	0.22
SSG	-0.45 [-1.18, 0.29]	6	78	0.23

Fig. 3. Forest plot on COD performance.

Network meta-analyses

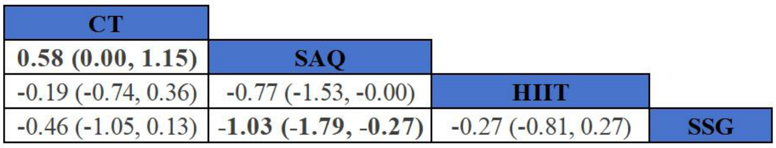
Sprint

Eighteen studies, including 666 participants, were analyzed for sprint performance. Of these, six studies evaluated SAQ training, ten assessed HIIT and nine focused on SSG interventions. The global inconsistency test from the network meta-analysis showed no significant inconsistency within the evidence network (χ^2=1.97, p=.373). The network diagram for sprint performance (Fig. 4) illustrates all possible pairings among the included trials; notably, no trial directly compared SAQ with HIIT for this outcome. Network meta-analysis (Fig. 5) revealed that SAQ was significantly more effective than both CT (SMD = –0.58, 95% CI: –1.15 to –0.00) and SSG (SMD = –1.03, 95% CI: –1.79 to –0.27) in enhancing sprint speed. A full summary of comparative effects is shown in Fig. 5. These findings identify SAQ as the most consistently effective inter-



Note. Each node represents an intervention, and the connecting lines between two nodes represent one or more randomized clinical trials (RCTs) in which the two interventions have been compared directly. The size of each node is proportional to the number of randomly assigned participants, and the thickness of the lines connecting two nodes is weighted according to the number of RCTs that directly compared the interventions they connected.

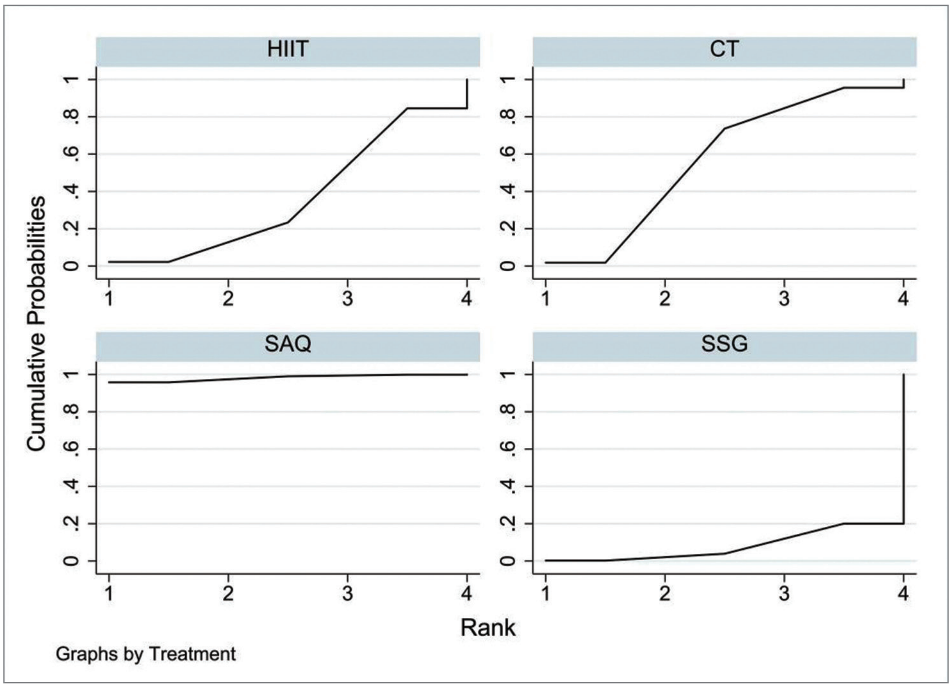
Fig. 4. Network plot of comparative evidence for sprint performance.



CT			
0.58 (0.00, 1.15)	**SAQ**		
-0.19 (-0.74, 0.36)	-0.77 (-1.53, -0.00)	**HIIT**	
-0.46 (-1.05, 0.13)	**-1.03 (-1.79, -0.27)**	-0.27 (-0.81, 0.27)	**SSG**

Note. For any cell, a negative SMD favors the upper-left intervention; a positive SMD favors the lower-right intervention. Significant results are in bold text. 95%CI = 95% confidence interval.

Fig. 5. Comparative effectiveness results for sprint performance.



Note. The horizontal axis represents the possible rank of each treatment (from best to worst according to the outcome). The vertical axis represents the cumulative probability for each treatment to be the best option.

Fig. 6. Cumulative ranking probability plots for sprint performance.

Table 4. The sprint performance rankings for different types of exercise

Exercise	SUCRA (%)	PrBest	Mean Rank
SAQ	98.2	95.8	1.1
HIIT	36.7	2.2	2.9
SSG	8.1	0.2	3.8
CT	57.0	1.8	2.3

vention. Based on the cumulative ranking curve and SUCRA values (Fig. 6 and Table 3), SAQ had the highest probability of being the most effective method for improving sprint performance, with a SUCRA of 98.2%. CT ranked second (SUCRA = 57.0%), followed by HIIT (SUCRA = 36.7%), while SSG had the lowest probability of enhancing sprint speed, with a SUCRA of 8.1%

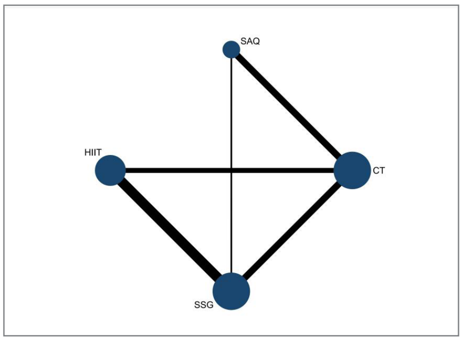
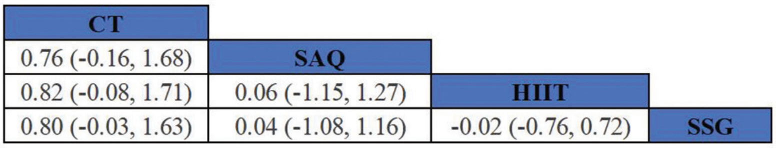


Fig. 7. Network plot of comparative evidence for COD performance.

COD

Sixteen studies, involving 543 participants, were included for the analysis of COD performance. Of these, five studies evaluated SAQ training, eight examined HIIT and nine assessed SSG interventions. The global inconsistency test from the network meta-analysis revealed no evidence of inconsistency within the evidence network ($\chi^2 = 0.61$, p=.961). The network geometry for COD performance (Fig. 7) displays all available pairwise comparisons among the included trials; notably, there were no direct comparisons between SAQ and HIIT. Network meta-analysis results (Fig. 8) showed that none of the interventions (CT, SAQ, HIIT, and RT) differed significantly from one another as all



CT			
0.76 (-0.16, 1.68)	**SAQ**		
0.82 (-0.08, 1.71)	0.06 (-1.15, 1.27)	**HIIT**	
0.80 (-0.03, 1.63)	0.04 (-1.08, 1.16)	-0.02 (-0.76, 0.72)	**SSG**

Fig. 8. Comparative effectiveness results for COD performance.

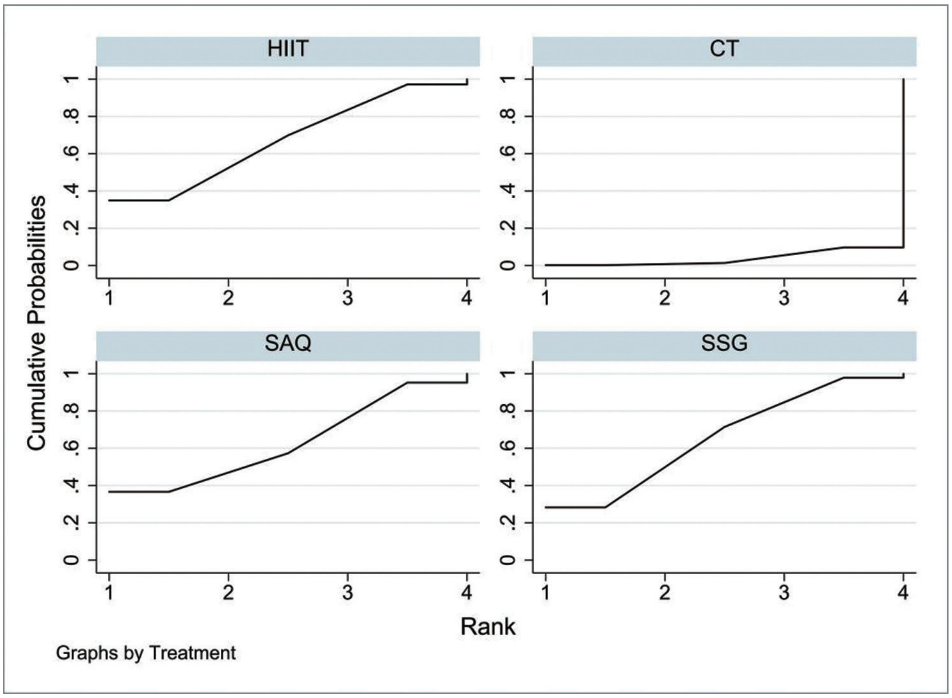


Fig. 9. Cumulative ranking probability plots for COD performance.

Table 5. The COD performance rankings for different types of exercise

Exercise	SUCRA (%)	PrBest	Mean Rank
SAQ	63.1	36.6	2.1
HIIT	67.3	34.9	2.0
SSG	65.9	28.3	2.0
CT	3.7	0.2	3.9

95 % confidence intervals crossed zero. According to the cumulative ranking curve and SUCRA values (Fig. 9 and Table 5), HIIT had the highest probability of being the most effective intervention for improving COD performance (SUCRA = 67.3%), followed closely by SSG (SUCRA = 65.9%) and then SAQ (SUCRA = 63.1%). CT had the lowest probability of effectiveness with a SUCRA value of 3.7%

Discussion and conclusion

The results indicate that SAQ training consistently enhanced sprint performance, as demonstrated by both pairwise and network meta-analyses. In contrast, for COD performance, SAQ yielded significant gains in direct comparisons with control conditions but did not maintain its advantage within the network meta-analysis. This discrepancy may stem from the limited number of head-to-head trials comparing SAQ with HIIT or SSG, the variability in observed effect sizes, and the reliance on indirect evidence within the network structure. Accordingly, the rankings for COD outcomes should be interpreted with caution, acknowledging potential constraints in network geometry and data heterogeneity.

Sprint performance

The PMA results of the present study demonstrated that SAQ training significantly improved sprint performance in soccer players, and the NMA further confirmed its relative superiority among various training interventions. Although previous meta-analyses have preliminarily supported the positive effects of SAQ training on sprint performance in soccer and other team sports athletes (Sun, et al., 2025, 2025; Uysal, et al., 2025), the present study provides several methodological advancements and refinements. Notably, several prior meta-analyses (Sun, et al., 2025, 2025) included intervention protocols that did not fully align with the standard definition of SAQ training, with certain studies lacking clear descriptions of training content and structure, potentially limiting the interpretability and generalizability of their findings. First, a network meta-analysis framework was applied that incorporates both direct and indirect comparisons, enabling a systematic and comprehensive evaluation of the relative efficacy of each training modality compared with traditional pairwise approaches. Second, the methodological quality of the included trials was rigorously appraised using the TESTEX scale; generally, high scores enhanced the stability and credibility of the results. Third, outcome measures were restricted to time-based metrics directly reflecting short-distance sprint performance, thereby avoiding potential confounding from repeated sprint or mixed task assessments and improving the specificity and interpretability of the findings. Given that NMA requires a single primary outcome per study, the 30-meter sprint test (or its closest equivalent) was prioritized as the representative metric, based on its well-established reliability and validity in assessing sprint ability in soccer players (Castagna, et al., 2018). Further, while existing research has reported significant effects of SAQ training, the underlying mechanisms contributing to its superiority remain insufficiently explored. Therefore, the present study also offers a preliminary discussion of potential mechanisms, such as neuromuscular adaptation, stretch-shortening cycle (SSC) activation, and energy system characteristics that may explain the observed improvements in sprint performance following SAQ interventions.

The present meta-analytic results suggest that the pronounced efficacy of SAQ training may be attributable to its strong conformity with soccer-specific movement demands, thereby facilitating a high degree of training transfer. In the field of training science, training transfer denotes the extent to which adaptations induced by training translate into enhanced sport performance (Bosch, Klomp, & Boer-Stallman, 2004; Zatsiorsky, 1995). Effective transfer is generally achieved when the following three conditions are met: (1) equivalent internal movement structures, such as similar muscle contraction types or joint ranges of motion that reflect the biomechanical characteristics of sport-specific actions; (2) equivalent external movement structures, meaning movement duration or patterns that closely resemble those required during actual performance; and (3) equivalent energy production mechanisms, with similar metabolic pathways engaged during both training and sport-specific activities (Lemberg, 2012). SAQ training exhibits strong neuromuscular specificity similar to the demands of soccer (Issurin, 2013), enabling athletes to reproduce similar muscle activation patterns and joint kinematics during training as those used in match play, thereby supporting effective internal structural transfer. Additionally, SAQ training elicits substantial neuromuscular adaptations by focusing on drills that involve rapid multidirectional and explosive movements. Typical components encompass ladder footwork drills designed to enhance step frequency alongside multiplanar sprint tasks that integrate phases of acceleration and directional change (e.g., 5-10-5 shuttle runs, reactive COD sprints). These exercises reproduce critical technical aspects of sprinting, such as anterior trunk lean during acceleration, core stability, and coordinated arm swing, thereby promoting efficient recruitment of high-threshold motor units and augmenting neural drive. Additionally, SAQ routines frequently include high-intensity short-duration linear sprint repetitions and plyometric movements that critically engage the stretch-shortening cycle. Such activities preferentially activate fast-twitch motor units and elevate the rate of force development (RFD), thus improving athletes' capacity for rapid movement initiation and acceleration (Rawson, Brightbill, & Stec, 2013; Turner & Jeffreys, 2010). Notably, the energy demands of SAQ training are closely aligned with those of sprinting, relying primarily on the ATP–CP energy system, which reflects a high degree of congruence between the external movement structure and the internal metabolic requirements of the sport.

In contrast, although several studies have reported that HIIT can improve sprint performance (Cao, Li, Wang, Geok, & Liu, 2025; Stankovic, et al., 2023), and it has recognized advantages in enhancing both aerobic and anaerobic metabolic capacities (Cavar, et al., 2019), such improvements are more commonly observed in longer-distance sprints or repeated sprint ability (RSA) tests. Its effectiveness in improving short-distance sprint performance, however, may remain limited (Zhang, et al., 2023). The present findings are consistent with those of Kunz, Engel, Holmberg, and Sperlich (2019), who observed that substantial differences in movement structure and energy system demands between HIIT and short sprints limited HIIT's effectiveness for improving maximal short distance acceleration. Although some HIIT programmes include brief sprint efforts, the majority consist of longer high-intensity runs or circuit-based protocols. These protocols typically feature sustained or variably paced runs at moderate intensities designed to enhance lactate threshold and maximal oxygen uptake and to strengthen both aerobic and anaerobic metabolism (Kunz, et al., 2019; Milioni, et al., 2024). However, such regimens do not specifically target the technical elements crucial for short distance acceleration, including explosive extension of the hip, knee and ankle joints at movement initiation, rapid transitions between swing and stance phases, and high step frequency adjustments. The internal movement structure of HIIT, especially in neuromuscular recruitment patterns and muscle contraction types (e.g., explosive SSC actions), differs markedly from sprinting and therefore fails to induce sprint-specific neuromuscular adaptations. Further, HIIT sessions generally involve medium to long duration high intensity efforts lasting from 20 to 75 seconds with an emphasis on cardiovascular endurance and fatigue resistance under intermittent loading. This temporal structure and load profile do not align with the performance demands of sprinting, which require maximal force output over very short durations (usually <10 seconds). In most HIIT protocols, intervals are designed around efforts at 90-95% of peak heart rate sustained for up to four minutes, rarely incorporating maximal sprint bouts at or near 100% intensity lasting only a few seconds (Lockie, Murphy, Schultz, Knight, & Janse de Jonge, 2012). Yet, existing research suggests that short intervals (<15 seconds) of high-intensity effort may be more beneficial for improving short sprint performance (Faude, Schnittker, Schulte-Zurhausen, Müller, & Meyer, 2013; Faude, Steffen, Kellmann, & Meyer, 2014). Additionally, HIIT primarily relies on a combination of glycolytic and oxidative energy systems (Buchheit & Laursen, 2013), whereas short distance sprinting depends almost entirely on the adenosine triphosphate creatine phosphate system (McArdle, Katch, & Katch, 2015). This multifaceted mismatch in exercise duration, movement mechanics, and metabolic requirements undermines the functional equivalence of HIIT to sprint tasks. As a result, the transfer of adaptations from HIIT to sprint performance is attenuated, reducing its efficacy for enhancing short distance sprint ability (Gastin, 2001).

Small-sided games serve as an integrated approach that combines technical, tactical and physical conditioning, offering particular benefits for performance in match-like scenarios (Clemente, et al., 2021c; Lemes, et al., 2020). These interventions emphasize in-game decision making, competitive intensity, and tactical coordination, and their external movement patterns closely mirror the demands of actual competition, providing strong ecological validity and promising transfer to real-world match performance. However, evidence indicates that small-sided games have limited impact on maximal sprint speed and explosive acceleration (Kunz, et al., 2019). The present findings align with those of Kunz et al. (2019) and Clemente et al. (2021c), who noted that the structural characteristics of SSG did not fulfil the training requirements for speed development, namely, repetition, standardization, and maximal intensity stimulation, thus restricting its efficacy in enhancing short-distance sprint performance. First, due to the random distribution of training load and frequent directional changes during SSG, athletes have limited opportunities to engage in continuous, linear, maximal-speed sprints, resulting in insufficient sprint-specific stimulus (Casamichana & Castellano, 2010). Second, the absence of standardized and repeatable movement patterns during play, with constant variation in direction, pace and objectives, prevents consistent neuromuscular reinforcement of stable acceleration-sprint sequences. This dynamic structure limits targeted activation and development of key sprint-relevant muscle groups, such as the hip extensors, quadriceps and gastrocnemius, along critical biomechanical parameters including step frequency, stride length and RFD (Rampinini, et al., 2007). Although the energy demands of SSG are complex and engage multiple metabolic pathways, it provides less specific stimulation to the ATP–CP system compared to dedicated sprint training. As a result, its effectiveness in improving short-duration, high-intensity sprint capacity remains limited.

COD performance

The present findings reveal that, although the network meta-analysis ranked SAQ below HIIT and SSG for change of direction performance, this outcome warrants cautious interpretation given methodological and structural limitations. First, network meta-analysis integrates direct and indirect comparisons but relies heavily on the integrity of the network structure and the distribution of comparison pathways. In this dataset, few head-to-head trials compared SAQ with HIIT or SSG, meaning that SAQ's estimated effects were derived primarily from indirect evidence. Such reliance increases susceptibility to interference from other intervention nodes, which may attenuate SAQ's apparent efficacy. Second, the tools used to assess change of direction, such as the 505 Test, T Test and Illinois Agility Test, differ substantially in movement angles, response components and task complexity. Considerable heterogeneity in intervention design and implementation across studies further contributed to wider confidence intervals around effect estimates, reducing the stability of SAQ's ranking within the network framework. To minimize measurement bias, agility tests featuring multidirectional movement patterns were prioritized when selecting outcomes, and unilateral or overly simplified assessments were excluded to preserve specificity. Although SAQ did not emerge as the top-ranked method in the network meta-analysis, pairwise meta-analysis demonstrated a statistically significant improvement in change of direction performance following SAQ training ($SMD = -0.79$, $p<.001$), supporting its efficacy based on direct comparisons. Given the neuromuscular activation demands, stretch-shortening cycle loading characteristics and structured drills targeting multidirectional acceleration and deceleration inherent to SAQ protocols, SAQ remains one of the most effective approaches for enhancing change of direction ability. Accordingly, network-based rankings may not fully capture SAQ's theoretical advantages and should be viewed in light of network geometry and study-level heterogeneity.

From the perspective of training science and exercise physiology, improvements in COD performance are underpinned by three key mechanisms: (1) efficient eccentric-concentric transition capacity, which facilitates optimized force production during deceleration and reacceleration phases (Dos'Santos, Thomas, Comfort, & Jones, 2018; Hewit, Cronin, & Hume, 2013); (2) precise neuromuscular control, enabling effective activation and coordination of motor units during multidirectional initiations (Aagaard, Simonsen, Andersen, Magnusson, & Dyhre-Poulsen, 2002; Dos'Santos, et al., 2018; Sheppard & Young, 2006); and (3) rapid energy system responsiveness, particularly the critical role of the ATP–CP system in fueling short-duration, high-intensity directional changes (Sheppard & Young, 2006). SAQ training aligns closely with the three mechanisms of training transfer and is distinguished by its integrative structure, effective transfer to sport performance and marked improvements in rate of force development. Typical protocols include short-duration high-intensity multidirectional change of direction tasks and plyometric drills featuring explosive stops, starts and angular transitions (Craig & Journal, 2004; J. M. Miller, Hilbert, & Brown, 2001; Parsons & Jones, 1998; Yap & Brown, 2000; Young, et al., 2001). These exercises continuously refine lower limb eccentric-concentric contraction efficiency and the ability to switch movement direction. For example, change of direction drills at predetermined angles (e.g., 45°, 90°) enhance the timing of joint torque production, while closed chain plyometric movements (e.g., lateral box jumps followed by COD sprints) improve stretch-shortening cycle efficiency and increase tendon stiffness, resulting in faster force generation. High frequency, short interval protocols (e.g., 3-5 s of maximal effort with 20-30 s rest) specifically activate the adenosine triphosphate creatine phosphate energy system, fostering sport-specific metabolic adaptation. Moreover, SAQ training evokes neuromuscular adaptations and promotes recruitment of high-threshold motor units, thereby enhancing coordination and control during complex movement execution (Aagaard, et al., 2002). It also positively influences neuromuscular excitation-inhibition transition speed, lower-limb eccentric strength, and the development of stable movement patterns. Accelerated neural regulation, improved eccentric control, and repeated movement pattern reinforcement collectively suppress redundant muscle activation, enhance braking-reacceleration efficiency, and establish more economical neuromuscular pathways, ultimately improving movement accuracy and translating more effectively to game performance (M. G. Miller, Herniman, Ricard, Cheatham, & Michael, 2006; Sheppard & Young, 2006). Notably, improvement in COD ability depends not only on physiological adaptations but also on perceptual-cognitive factors (Hallemans, Verbeque, & Van de Walle, 2020). SAQ protocols frequently include reactive tasks triggered by visual or auditory cues, which compel players to rapidly interpret incoming information and execute decisions under conditions of uncertainty (Joyce, Lewindon, & Verstegen, 2013). Such exercises enhance situational awareness and anticipation skills, diminish decision response times and refine movement accuracy in the dynamic context of competition.

In contrast, while HIIT and SSG offer certain advantages in enhancing metabolic capacity and tactical adaptation, respectively, they exhibit notable limitations in addressing the core mechanisms underlying improvements in COD performance. HIIT typically involves repeated runs of moderate to long duration (e.g., ≥30 seconds), aiming to increase lactate tolerance and aerobic recovery capacity, or to improve re-acceleration under fatigue via repeated sprint training (Buchheit & Laursen, 2013). Nevertheless, these protocols primarily emphasize high load aerobic and anaerobic metabolic cycling while providing minimal specific stimulus for rapid directional changes or refined neuromuscular control. Consequently, they do not effectively enhance the eccentric to concentric transition ability that is critical for COD tasks. Buchheit and Laursen (2013) observed that the loading structure and objectives of HIIT differ markedly from the neuromechanical requirements of change of direction, making it less effective at eliciting the explosive neuromuscular adaptations needed for rapid directional changes. Moreover, HIIT relies predominantly on the glycolytic energy system and is less effective at activating the ATP–CP system, which is essential for rapid initiation and directional transitions. SSG, on the other hand, centers on small-area, opponent-based play that emphasizes tactical coordination and in-game decision-making. It offers high ecological validity and has been shown to enhance perceptual-cognitive capabilities (Clemente, et al., 2021c; Davids, Araújo, Correia, & Vilar, 2013). Nonetheless, their primary benefit appears to lie in accelerating decision-making rather than improving the mechanical execution of movement. Previous investigations have reported that small-sided games enhance COD performance chiefly by refining decision-making processes rather than by increasing actual movement velocity (Young & Rogers, 2014). A. Hammami et al. (2018) suggested that SSG could enhance overall agility in game-like scenarios but also acknowledged that it provided insufficient stimulus for lower-limb explosive strength and standardized COD technique, particularly in high-intensity, short-duration tasks that require controlled, sport-specific loading. Further, SSG sessions are highly dependent on tactical design and game scenarios, often lacking repeated reinforcement of key movement patterns such as deceleration-initiation and directional change-reacceleration (Clemente, 2020). Directional changes are determined by ball possession, opponent positioning and tactical requirements, resulting in varied but non standardized movement patterns that impede consistent improvements in neuromuscular control and mechanical output (Makar, et al., 2023). This view is reinforced by scholars who contend that, although the tactical complexity of SSGs may enhance reaction speed, it does not systematically foster the core strength and coordination processes essential for directional speed (Clemente, et al., 2021c). In addition, the primary energy systems activated during SSG are aerobic and glycolytic (W. H. Yang, Park, Kwak, Kim, & Choi, 2024), with limited stimulation of the ATP–CP system, reducing its specificity and efficiency for improving COD performance. Notably, the development of COD ability relies on frequent explosive initiations, efficient eccentric-concentric transitions, and SSC-related neuromuscular adaptations, key elements that are generally lacking in typical HIIT and SSG protocols (Nygaard Falch, Guldteig Rædergård, & van den Tillaar, 2019).

In summary, SAQ training has demonstrated significant effectiveness in enhancing both short distance sprint and change-of-direction performance owing to its high neuromuscular specificity similar to football-related movements and its reliance on the ATP- CP energy system. Its short-duration, high-intensity, multidirectional, and precision-controlled training model effectively reinforces sport specific movement patterns such as sudden stops, directional changes and reaccelerations, providing strong task specificity and training transfer potential. In contrast, HIIT contributes to improvements in both aerobic and anaerobic metabolic capacity, but its structural characteristics, particularly temporal features, neuromuscular activation patterns and energy system demands, differ substantially from those required in sprinting and COD tasks, thus limiting its specificity and efficacy. Small-sided games combine physical conditioning with technical drills and tactical instruction and exhibit strong ecological validity; however, the randomness of training load distribution, variability of movement patterns and lack of repetitive motor reinforcement reduce their capacity to provide targeted stimuli for the physical components essential to sprinting and COD, ultimately constraining their effectiveness in speed and agility development. Although SAQ was not ranked as the most effective intervention for improving COD performance in the network meta-analysis, which may be attributed to the limited number of direct comparisons and variations in intervention protocols across studies, we contend that, with continued refinement of training designs and the accumulation of high-quality empirical evidence, the potential of SAQ training in enhancing COD performance is likely to be more fully recognized and substantiated.

Limitations

Several limitations of this network meta-analysis should be acknowledged. First, the study focused exclusively on soccer players, and the screening process may have excluded data from athletes in other team sports, which potentially limits the generalizability and interpretation of the findings. Second, a considerable degree of heterogeneity was observed, likely attributable to variations in training protocols (such as the proportion of each intervention within the overall training plan, and session intensity and volume), participant characteristics (including their training status, age, and sex), and differences in study designs (such as the experimental setting and the measurement tools and methods for outcome assessment). Although this heterogeneity complicates the interpretation of the results, it may also enhance external validity by reflecting the variability of exercise interventions in real-world practice. The absence of direct comparisons between SAQ and either HIIT or SSG, together with SAQ's limited advantage in indirect comparisons, may have attenuated its overall effect size. In addition, the relatively small number of studies examining COD performance, only sixteen in total, with five involving SAQ, and the wide confidence intervals further diminish the precision and statistical significance of the effect estimates, warranting cautious interpretation.

In conclusion, the effects of SAQ, HIIT, and SSG training on sprint and COD performance in soccer players were evaluated in the present study. Pairwise meta-analysis revealed that SAQ training significantly improved both sprint and COD performance. Network meta-analysis confirmed SAQ as the most effective modality for improving sprint performance. Although SAQ produced substantial gains in direct comparisons for COD, its relative advantage was not maintained in the network ranking, where HIIT and SSG attained slightly higher SUCRA values. Taken together, these findings indicate that, while SAQ constitutes the optimal strategy for augmenting sprint capacity, its superiority for enhancing COD requires further validation through head-to-head trials and should be interpreted with caution when based solely on indirect comparisons. Accordingly, practitioners are advised to implement a comprehensive training regimen centered on SAQ, supplemented by elements of HIIT and SSG, to maximize both sprint velocity and multidirectional agility in soccer athletes. Such an integrated approach addresses the complex interplay of physical and cognitive demands encountered during competition.

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Availability of data and materials

Data available on request from the authors.

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Authors’ contributions

The first author conceived and designed the study, analyzed the data, and wrote the full text. The second author extracted the data and handled article review and formatting. The third author extracted the data. The corresponding author revised and polished the article content.

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