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Effects of Small-Sided Game Interventions on the Technical Execution and Tactical Behaviors of Young and Youth Team Sports Players: A Systematic Review and Meta-Analysis

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Background: Small-sided games (SSGs) are an adjusted form of official games that are often used in training scenarios to introduce a specific tactical issue to team sports players. Besides the acute effects of SSGs on players' performance, it is expectable that the consistent use of these drill-based games induces adaptations in the technical execution and tactical behaviors of youth team sports players.

Objective: This systematic review with meta-analysis was conducted to assess the effects of SSG programs on the technical execution and tactical behaviors of young and youth team sports players.

Data Sources: The data sources utilized were PubMed, Scopus, SPORTDiscus, and Web of Science.

Study Eligibility Criteria: (i) Young and youth team sports players (i.e., < 18 years old) of any sex or skill level, without injury, illness, or other clinical conditions; (ii) SSGs-based programs not restricted to the duration and a minimum of one weekly training session; (iii) passive or active control groups; (iv) pre-post interventions values of technical execution and/or tactical behavior; (v) randomized and non-randomized controlled trials; and (vi) peer-reviewed original full-text studies written in English, Portuguese and/or Spanish.

Results: The database search initially yielded 803 titles. From those, six articles were eligible for the systematic review and meta-analysis. None of the included studies presented tactical behavior outcomes. The results showed a small effect of SSGs on

technical execution (ES = 0.59; 95% CI = 0.29 to 0.89; $p < 0.001$; $I^2 = 0.0\%$; Egger's test $p = 0.590$) when compared to controls. Sub-group analysis of the training factor revealed similar ($p = 0.433$) moderate (ES = 0.68, four study groups) and small (ES = 0.44, three study groups) improvements in technical execution after >17 and <17 SSG training sessions, respectively.

Conclusions: This systematic review and meta-analysis revealed a significant beneficial effect of using SSG training programs for enhancing technical execution in young and youth players. The benefits were similar despite the various numbers of training sessions applied. Further studies should add tactical behaviors as one of the outcomes for controlling the effects of SSG training programs.

Keywords: football, Soccer, athletic performance, youth sports, decision-making, motor skills

INTRODUCTION

Small-sided games (SSGs), are adjusted formats of play, in which the coach modifies the number of players involved, the pitch configuration, or specific rules of the game to introduce a specific tactical issue to team sports players (Davids et al., 2013). The manipulation of these constraints (or conditions) promotes an immediate effect on players' responses, namely in terms of tactical behaviors (Clemente et al., 2020), technical execution (Clemente and Sarmento, 2020), or physiological and physical demands (Clemente, 2016; Sarmento et al., 2018). The consistent use of these drills over several weeks will likely promote changes in players' tactical or technical skills (Práxedes et al., 2018a) or their fitness status (Hammami et al., 2018; Moran et al., 2019a; Clemente et al., 2021).

SSGs can play an important role in young and youth team sports training, as they develop multidimensional factors (e.g., technical/tactical and physical/physiological factors) (Fernández-Espínola et al., 2020). Indeed, these drills may apply a multidimensional stimulus to players (e.g., technical/tactical, physiological/physical) while keeping them attentive to specific tactical aspects of the game (Ometto et al., 2018). The effects of SSGs on young and youth team sports players vary based on different factors (e.g., age-group, expertise level, fitness status) (Olthof et al., 2018; Práxedes et al., 2018b). However, SSGs may promote changes in players' tactical behaviors and technical execution since they are playing a modified version of the game that maintains the fundamental dynamics and specificities of their sport (Davids et al., 2013).

Young and youth players are sensitive to learning and developing game-related skills (Serra-Olivares et al., 2016), thus promoting qualitative acquisition leading to expertise (Silva et al., 2020). In the particular case of team sports, skill-related outcomes are associated with players' technical abilities (or execution), tactical behaviors, and the decisions related to tactical behaviors (González-Víllora et al., 2015). Usually, technical skill or execution is analyzed using observational instruments that focus on the accuracy of skill-related actions. Meanwhile, tactical behaviors can be coded based on the accomplishment of tactical principles or expectations of attacking and/or defensive behaviors (González-Víllora et al., 2015). Pre-post analyses of

such outcomes are often used to monitor the development of young and youth players (Turner et al., 2011).

While maintaining certain dynamics of official games, SSGs also ensure considerable levels of heterogeneity on the players' stimulus (Clemente, 2019). They also provide great intra-player variability across the same format of play (Clemente et al., 2018; Clemente et al., 2019). Thus, despite expected medium-to-long term adaptations in the technical execution or tactical behaviors of young and youth team sports players, it is also likely that these adaptations are not similar for all players. In that sense, there is a need for a systematic review and meta-analysis summarizing the evidence about the effects of SSGs on the technical execution and tactical behaviors of young and youth team sports players against control groups.

Despite the growing number of systematic reviews and meta-analyses published on SSGs (Hammami et al., 2018; Bujalance-Moreno et al., 2019; Clemente and Sarmento, 2020; Clemente et al., 2020), and some dedicated systematic reviews about acute (immediate) effects of SSG in technical and tactical outcomes (Clemente and Sarmento, 2020; Clemente et al., 2020), no meta-analysis has investigated the effects of SSG-based programs on the technical execution and tactical behaviors of young and youth team sports players. A results-derived meta-analysis, along with a related systematic review and analysis of the available literature, may offer coaches an evidence-based overview of the effects of SSGs on young and youth team sport player's technical execution and tactical behaviors. This would also provide practical guidelines regarding potentially effective SSG configurations.

Therefore, the purpose of the present systematic review with meta-analysis was to assess the effects of SSG programs on the technical execution and tactical behaviors of young and youth team sports players. Specifically, within-group and between-group analyses against controls for each outcome are considered in the meta-analysis.

METHODS

This systematic review and meta-analysis followed the Cochrane Collaboration (Green and Higgins, 2005) and PRISMA

(Preferred Reporting Items for Systematic Reviews and Meta-analyses) guidelines (Moher et al., 2009). The PICOS approach (Population, Intervention, Comparator, Outcomes, Study design) was followed: (P) youth team sports players (i.e., < 18 years old) from any sex or skill, without injury, illness or other clinical condition; (I) SSGs-based programs no restricted to duration and a minimum of one weekly training sessions; (C) Passive or active control groups; (O) pre-post interventions values of technical execution and/or tactical behavior; and (S) randomized and non-randomized controlled-trials. The protocol was registered with the International Platform of Registered Systematic Review and Meta-Analysis Protocols with the number 202110108 and the DOI number 10.37766/inplasy2021.1.0108.

Eligibility Criteria

Inclusion and exclusion criteria for this systematic review and meta-analysis can be found in **Table 1**.

Duplicates were identified using the reference manager software (EndNote™ X9, Clarivate Analytics, Philadelphia, PA, USA). Two authors (FMC and HS) independently performed screening of the title, abstract and reference list of each study to locate potentially relevant studies. Additionally, they reviewed the full version of the papers in detail to identify articles that met the selection criteria and those that were excluded. A discussion was made in the cases of discrepancies regarding the selection process with the participation of a third author (AFS).

Information Sources

Electronic databases (PubMed, Scopus, SPORTDiscus, and Web of Science) were searched for relevant publications, from inception up to 28th January 2021. Keywords and synonyms were entered in various combinations in all fields: (youth OR young OR “child*” OR “adolescent”) AND (“team sport” OR football OR soccer OR futsal OR handball OR volleyball OR basketball OR hockey OR rugby OR cricket OR “water polo” OR lacrosse OR softball OR korfbal OR baseball) AND (“small-sided games” OR “sided-games” OR “drill-based games” OR “SSG” OR “conditioned games” OR “small-sided and conditioned games”) AND (“technical” OR “tactic*” OR “skill” OR “ability” OR “behavior*” OR “decision making”). An external expert was contacted to verify the final list of references included in this systematic review and to indicate if there was any study that was not detected through our search.

Extraction of Data

A data extraction sheet, adapted from the Cochrane Consumers and Communication Review Group’s data extraction template (Collaboration, 2016), was used to assess inclusion requirements and subsequently tested on ten randomly selected studies (i.e., pilot testing). This process was conducted by two independent reviewers (FMC and HS). Any disagreement regarding study eligibility was resolved in a discussion between both reviewers and a third author (AFS). Full text articles excluded, with reasons, were recorded. The records were registered in a form created in Microsoft Excel (Microsoft Corporation, Readmon, WA, USA).

Data Items

Aiming to establish consistency in data analyzing and reporting, only measures that were analyzed three or more times for different articles were included. For technical execution were considered the pre-post intervention outcomes that analyzed the skill level of the player in the specific sport, or the accuracy of skill. For tactical behavior, were considered the pre-post intervention outcomes that assessed individual ability to organize the behavior based on the tactical principles and collective dynamics of the game. The method used for the assessment of technical and tactical outcomes was also extracted. Adverse effects were also extracted as secondary outcome, in case of any reported. Additionally, the following information was extracted from the included studies: (i) number of participants (n), age (years), competitive level (if available) and sex; (ii) the SSGs format and pitch size (if available); (iii) period of intervention (number of weeks) and number of sessions per week (n/w); and (iv) regimen of intervention (work duration, work intensity, modality, relief duration, relief intensity, repetitions and series, between-set recovery).

Assessment of Methodological Quality

The version 2 of the Cochrane risk-of-bias tool for randomized trials (RoB2) (Sterne et al., 2019) was used to assess the risk of bias in the included randomized-controlled trials. Five dimensions are inspected in this assessment tool: (i) bias arising from the randomization process; (ii) bias due to deviations from intended interventions; (iii) bias due to missing outcome data; (iv) bias in measurement of the outcome; and (v) bias in selection of the reported result. Using RoB2 a qualitative synthesis was performed. Two of the authors (JA and HS) independently assessed the risk of bias. Any disagreement in the rating was resolved through discussion and by a third author (FMC).

The Cochrane risk of bias in non-randomized studies of interventions (ROBINS-I) was used to assess the risk of bias in included non-randomized intervention studies (Sterne et al., 2016). Three domains are analyzed in this assessment tool: (i) pre-intervention (bias due to confounding; bias in selection of participants into the study); (ii) at intervention (bias in classification of interventions); and (iii) post-intervention (bias due to deviations from intended interventions; bias due to missing data; bias in measurement of outcomes; bias in selection of the reported results). Two of the authors (JA and HS) independently assessed the risk of bias. Any disagreement in the rating was resolved through discussion and by a third author (FMC).

Summary Measures, Synthesis of Results, and Publication Bias

We followed previously established methods (Clemente et al., 2021). Briefly, analysis and interpretation of results were only conducted in the case of at least three studies provided baseline and follow-up data for the same measure. Pre-training and post-training means and standard deviations (SD) for dependent variables were used to calculate effect sizes (ES; Hedge’s *g*) for each outcome measure in the SSGs and control groups. Data were

TABLE 1 | Inclusion and exclusion criteria.

Item	Inclusion criteria	Exclusion criteria
Population	Youth team sports players (< 18 years old) from any sex or skill, without injury, illness or other clinical condition. Team sports considered, among others: soccer (association football), futsal, handball, volleyball, basketball, hockey, rugby, Australian football, American football, water polo, lacrosse, softball, baseball, korfbal.	Team sports players with more than 18 years old. Team sports players in rehabilitation or in return-to-play programs. Other sports than team sports with ball.
Intervention	SSGs-based programs no restricted to duration and a minimum of one weekly training sessions	Other training methods not related to SSGs (e.g., analytical exercises, running exercises). SSGs combined with other training methods will be also included, if any.
Comparator	Passive or active control groups.	Other SSGs training groups.
Outcome	Pre-post intervention values of technical execution (i.e., measures that assess individual ability skill or accuracy of technical execution related with the sport) and/or tactical behavior (i.e., measures that assess individual ability to organize the behavior based on the tactical principles and collective dynamics of the game).	Outcomes not related to technical execution or tactical behavior; no information (e.g., mean; standard deviation) reported for pre- and/or post-intervention (e.g., follow-up excluded).
Study design	Randomized and non-randomized controlled and/or parallel trials, with no significant differences between groups in baseline assessment of the main outcome.	Non-controlled studies or controlled trials in which baseline levels were significantly different between groups for the main outcome.
Additional criteria	Peer reviewed, original, full-text studies written in English, Portuguese and/or Spanish.	Written in other language than those selected. Reviews, letters to editors, trial registrations, proposals for protocols, editorials, book chapters, conference abstracts.

standardized using post-intervention SD values. The random-effects model was used to account for differences between studies that might impact the SSG-based effect (Deeks et al., 2008; Kontopantelis et al., 2013). The ES values are presented with 95% confidence intervals (CI). Calculated ES were interpreted using the following scale: <0.2, trivial; 0.2–0.6, small; >0.6–1.2, moderate; >1.2–2.0, large; >2.0–4.0, very large; >4.0, extremely large (Hopkins et al., 2009). Heterogeneity was assessed using the I^2 statistic, with values of <25%, 25–75%, and >75% considered to represent low, moderate, and high levels of heterogeneity, respectively (Higgins and Thompson, 2002). The risk of bias was explored using the extended Egger's test (Egger et al., 1997). When bias was present, the trim and fill method was applied (Duval and Tweedie, 2000), in which case L0 was assumed as the default estimator for missing studies (Shi and Lin, 2019). All analyses were carried out using the Comprehensive Meta-Analysis software (version 2; Biostat, Englewood, NJ, USA). Statistical significance was set at $p \leq 0.05$.

Moderated analyses were planned to use a random-effects model and independently calculated single factor analysis. When possible, the median split technique was planned (Moran et al., 2019b). Moderator analysis was considered for the total session during interventions.

RESULTS

Study Identification and Selection

The searching of databases identified an initial 803 titles. Duplicates (160 references) were subsequently removed either automatically or manually. The remaining 643 articles were screened for their relevance based on titles and abstracts, resulting in the removal of a further 593 studies. The full

texts of the remaining 50 articles were examined diligently. After reading full texts, a further 43 studies were excluded owing to a number of reasons: did not develop an intervention program ($n=35$); lack of control group ($n = 3$); did not include technical/tactical outcome ($n = 3$); insufficient statistical data ($n = 1$); did not reported pre-post data ($n = 1$). After methodological assessment, one article was excluded by critical risk of bias. None of the included articles were written in other language than English. Six articles were eligible for the systematic review and meta-analysis (Figure 1). The included articles provided mean and standard deviation pre-post-training data for at least the main outcome.

Methodological Quality

The randomized-controlled trials included in this study were analyzed with the RoB2 tool and the results can be found in Table 2.

The assessment of the non-randomized studies intervention studies can be found in Table 3. Since one article (Práxedes et al., 2016) presented overall critical evaluation (based on the assessment criteria of the instrument), and in accordance with Cochrane manual (Higgins et al., 2019), was not included in qualitative and quantitative synthesis.

Study Characteristics

Although only three of the six included articles in the qualitative and quantitative synthesis were randomized (Radziminski et al., 2013; Chaouachi et al., 2014; Daga et al., 2020), none of the six included articles reported significant differences between control and experimental groups at baseline. The characteristics of the six studies included in the meta-analysis can be found in Table 4. Additionally, the details

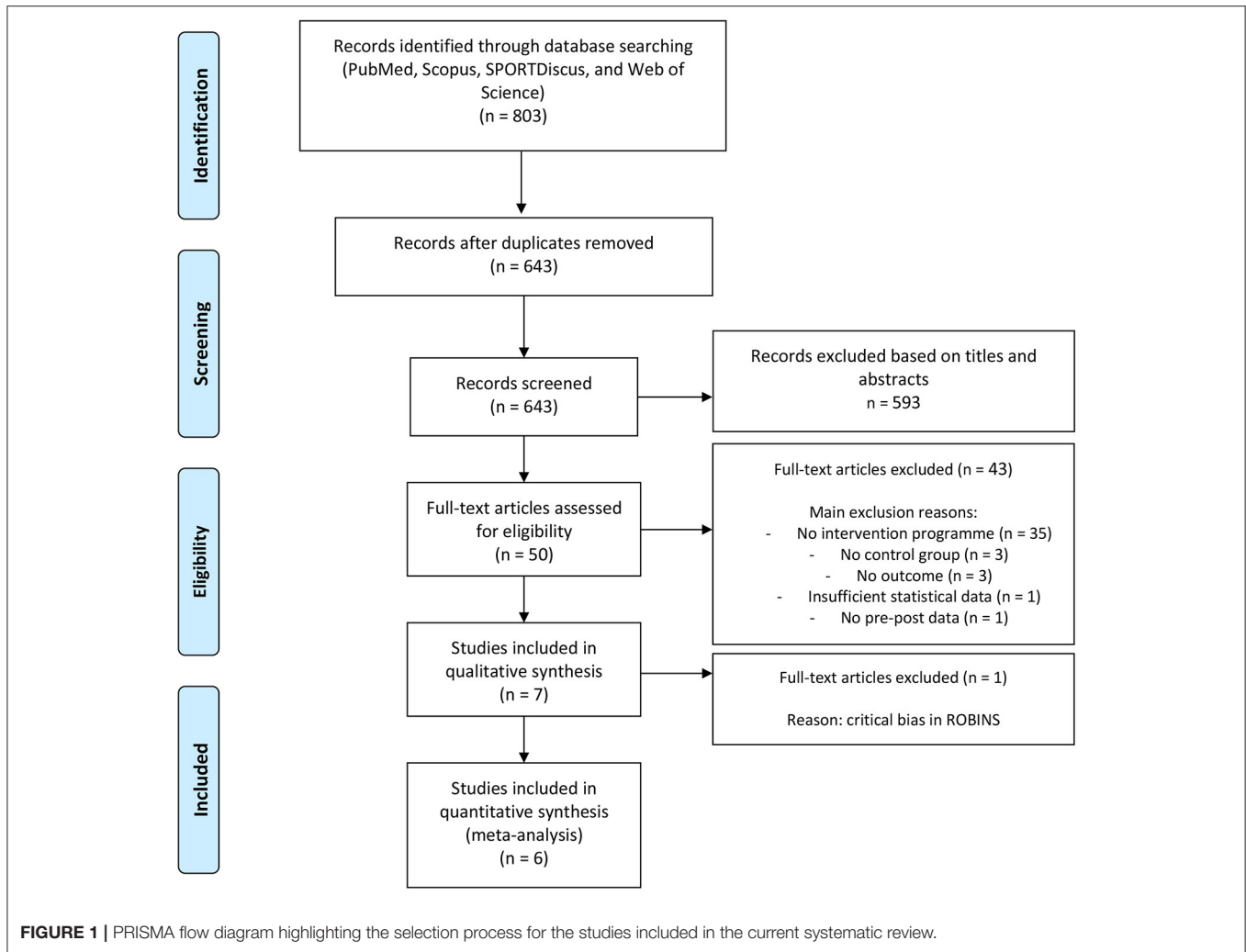


TABLE 2 | Assessment of risk of bias of randomized trials with The Risk of Bias 2 (RoB2).

	D1	D2	D3	D4	D5	Overall	Direction (overall)
Chaouachi et al., 2014	!	+	+	+	!	!	NA
Radziminski et al., 2013	!	+	+	-	!	-	Favors experimental
Trajkovic et al., 2017	-	+	+	+	!	-	Favors experimental

D1: randomization process; D2: Deviations from the intended interventions; D3: Missing outcome data; D4: Measurement of the outcome; D5: Selection of the reported result. Green: low risk; Yellow: Some concerns; Red: high risk; NA: not applicable; Direction provide information about the tendency of methodological favoring.

of the SSGs-based programs can be found in **Table 5** and the other training interventions in **Table 6**. The three included randomized-controlled studies involved three individual experimental groups and 43 participants, and 55 participants in the four control groups. The three included non-randomized studies involved three individual experimental groups and 39 participants, and 35 participants in the three control groups.

SSGs vs. Control: Effects on Technical Execution

A summary of the included studies and results of technical execution reported before and after SSGs-based compared to control intervention are provided in **Table 7**.

Six studies provided data for technical execution, involving six experimental and seven control groups (pooled $n = 172$). Results showed a small effect of SSGs on technical execution ($ES = 0.59$;

TABLE 3 | Assessment of risk of bias of non-randomized trials with ROBINS-I.

Study	D1	D2	D3	D4	D5	D6	D7	Overall
Arslan et al., 2020	+	+	+	+	+	!	!	!
Daga et al., 2020	!	+	!	+	!	!	!	!
Jastrzebski et al., 2014	+	+	-	-	+	!	!	!
Práxedes et al., 2016	-	+	!	!	+	!	!	+

D1: reaching risk of bias judgements for bias due to confounding; D2: reaching risk of bias judgments in selection of participants into the study; D3: reaching risk of bias judgments for bias in classification of interventions; D4: reaching risk of bias judgments for bias due to deviations from intended interventions; D5: reaching risk of bias judgements for bias due to missing data; D6: reaching risk of bias judgements for bias in measurement of outcomes; D7: reaching risk of bias judgments for bias in selection of the reported result; Green: low risk; Yellow: moderate/serious risk; Red: critical risk.

95% CI = 0.29 to 0.89; $p < 0.001$; $I^2 = 0.0\%$; Egger's test $p = 0.590$; **Figure 2**) when compared to controls.

The single training factor analysis revealed a similar ($p = 0.433$) moderate (ES = 0.68, four study groups) and small (ES = 0.44, three study groups) improvement in technical execution after >17 and <17 SSG training sessions, respectively.

The within-group meta-analysis showed a moderate effect on technical execution after both SSGs (six groups, pooled $n = 82$; ES = 0.106; 95% CI = 0.63 to 1.48; $p < 0.001$; $I^2 = 75.9\%$; Egger's test $p = 0.090$; **Figure 3A**), and control conditions (seven groups, pooled $n = 90$; ES = 0.65; 95% CI = 0.26 to 1.04; $p = 0.001$; $I^2 = 80.3\%$; Egger's test $p = 0.003$, unchanged after the trim and fill method was applied; **Figure 3B**).

SSGs vs. Control: Effects on Tactical Behavior

None of the six included studies presented tactical behavior-related outcomes. In screening only one study presented tactical behavior outcome (Práxedes et al., 2016), although was excluded based on a critical score obtained after using the ROBINS tool.

DISCUSSION

This study aimed to assess the effects of SSG programs on the technical execution and tactical behaviors of youth team sports players. The results indicated positive and small effects of training programs with SSGs on technical execution. No studies regarding tactical outcomes were included in the review. The discussion will be divided into topics, each regarding one of the two outcomes selected for this review (technical execution and tactical behaviors).

SSGs vs. Control: Effects on Technical Execution

SSGs were effective for improving players' technical execution in the selected studies. This result is in line with the assumption that SSGs might nurture youth sports players' technical development, as they provide players with a game-based environment in which they are constantly required to apply motor actions to solve emerging problems. Interestingly, all the selected studies

(Radziminski et al., 2013; Chaouachi et al., 2014; Jastrzebski et al., 2014; Trajkovic et al., 2017; Arslan et al., 2020; Daga et al., 2020) adopted formats ranging from 1 vs. 1 to 3 vs. 3. These smaller SSG formats were reported to increase players' ball engagement and provide more variable stimuli (Clemente et al., 2019; Caso and van der Kamp, 2020), which might explain the performance enhancements. The current review, therefore, reinforces the positive role that SSGs play in technical development and encourages coaches to adopt this tool in their training programs.

Although positive adaptations in technical execution were reported when comparing control vs. intervention groups, the magnitude of these differences was small. We argue that the type of measurement regarding technical execution might explain this reduced statistical effect. Specifically, most of the adopted tests are based on measuring agility with the ball or change-of-direction abilities (Radziminski et al., 2013; Chaouachi et al., 2014; Jastrzebski et al., 2014; Arslan et al., 2020; Daga et al., 2020), while others adopted a battery of closed-environment tests (Radziminski et al., 2013; Jastrzebski et al., 2014). In both cases, the measurements were taken out of the game context. Contrarily, in SSGs, technical executions are always integrated with tactical decisions, so larger differences between control and intervention groups could be expected if the measurements were taken in a more representative game-based scenario. Interestingly, a previous study found no significant correlations between in-game tactical-technical dribbling performance and players' dribbling performance in a technical test without the game context (Praça et al., 2015), reinforcing the previous rationale.

Also, the performance in the agility test is influenced by a cognitive aspect (perceptual and decision-making processes) and by players' abilities to quickly change direction (Young et al., 2015; Pojskic et al., 2018). Therefore, technical execution is not directly measured. Consequently, players might experience an improvement in the testing performance, which is not fully explained by an improvement in ball dribbling technical execution. Therefore, the magnitude of the difference between control and experimental groups is expected to be reduced. For both mentioned reasons, future studies should look to

TABLE 4 | Characteristics of the included studies and outcomes extracted.

Study	N	Mean age (yo)	Experience (y)	Sex	Team Sport	Randomized	Design	Control	Sig. Dif. Baseline	Variables assessed in the study and tendency	Tests or tools used	Outcome extracted
Arslan et al., 2020	SSG: 11 ActCon: 10	14.2	3.3–3.5	Male	Soccer	No	Parallel	Running-based group	No	Agility with ball (s) – less is better	Zig-zag agility with ball	TE: agility with ball
Chaouachi et al., 2014	SSG: 12 ActCon: 12 PassCon: 12	14.2	ND	Male	Soccer	Yes	Parallel	ActCon: multidirectional sprints PassCon: only field training	No	Reactive agility test with ball (s)–less is better	Reactive agility test with ball	TE: reactive agility test with ball
Daga et al., 2020	SSG: 17 ActCon: 14	9.0	ND	Male	Soccer	No	Parallel	Multilateral training	No	Shuttle dribble test–less is better	Shuttle dribble test	TE: shuttle dribble test
Jastrzebski et al., 2014	SSG: 11 ActCon: 11	15.8	6–7	Male	Soccer	No	Parallel	Running-based group	No	DFB test (n) –high is better	Technical skill battery of the German Soccer Federation	TE: DFB
Radziminski et al., 2013	SSG: 9 ActCon: 11	15.1	5–7	Male	Soccer	Yes	Parallel	Running-based group	No	DFB test (n) – high is better	Technical skill battery of the German Soccer Federation	TE: DFB
Trajkovic et al., 2017	SSG: 22 ActCon: 20	11.2	2.1–2.2	Female	Volleyball	Yes	Parallel	Instructional training	No	Overhead pass Forearm pass Setting Serving Serving under fatigue –high is better	Observational test	TE: overhead pass

N, number of participants in the study; *Yo*, years old; *Y*, years; *M*, men; *W*, women; *h*, hour; *ActCon*, active control group; *PassCon*, passive control group; *Sig. Dif. Baseline*, significant differences at baseline; *ND*, not-described; *CT*, controlled trial; *RCT*, randomized controlled trial; *TE*, technical execution; *TB*, tactical behavior; *DFB*, German Soccer Federation test.

TABLE 5 | Characteristics of the SSG-intervention programs in the included studies.

Study	Duration (w)	d/w	Total sessions	SSG formats	SSG pitch dimension (length x width)	SSG area per player (m ²)	Other conditions	Sets	Reps	Work duration	Work intensity	Between reps duration	Type of recovery
Arslan et al., 2020	5	2	10	2 vs. 2	20 x 15-m	75 m ²	ND	2	2	2.5–4.5 min	ND	2 min	Passive
Daga et al., 2020	12	2	24	2 vs. 1, 2 vs. 2, 3 vs. 3, 4 vs. 2	ND	ND	ND	ND	ND	ND	ND	ND	ND
Chaouachi et al., 2014	6	3	18	1 vs. 1, 2 vs. 2 and 3 vs. 3	10 x 20, 20 x 20 and 20 x 30-m	100 m ²	Ball contacts restricted (2-3)	1–2	2–4	30 s–2 min	80–85% HRmax	2 min	ND
Jastrzebski et al., 2014	8	2	16	3 vs. 3	18 x 30-m	90 m ²	ND	ND	7	3 min	NR	90 s	Active recovery
Radziminski et al., 2013	8	2	16	3 vs. 3 or 3 vs. 3 +1	18 x 30-m	77–90 m ²	ND	ND	5	4 min	>90% HRmax	3 min	Light activity
Trajkovic et al., 2017	12	3	36	2 vs. 2 and 3 vs. 3	7 x 3 and 12 x 6-m	5 m ² and 12 m ²	ND	ND	ND	ND	ND	ND	ND

d/w, days per week; SSG, small-sided games; TGFU, questioning used as strategy for promotion of tactical learning; ND, not described; HRmax, maximal Heart Rate.

develop and adopt valid and reliable in-game-based instruments to measure improvements in technical execution.

Moderate pre-to-post improvements were observed within control and intervention groups. While improving technical execution is an expected outcome for the intervention group, the same did not apply to the control groups. Besides the abovementioned issues regarding the tests and measurements, we argue that this unexpected outcome is linked to the way the training programs were designed. Specifically, most of the selected studies included game-based activities (in which technical executions were required) in the training program of the control group as players took part in sport-specific team training (Radziminski et al., 2013; Chaouachi et al., 2014; Jastrzebski et al., 2014; Trajkovic et al., 2017; Arslan et al., 2020). In the selected studies, however, there was no information regarding the content of such sport-specific team training.

Considering how training programs are usually developed, we might expect players to engage in technical execution training, which explains the improvement in the control group. However, as the magnitude of the difference was higher in the intervention groups than in the control ones (ES 1.06 and 0.65, respectively), the SSGs boosted the technical execution enhancements attained through regular training regimens, which reinforces their positive role. However, as high heterogeneity between the studies was observed in the control and intervention groups, generalizations are not recommended and future studies are required.

Finally, a similar small-to-moderate improvement in technical execution was observed after >17 and <17 SSG training sessions. Although longer interventions are expected to generate greater improvements, two issues might explain the current results. While one study (Trajkovic et al., 2017) included 36 sessions, all the other >17 training session interventions varied from 18 to 24 sessions. Therefore, the magnitude of the difference in the length of the training program was likely to be not enough to elicit different adaptations. Moreover, none of the selected studies introduced non-arbitrary pedagogical strategies to control and progress the training contents in the intervention group. Adjusting the task complexity to players' current levels is expected to facilitate the learning (Machado et al., 2020). Therefore, the absence of a control condition for the training process might have reduced the expected impact of the longest intervention programs on players' technical execution.

While the abovementioned rationale seems to explain the current results, the two longest intervention programs (Trajkovic et al., 2017; Daga et al., 2020) were coincidentally the two most statistically weighted studies in the meta-analysis (see **Figure 2**), as they showed the most relevant intervention impact on the responses (see hedge's G and 95% CI) and the lowest variance across the studies.

In team sports, learning is not a linear process, and differences are age and maturity-dependent (Fransen et al., 2017). For this reason, although the current analysis did not show differences between >17 and <17 SSG training session programs, short training programs might not be enough to favor the development of technical skills in late-developed players, who require longer training periods to achieve such improvements.

TABLE 6 | Characteristics of the other training programs in the included studies.

Study	Characteristics
Arslan et al., 2020	Running-based HIIT was implemented twice a week over 5 weeks. Two sets of 6–10 min of 15"–15" running at 90–95% VIFT were performed.
Daga et al., 2020	The multilateral approach consisted of 25 min per session in which the players developed physical qualities using multilateral or general exercises such as sprint, relays, jumps over the hurdle. The ball was not included.
Chaouachi et al., 2014	The change-of-direction group performed preplanned COD drills (e.g., skipping, 5-0-5 meters, half-7-test 20 m, shuttle 4 x 10 m). The ball was not included.
Jastrzebski et al., 2014	The interval running group performed seven 3 min (15"–15") runs with 90 s of active recovery. The ball was not included.
Radziminski et al., 2013	The interval running protocol consisted in 5 intervals of 4 min of running, interspaced by 3 min of active recovery.
Trajkovic et al., 2017	The instructional training sessions have used blocked practice, performing individual skills against the wall or to a partner in non-competitive environment, multiple repetitions, and practice of technique in a closed-skill context.

HIIT, high-intensity interval training; VIFT, final velocity at 30–15 intermittent fitness test.

TABLE 7 | Summary of the included studies and results of technical execution before and after intervention.

Study	Group	N	Before Mean ± SD	After Mean ± SD	After-before (%)*	Tendency of change
Arslan et al., 2020	SSG	11	8.85 ± 0.54	8.36 ± 0.53	–5.5	Beneficial
Chaouachi et al., 2014	SSG	12	2.65 ± 0.09	2.45 ± 0.11	–7.5	Beneficial
Daga et al., 2020	SSG	17	15.76 ± 1.13	12.75 ± 1.52	–19.1	Beneficial
Jastrzebski et al., 2014	SSG	11	325.2 ± 43.9	342.5 ± 33.0	5.3	Beneficial
Radziminski et al., 2013	SSG	9	307.8 ± 59.0	341.0 ± 50.2	10.8	Beneficial
Trajkovic et al., 2017	SSG	22	5.24 ± 1.56	6.73 ± 1.79	28.4	Beneficial
Arslan et al., 2020	CON	10	8.56 ± 0.34	8.45 ± 0.36	–1.3	Beneficial
Chaouachi et al., 2014	CON ^a	12	2.67 ± 0.18	2.54 ± 0.16	–4.9	Beneficial
Daga et al., 2020	CON	14	14.00 ± 1.29	12.07 ± 0.97	–13.8	Beneficial
Jastrzebski et al., 2014	CON	11	333.4 ± 34.11	344.0 ± 34.6	3.2	Beneficial
Radziminski et al., 2013	CON	11	302.3 ± 40.4	319.6 ± 35.7	5.7	Beneficial
Chaouachi et al., 2014	CON ^b	12	2.68 ± 0.08	2.55 ± 0.08	–4.9	Beneficial
Trajkovic et al., 2017	CON	20	6.36 ± 2.29	6.59 ± 1.92	3.6	Beneficial

a, active control; b, passive control. SSG, small-sided games group; CON, control group*, although some values reflects negative and other positive values (depending on the outcome measure), all changes denotes favorable changes in both the SSG and CON groups; SD, standard-deviation.

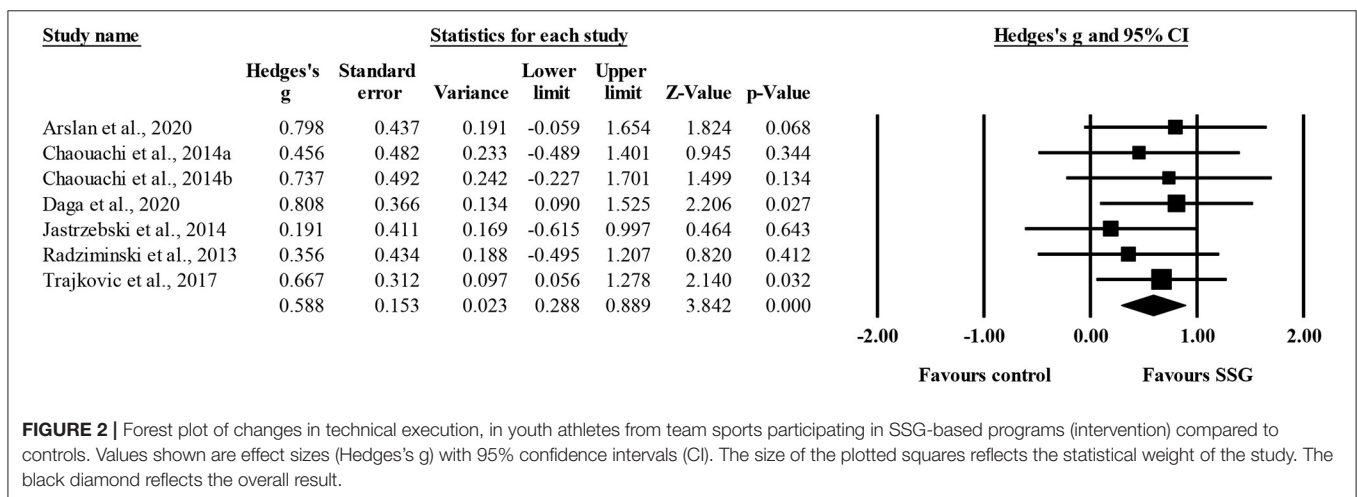
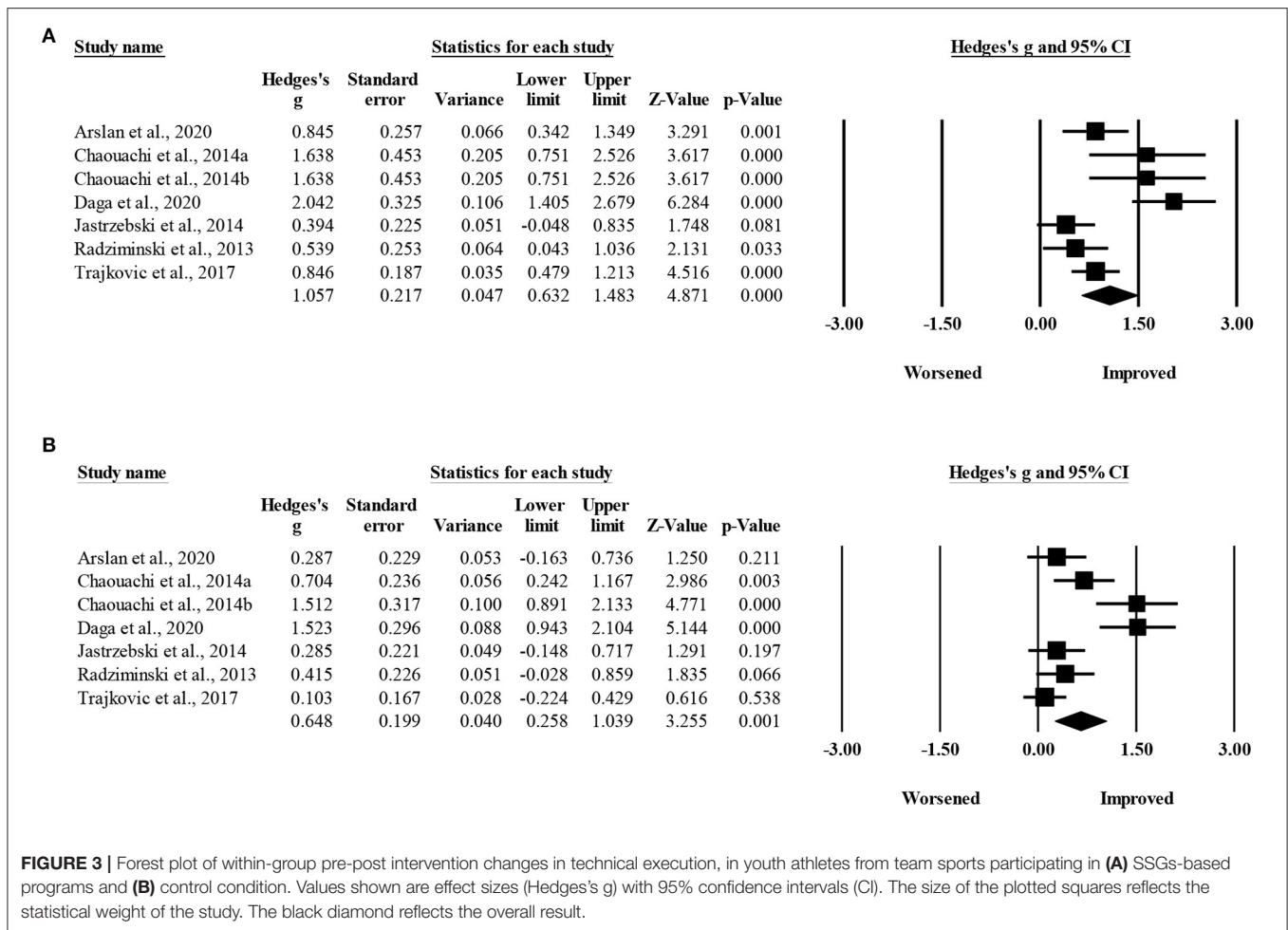


FIGURE 2 | Forest plot of changes in technical execution, in youth athletes from team sports participating in SSG-based programs (intervention) compared to controls. Values shown are effect sizes (Hedges's g) with 95% confidence intervals (CI). The size of the plotted squares reflects the statistical weight of the study. The black diamond reflects the overall result.



SSGs vs. Control: Effects on Tactical Behavior

No selected study examined the effects of SSGs on tactical behavior. This result indicates the need for further research on this topic for an evidence-based prescription. We acknowledge that the absence of evidence must not be understood as evidence of absence, as previous game-based approaches that are strongly based on small-sided games have been effective in nurturing team sports players' tactical skills (Kinnerk et al., 2018). There are two main possible causes for this absence of studies: the difficulty in choosing instruments to evaluate tactical behaviors and the challenge of designing interventions with high external validity in team sports.

Previous instruments used to evaluate tactical behaviors are largely based on observational designs (Oslin et al., 1998; Costa et al., 2011; González-Víllora et al., 2015). Although this low-cost strategy allows performance indicators to be obtained in team sports, there are issues regarding their reliability, as they account for discrete events. Specifically, low-frequency events are less likely to present a good test-retest reliability, which increases the variability of the responses and reduces the power of the analysis. For example, weak intersession intraclass correlation coefficients

were reported for the frequency of tactical principles in a previous study in soccer (Bredt et al., 2016).

Moving toward contemporary technologies, such as positional analysis, might allow the researchers to access more reliable measures, which will encourage the development of intervention studies. Previous studies adopted this perspective using linear and nonlinear modeling to detect players' and teams' behaviors in game-based contexts (Ramos et al., 2017; Ribeiro et al., 2020) and showed interesting pathways for future research.

Limitations, Future Research and Practical Applications

This review provides interesting practical applications for coaches and researchers. Specifically, because significant and beneficial effects of using SSG training interventions for improving technical execution were observed, coaches are encouraged to systematically include SSGs in training programs to nurture players' technical skills. During SSGs, players experience high variability in their actions, which may also provide players with a more adaptive technical pattern in line with the demands of the matches in team sports.

On the other hand, limitations must be accounted for. From the selected studies, five addressed improvements in technical execution in soccer, while only one included volleyball athletes. Therefore, although our conclusions seem to be more generalizable to soccer, studies in other sports are required. Also, the studies did not include players of different age groups and did not include elite youth players. As the technical development of high-level athletes might be different from novice youth-academy players, future studies in elite groups are recommended. Also, in-game technical execution assessments are still required, as there is no evidence that the SSGs are more effective than control training for improving in-game performance. Finally, constantly developing valid and reliable instruments to assess players' behaviors related to game-based tasks will benefit researchers and practitioners by increasing the quality of the information used to adjust training contents and complexity.

The only selected study that considered tactical behaviors was excluded due to methodological issues. The lack of control for confounding variables might have biased the results, which reduced the methodological quality and demands caution when interpreting such results. As there were no selected studies regarding players' tactical behavior development after SSGs-based training programs, we encourage researchers to search for suitable experimental designs to address this issue.

Finally, integrated analysis covering the impacts of SSG-based on programs in multiple dimensions (e.g., physiological/physical, technical, and tactical) must be considered, namely integrating into the analysis the dose-response effects by monitoring the load imposed (Gomez-Carmona et al., 2018; Gómez-Carmona et al., 2019) and the accumulated effects of technical/tactical responses to specific drills (Fernández-Espínola et al., 2020).

CONCLUSIONS

This systematic review revealed the significant and beneficial effects of using SSG training interventions to improve technical execution in comparison to control groups. Interestingly, the sub-group analysis revealed that using more or less than 17 training sessions had similar effects on the improvement of technical execution. The within-group analysis had great

heterogeneity; thus, any generalization of beneficial effects should be avoided. Interestingly, a search for the effects of SSG training interventions on tactical behaviors yielded no eligible articles. Therefore, future research should consider tactical behaviors as outcomes to be assessed during SSG interventions.

DATA AVAILABILITY STATEMENT

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

AUTHOR CONTRIBUTIONS

FC lead the project, wrote and revised the original manuscript. RR-C analyzed and interpreted the data, wrote the statistical report, and revised the original manuscript. FC and HS run the data search, performed the methodological assessment, conducted the data extraction, wrote, and revised the original manuscript. GP, JA, AS, TR, and BK wrote and revised the original manuscript. All authors contributed to the article and approved the submitted version.

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Conflict of Interest: The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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