The Journal of sports medicine and physical fitness, 2017

Does Small-Sided Games Training Improve Physical-Fitness and Specific Skills for Team Sports? A Systematic Review with Meta-Analysis

Short title: Small-Sided Game Training for Team Sports

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Funding No financial organisation was involved in the material discussed in the manuscript.

Conflicts of Interest The authors certify that there is no conflict of interest regarding the material discussed in the manuscript.

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Abstract

INTRODUCTION: This paper aimed to systematically review and meta-analyze the training effects of small-sided games (SSG) on physical fitness and specific skills related to team sport according to the level of play and the period of the season. EVIDENCE ACQUISITION: The search covered the following electronic databases (PubMed, Google Scholar, and ScienceDirect). The publications' search period ranged from 2000 to 2016. The terms (small-sided game, training, skill-based game, aerobic fitness, sprint, agility, jump and team sports) were used either singularly or combined in a systematic sequence. Appraisal of 16 articles (15 were meta-analysed) was performed after the application of exclusion criteria and quality assurance processes and the standardized mean effects were measured using random effects. EVIDENCE SYNTHESIS: The results revealed that SSG training had a *large* beneficial effect on maximal oxygen uptake [$\dot{V}O_{2max}$] (effect size (ES) = 1.94; 95 % CI 0.15, 3.74; I^2 = 94 %), agility (ES = -1.49; 95% CI -2.27, -0.71; I^2 = 80%), and repeated sprint ability (ES = -1.19; 95% CI -2.17, -0.21; I^2= 53%). There was a *moderate* beneficial effect on 10- and 20-m sprint performance (ES = -0.89; 95 % CI -1.7, -0.07; I^2 =88%), jump height (ES = 0.68; 95% CI 0.03, 1.33; I^2= 79%), and intermittent endurance (ES = 0.61; 95% CI 0.17, 1.05; I^2= 0%). The results also showed greater positive effects on specific skills (specific endurance and agility tests and techniques) after SSG when compared with generic or agility training. CONCLUSION: Small-sided games may represent an effective strategy of multicomponent training that can induce greater positive effects on specific skills tasks when compared with interval or agility training and *moderate* to *large* improvements in team sport-related physical fitness.

Key words: Team sports, performance, training, endurance.

Introduction

Team sports are characterized by long periods of low intensity activity including walking and jogging interspersed by repeated bouts of high intensity running/efforts. Furthermore, team sport athletes are typically required to perform explosive actions such as kicking, dribbling, jumping, changes of direction, and sprinting during training and competition. Currently, different training methods such as endurance training, [1] high-intensity interval training, [2] and strength training [3, 4] have been proposed to enhance team sport-related physical fitness. More recently, specific sport training or small-sided games (SSG) have been extensively investigated in order to develop the team-specific performance of players. [5-7]

Small-sided game training or skill-based conditioning games have received attention within the recent scientific literature. [8, 9] This type of training is often played with modified games on reduced pitch areas, using adapted rules and involving a smaller number of players than traditional games. [9] Currently, SSG represent one of the most common training drills used by amateur and professional teams to improve physical fitness while also developing technical and tactical proficiency. [9]

Recent reviews on the physiological responses to SSG in team sports highlighted that high-intensity exercise can be achieved during SSG with a high degree of neuromuscular and metabolic stress, with mean heart rate (HR) generally exceeding 80% of HR_{max} and blood lactate concentrations above 6 mmol/l. [10] Therefore, SSG appear to be an effective strategy of training the multiple components (i.e. physical, technical, and tactical skills) of team sports, while at the same time, ensuring a high level of motivation. [5, 11] Moreover, it has been demonstrated that the physiological response and technical actions in SSG is influenced by a range of variables such as number of players, pitch size, duration and format; varying one or more of these variables may affect SSG intensity. [10]

The recent growth in the use of SSG as a training mode in team sports [6, 12] shows an increased interest of its potential benefits to team sport-related physical fitness. However, to date, the long-term effects of SSG training on physical fitness in team sports have yet to be meta-analysed. Therefore, the aim of this systematic review and meta-analysis was to study the effects of SSG training upon indices of physical fitness and specific skills related to team sports. Furthermore, the effects according to the level of play and the period of the season were also assessed.

Methods

Search strategy

The search process followed the "Preferred Reporting Items for Systematic Reviews and Meta- Analyses" (PRISMA) guidelines for the conduct of systematic reviews. [13] The search covered the following electronic databases (PubMed, Google Scholar, and ScienceDirect). The publications' search period ranged from 2000 to 2016. The terms (small-sided game, training, skill-based game, aerobic fitness, sprint, agility, jump and team sports) were used either singularly or combined in a systematic sequence. Manual searches were also made using reference lists from the recovered articles (see figure 1).

Study selection and inclusion criteria

Studies were included in the review if they met the following criteria: (1) Randomized controlled and non-controlled trials involving a SSG training intervention of > 4 weeks in duration; (2) Involved trained and competitive team sport athletes; (3) The outcomes were field- or laboratory-based fitness measures such as: $\dot{V}O_{2max}$, sprint, jump, agility, or repeated sprint performance in addition to the specific skills related to each type of team sport; (4) Articles were written in the English language and were published in peer-reviewed journals,

using techniques of high reliability and validity. Conference proceedings and theses were excluded. Following an initial literature search and the screening of titles and abstracts from the cited databases, a full text review of apparently relevant articles was made to ensure that they met the specified inclusion criteria.

Data extraction

The participants and training characteristics, sport types and the outcome measurements of the meta-analysed studies are displayed in table 1. Data from studies that met the inclusion criteria, including authors, year of publication, study subjects' characteristics, training program (duration, frequency and intensity), outcome measures and the most important results were extracted. The present study included a range of physical fitness tests (i.e. $\dot{V}O_{2max,}$ jump, sprint, agility, intermittent endurance and repeated sprint) and specific skills related to team sports (i.e. shooting, match performance, tasks with the ball) that are often used within the literature to assess specific tasks, endurance capacities, leg power and speed.

Data analysis

Review Manager statistical software V.5.0 (Nordic Cochrane Centre, Copenhagen, Denmark) was used to determine the standardized mean differences and 95% confidence intervals for the included studies using a random effects model. Inconsistency was measured using the (I^2) expressed as a percentage between 0 and 100%, with values greater than 50% considered indicative of high heterogeneity. Magnitude of change was assessed based on standardized thresholds for small, moderate and large changes (0.2, 0.6 and 1.2, respectively). [14]

Insert figure 1 here

Quality analysis

The Physiotherapy Evidence Database (PEDro) rating scale was chosen for quality assessment of the included studies. [35] This rates validity on a scale of 1-11 according to the following criteria: 1) Eligibility criteria specified. 2) Random allocation of subjects. 3) Concealed allocation of subjects. 4) Groups similar at baseline. 5) Subject blinding. 6) Therapist blinding. 7) Assessor blinding. 8) Less than 15% dropouts. 9) Intention-to-treat analysis. 10) Between-group statistical comparisons. 11) Point measures and variability of the data. Item 1 is not used in the scoring because it is related to external validity

Results

Study selection and characteristics

The overall sample size for the 15 training studies that were meta-analysed was 200 players (14 female); the participants who undertook SSG training were compared with either a control group (habitual training) or subjects receiving alternative interventions (interval training, generic training and strength training). The training period ranged from 4 to 12 weeks, with most studies continuing over 6-8 weeks. The average frequency of training and exercise intensity during SSG were 2 sessions per week and 81.4 ± 3.0 % of HR max, respectively. SSG training was conducted with different formats such as 2v2, 3v3 in volleyball, 4v4 and 5v5 in soccer, 5v5 and 5v3 in rugby. The physical fitness measures such as jumping, 10–30 m sprinting, $\dot{V}O_{2max}$, repeated sprinting and intermittent endurance were used to assess leg power, different aspects of speed and aerobic fitness, and were therefore included in the present analysis. Concerning the specific skills, the search identified 7 studies examining the effects of SSG on some specific skills related to team sport such as shoot velocity, change of direction

with the ball and offensive and defensive techniques. Three studies focused on the effects of SSG on specific skills in handball players, 2 in soccer players, one study in basketball and one in volleyball players. See table 4.

Insert Table 1 near here

Meta-analysis results

The effects of SSG on physical qualities

The results of the meta-analysis are presented in figure1 to figure 7. The meta-analysed results revealed that SSG training had a *large* beneficial effect on $\dot{V}O_{2max}$ (effect size (ES) = 1.94; 95 % CI 0.15, 3.74; I^2 = 94 %), agility (ES = -1.49; 95% CI -2.27, -0.71; I^2 = 80%), and repeated sprint ability (ES = -1.19; 95% CI -2.17, -0.21; I^2= 53%). There was a *moderate* beneficial effect on 10- and 20-m sprint performance (ES = -0.89; 95 % CI -1.7, -0.07; I^2 =88%), jump height (ES = 0.68; 95% CI 0.03, 1.33; I^2= 79%), and intermittent endurance (ES = 0.61; 95% CI 0.17, 1.05; I^2= 0%).

The effects of SSG training on specific skills

The results demonstrated a significantly greater improvement of some specific skills related to team sports after a periodized SSG training compared with other training types such as interval and generic training. These results were observed for shoot velocity, handball agility and standing throw performance in handball players, [5, 15, 16] agility with the ball and match performance in soccer [6, 17] and for technique skills and shooting in volleyball and basketball players. [18, 19]

Risk of bias and methodological qualities

The results showed that 14 studies used a randomized fashion and 2 studies used one group pre-post intervention study design. However, only 2 studies used control groups. Heterogeneity that was determined using the I^2 value revealed a high heterogeneity of almost of the studies included. The quality of the studies included in our analysis presented in Table 4. The mean PEDro score was 5.8/10 (range 5 to 7). Almost of investigations were randomized with an acceptable sample size. For practical reasons, most studies did not adopt a blinding design, but all made a between-group comparison.

Discussion

Many team sports such as soccer, handball, Australian football, rugby and hockey necessitate the development of specific capacities of physical fitness including peak speed and power, strength, repeated sprint ability, and aerobic endurance. [20-22] Recently, SSG has emerged as a feasible and efficacious strategy for increasing team sport-related physical fitness while at the same time developing game-specific muscle-groups and improving technical and tactical abilities through game-specific conditions. [10] The present meta-analysis and systematic review showed a clear beneficial effect (moderate to large effects) of SSG training on measures of $\dot{V}O_{2max}$, jump, sprint, agility, repeated sprint, and intermittent endurance.

Effects of SSG on aerobic fitness

Insert figure 2 and 6 here

It has been shown that SSGs elicit exercise intensities equal or higher than traditional-based training approaches. For example, Dellal et al. [23] demonstrated that some soccer SSG resulted in comparable HR to short-duration intermittent running, with HR exceeding 80% HR_{max}. These high exercise intensities and the higher metabolic stress placed on the body during SSG

may represent the main factors for the important gains showed in aerobic fitness. For example, it has been shown in rugby league players that $\dot{V}O_{2max}$ increased by 4.7% after a 9 week program (2 sessions per week) of SSG. [24] Furthermore, 8 weeks of SSG (2 sessions / week; 91.3% HR_{max}) resulted in a large increase in $\dot{V}O_{2max}$ in professional soccer players. [17] This improvement was as efficient as high-intensity interval training.

The present meta-analysis revealed a moderate beneficial effect (4 studies, ES = 0.61) of SSG on intermittent endurance measured by the 30–15 Intermittent Fitness Test (30-15 $_{IFT}$). It is well established that repeated high (and low) intensity actions are of great interest to coaches and fitness coaches in many team sports. [25, 26] Dellal et al. [27] showed that 6 weeks of both SSG and HIT interventions were equally effective in developing the ability to perform intermittent exercises with changes of direction in male amateur soccer players. Similar results were found when adolescent handball players performed handball-based training (86.8% HR_{max}) or high-intensity interval training (87.6% HR_{max}) twice per week for 10 weeks. [5] The authors found that the two training modes were effective in improving a range of intermittent endurance indices such as velocity reached at the end of the 30–15 IFT test and times-to-exhaustion. It has also been suggested that handball-based SSG should be considered as a preferred training method due to its higher game-based specificity. [5] The present results are in conjunction with the results of recent systematic review who demonstrated that SSG seems to be slightly more physically strenuous than traditional training approaches as demonstrated by the elevated HR responses which may potentially evoke greater improvements in cardiovascular function and subsequently aerobic fitness adaptations. [10]

Effects of SSG on sprint, agility and jump performances

Explosive and short-duration high-intensity tasks such as strength, power, speed and agility, particularly during critical moments in competition, represent a determining component of

success in team sport. [28] The development and improvement of these specific physical capacities is of great interest to team sports coaches and players. The effect of SSG on these qualities has been the focus of some studies. The results of the present meta-analysis revealed a moderate beneficial effect on 10- and 20-m sprint performance and jump height, and a large beneficial effect on agility. It has been shown that 6 weeks of SSG training in young soccer players produced a greater improvement in agility tests conducted with the ball in comparison to a specific change of direction training program. [6] Moreover, it has been shown that U-18 Australian Rules football players improved their reactive agility and speed of decision-making after 7 weeks (2 sessions /week) of SSG training compared with change of direction training during the season. [12] Gabbett [24] demonstrated that a 9-week SSG training program (2 sessions/week) elicited greater improvements in sprint performance than traditional conditioning (i.e., running activities with no skill component) in rugby league players. These improvements in short sprints and agility tasks may be explained in part by the multiple specific power-related actions such as jumps, blocks, stops, accelerations and decelerations that took place in the SSG that were performed at high intensity and over playing areas of small dimensions. Thus, specific SSG can be used as an effective training stimulus during the competitive phase of the season with positive effects on specific tasks and physical performance. Thus, given the time restrictions facing coaches and strength and conditioning practitioners, SSG appear to be a suitable method for improving physical fitness while developing technical and tactical efficiency.

***Insert Figure 2, 3 and 4 here ***

Effects of SSG on repeated sprint performance

Repeated sprint ability was defined as the ability to repeat short-duration sprints (<10 seconds), interspersed with brief recovery periods. [29] It has been shown that repeated sprint ability (RSA)

performance (mean sprint time) predicts distance of high intensity and total distance running performed during a soccer match. [30] Thus, it could be crucial to successful performance in team sports and it is important to optimize training strategies that can improve RSA. In the present review, only 4 studies evaluated the effects of SSG on RSA performance. Different RSA indices were evaluated in each study (mean sprint time, total sprint time, fatigue index). However, total sprint time was evaluated in two studies [5, 16] and meta-analysed in the present study. The results showed a large beneficial effect of SSG training on total sprint time during a RSA test. In handball players, both Iacono et al. [16] and Buchheit et al. [5] found a significant and large improvement in total sprint time during RSA after a period of SSG training. It seems that the high-intensity exercise tasks performed during SSGs sessions such as sprints, jumps and changes of direction represent the main stimulus that elicited the improvement in RSA. Moreover, the improvement in RSA may be due in part to the improvement in agility and coordination that improved the ability to change direction, which in turn increased repeated shuttle sprint performance. [5]

Effects of SSG on specific skill tasks

During recent years, team sport coaches have used SSG in their training programs because of their proposed advantages in terms of specificity of movements and inclusion of decision making. Our results demonstrated that SSG had large positive effects on some specific tasks compared with other training modes such as interval and agility training. It has been shown for example that handball agility specific test and standing throw performance improved significantly after 8 weeks of regular SSG compared with interval training or repeated sprint training. [15, 16] For amateur soccer players, change of direction and reactive agility with the ball improved significantly after 6 weeks of SSG. [6] These improvements were superior to change of direction training. These studies clearly showed that SSG permit a significant and superior improvement in some specific skills compared with other training modes.

Effects of SSG training on enjoyment and motivation

In addition to the positive effects observed after SSG training on physical fitness for team sports, it has been suggested that SSG may be considered as the preferred training method compared to other training types due to its higher game-based specificity. [5] To date, only one study has examined the effects of SSG training on enjoyment in soccer player. [11] The authors showed a *very likely* greater enjoyment (using the Physical Activity Enjoyment Scale) after SSG compared with high-intensity interval training in soccer players. Although SSG may be considered an efficient training method to maintain physical fitness and promote a high level of enjoyment and motivation, future research is needed to examine the effects of SSG on enjoyment and motivation in different SSG formats and for different sport practices.

Effects of SSG according to period of the season

The effects of the period of the season on the performance change in responses to SSG training was presented in table 3. Three studies assessed the effects of SSG during the pre-season period and all of the studies were conducted on soccer players. [17, 31, 32] All these studies showed a significant improvement in aerobic performance ($\dot{V}O_{2max}$, Yo-Yo, running economy and peak power); however, these improvements were comparable to generic training. Furthermore, 9 studies examined the effects of SSG during the competitive season. The results also demonstrated a significant improvement in a range of physical and task specific performance markers in all the studies. A greater improvement in performance after SSG compared with other training types (repeated sprint training, generic training, interval training) was detected in 5 studies [6, 12, 15, 16, 24] and only one study reported an equal improvement compared with interval training. [11] These results clearly demonstrate that a periodized SSG training program leads to important improvements in physical performances

either in the pre-or in-season period. When comparing SSG with other training regimens, performance improvements were greater during the in-season than the pre-season. Accordingly, improvements were greatest for skills activities such as specific agility, decision making and throwing performances. [16, 33] However, given the limited number of studies reporting the effects of SSG in the pre-season period, these interpretations should be treated with caution and further research on this topic is needed.

Effects of SSG according to the level of play

The results of the effects of SSG training on performance of team sport players according to the level of play are presented in table 3. For soccer players, the positive effects seen after SSG training were evident in amateur, elite and professional players. [6, 11, 34] Indeed, significant improvements were seen for RSA, intermittent endurance, $\dot{V}O_{2peak}$ and running economy for both level of players. The same interpretations can be drawn for other team sports such as handball and rugby players. [5, 15]

Limitations and methodological consideration

Despite the important conclusions that can be drawn from this review concerning the usefulness of SSG training for improving physical and skill performance in team sports, it is important to note that some limitations should be considered. We observed a high heterogeneity in almost of the studies, particularly of the outcomes of VO2max, 10- and 20-m sprint and jump performances, and this may be due to the low sample size used and the large standard mean difference in the study of Gabbet. [24] This could be explained by the greater improvements in physical fitness and lower incidence and severity of injuries in the athletes performing skill-based conditioning games in comparison to traditional conditioning activities.

[24] Another issue is that almost studies did not adopt the RCT design and this is may be related to ethical issues. Indeed, it is difficult to obligate high level athletes to not use small-sided games drills during training. Furthermore, as many SSG training interventions are implemented during the season (see table 2), it difficult to isolate the true effects of SSG (additional to usual training). The general focus on team sports rather than specific sports may also represent a limitation; differences in rules, player numbers and exercise mode clearly exist between specific team sports. Thus interpretations should be drawn based on each team sport in isolation.

Conclusions

The present review and meta-analysis revealed that conducting 2-3 SSG training sessions per week induced large improvements in specific skills and moderate to large improvements in team sport-related physical fitness such as $\dot{V}O_{2max,}$ speed, agility, jumping, and repeated sprint performance. These improvements appear to be independent of playing level and can occur either in the pre-or in-season period. Given the time constraints of team sports and the wide-ranging benefits of SSG, in addition to the greater game-based specificity and enjoyment, SSG training may be suggested as an alternative or complementary form of training to traditional physical fitness training during team-sports sessions. Further research is needed to isolate the long term effects of manipulating SSG training variables, such as volume and pitch size in order to optimize training prescription according to level, sport, nature and period of season.

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Table 1: Study, type of sport, participant and training characteristics and the outcomes measures for the meta-analysed studies.

References	Design	Sample/ Gender	Sport	Age (years)	Duration (weeks)	Frequency (per week)	Type of SSG	Outcome measures
Buchheit et al. (2008)	RNC	15 (8 F)	Handball	15.5	10	2	4v4 without GK	CMJ, 10m, RSA best
Chaouachi et al. (2014)	RC	12 M	Soccer	14.2	6	NR	1vs1, 2v2 and 3v3 over a 10x20, 20x20 and 20x30m without GK	15 and 30-m sprint, reactive-agility, vertical and horizontal jumping
Dello Iacono et al. (2016)	RNC	18 M	Handball	24.8±4.4	8	2	3 v3 without GK	Sprint, agility, jump, Yo-Yo, RSA
Dello Iacono et al. (2015)	RNC	9 M	Handball	25,6±0,5	8	2	3v3 , without GK	Sprint, agility, strength (arm), CMJ, aerobic (yo-yo)
Delextrat and Martinez (2014)	RNC	9 M	Basketball	U 17	6	2	2v2, 28m x 7,5m	Aerobic fitness, RSA, agility
Dellal et al. (2012)	RC	8 M	Soccer	26,3±4,7	6	9 *	2v2 and 1v1 without GK	Aerobic fitness
Gabbett (2006)	RNC	32 M	Rugby	22,1± 0,9	9	2	NR	Jump, sprint, agility, aerobic fitness
Gabbett (2008)	RNC	12 M+F	Volleyball	15.6± 0.1	12	3	5v5, 5v4, 5v3	Jump, agility, sprint, $\dot{V}O_{2max}$
Hill-Haas et al. (2009)	RNC	9M	Soccer	14.6 ± 0.9	7	2	2v2 to 7v7: 40mv20m	$\dot{V}O_{2max}$, Yo-Yo, RSA, sprint
Harrison et al. (2015)	RNC	10 M	Field hockey and Rugby	13,9±0,4	6	2	3v3	$\dot{V}O_{2peak}$, sprint, Jump

Impellizzeri et al. (2006)	RNC	20 M	Soccer	Junior	8	2	3v3,4v4, 5v5 with GK	$\dot{V}O_{2max}$, running economy, indices of physical and performance during matches
Los Arcos et al. (2015)	RNC	7 M	Soccer	15.1 ± 0.7	6	2	4v4 with GK	CMJ, aerobic fitness
Owen et al. (2012)	NC*	15 M	Soccer	24.5±3.45	4	2	3 v 3 + GK	Fastest and total sprint time + submax $\dot{V}O_2$
Seitz et al. (2014)	NC*	10 M	Rugby	20,9±1,4	8	2	Specific skills: catching, passing, kicking, wrestling, attacking or defending.	Aerobic fitness, RSA, sprint,
Radziminski et al. (2013)	RNC	9 M	Soccer	15,0±0,46	8	2	3v3 18mx 30m	$\dot{V}O_{2max}$, sprint, agility, jump
Young and Rogers (2014)	RNC	13 M	Australian football	17,5± 0,8	7	2	2v2 15mx15m	Planned agility

Notes : SSG = Small-sided games, $\dot{V}O_{2max:}$ = Maximal oxygene uptake; RSA = Repeated sprints ability; GK = Goal keeper, NR = Not reported: C = Controlled study, R= Randomized design, NC = non controlled study

*= One group intervention study design.

Table 2: Effects of SSG according to level of players and period of the season.

References	Sport	Level of players	Period of saison	Intensity	Results
In-season					
Adam et al. (2012)	Soccer	Elite	In-season	NR	↑RSA * ↑Running economy*
Dello Iacono et al. (2016)	Handball		Last part of the in-season	94.3 6 1.4%	↑Sprint, agility specific test, CMJ* SSG>HIIT
Dello Iacono et al. (2015)	Handball	Elite	First part of the in-season	90.6±1.1%	↑Agility, standing throwing* SSG>RST#
Gabbett (2006)	Rugby	subelite	In-season	NR	↑10m print, muscular power, maximal aerobic power* ↑Sprint, jump: SSG>traditional training#
Los Arcos et al. (2015)	Soccer	Elite	Last weeks of the season	NR	↑Continuous maximal multistage running test* SSG = Interval training
Chaouachi et al. (2014)	Soccer	Amateur	The second part of the competitive season	80-85%	↑Agility with the ball*: SSG>COD or control# Sprint, jump, agility without the ball: COD>SSG#
Delextrat and Martinez (2014)	Basketball	Regional	The competitive season	90.6%	↑10m sprint and CMJ : RST>SSG#
Seitz et al. (2014)	Rugby	Elite	The competitive season	NR	↑Intermittent endurance, speed tests, RSAindices*
Young and Rogers (2014)	Australian football	Elite	The early part of the competitive season	NR	↑Agility, decision making* SSG>COD training #
The pre-season					
Hill-Haas et al. (2009)	Soccer	Elite	Pre-season	RPE = 7.5 ± 1.2	↑Yo-Yo IR1*: SSG = Generic training
Impellizzeri et al. (2006)	Soccer	Professional	Pre-season	91.3 ± 2.2 %,	↑V˙O2peak n running economy, soccer specific endurance * SSG = Generic training (running)
Radziminski et al. (2013)	Soccer	NR	Pre-season	92.3 ± 1.1%	↑VO2max, peak power and total work capacity *

Notes : * = Significant changes compared with Pre-tests, # = Significant difference compared with other training type, SSG = Small-sided game training, HHIT = High intensity interval training, COD = Change of direction training, RST = repeated sprint training, Mixed training = SSG + HIIT

Table 3: Effects of SSG on specific skills related to team sports.

References	Sports	Specific skills	Results
Buchheit et al. (2009)	Handball	• Shoot velocity	• Non change
Chaouachi et al. (2014)	Soccer	• COD with the ball • Reactive agility with the ball	• ↑9.1%* • ↑7.5%* • SSG>COD and Control #
Dello Iacono et al. (2015)	Handball	• Handball agility specific test	• ↑2.2%* : SSG>HIIT#
Dello Iacono et al. (2016)	Handball	• Standing throw	• ↑9%*: SSG>RST #
Delextrat and Martinez (2014)	Basketball	• Defensive and offensive agility • Shooting and passing skills	• ↑4.5* • ↑7.4* SSG>HIIT#
Gabbett (2008)	Volleyball	• Spiking accuracy and technique • Setting accuracy • Passing accuracy and technique	• ↑1.9 and 6.5%* • ↑5.8%* • ↑2.7 and 6.5%*
Impellizzeri et al. (2006)	Soccer	• Soccers pecific endurance test (Ekblom's circuit). • match performance (total distance and time spent standing, walking, and at low- and high-intensity running)	• No change • ↑Match performance SSG = Generic training
Notes: COD = Change of direction test; HIIT = High intensity interval training; SSG = Small-sided game; *=Significant improvement compared with pre-test, # = Significant difference compared with other training type			

Table 4. Methodological qualities of the included studies

References	Sport	Item number											Score
		1*	2	3	4	5	6	7	8	9	10	11	
Buchheit et al. (2008)	Handball	+	-	-	+	-	-	-	+	+	+	+	5
Chaouachi et al. (2014)	Soccer	+	+	-	+	-	-	-	+	+	+	+	6
Dello Iacono et al. (2016)	Handball	+	+	-	+	-	-	-	+	+	+	+	6
Dello Iacono et al. (2015)	Handball	+	+	-	+	-	-	+	+	+	+	+	7
Delextrat and Martinez (2014)	Basketball	+	+	-	+	-	-	-	+	+	+	+	6
Dellal et al. (2012)	Soccer	+	+	-	+	-	-	-	+	+	+	+	6
Gabbett (2006)	Rugby	+	-	-	+	-	-	-	+	+	+	+	5
Gabbett (2008)	Volleyball	+	+	-	+	-	-	-	+	+	+	+	6
Hill-Haas et al. (2009)	Soccer	+	+	-	+	-	-	-	+	+	+	+	6
Harrison et al. (2015)	Field hockey + Rugby	+	+	-	+	-	-	-	+	+	+	+	6
Impellizzeri et al. (2006)	Soccer	+	+	-	+	-	-	-	-	+	+	+	5
Los Arcos et al. (2015)	Soccer	+	+	-	+	-	-	-	+	+	+	+	6
Radziminski et al. (2013)	Soccer	+	+	-	+	-	-	-	+	+	+	+	6
Young and Rogers (2014)	Australian Rules Football	+	+	-	+	-	-	-	+	+	+	+	6

* : Not included in scoring

Figures' legend

Figure 1: Preferred Reporting Items for Systematic Reviews and Meta-analysis (PRISMA) flow-chart.

Figure 2: A forest plot of the effects SSG training on O2max performance.

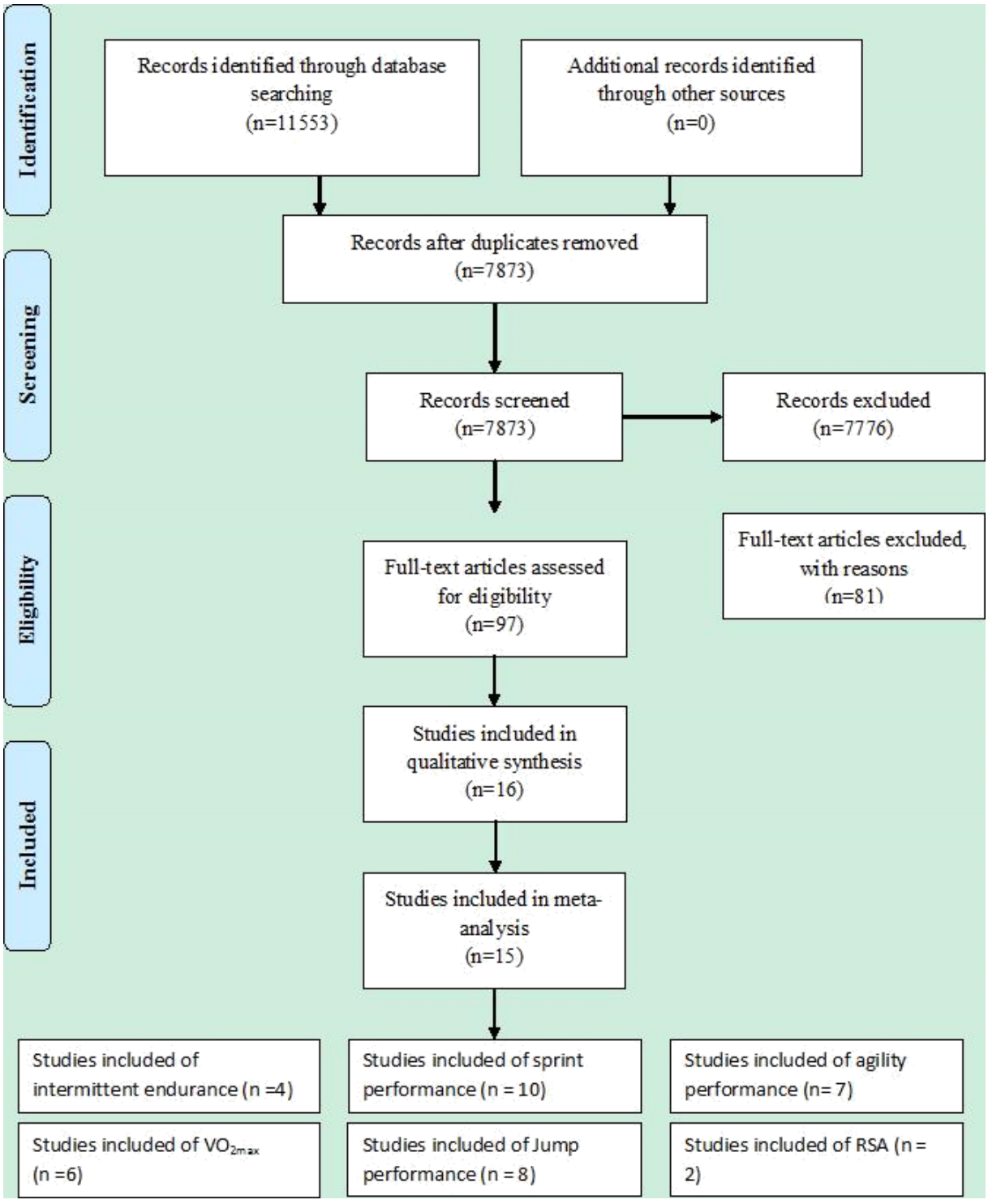
Figure 3: A forest plot of the effects of SSG training on 10- and 20-m sprint performance.

Figure 4: A forest plot of the effects of SSG training on Jump performance.

Figure 5: A forest plot of the effects of SSG training on agility performance.

Figure 6: A forest plot of the effects of SSG training on intermittent endurance measured by the 30–15 Intermittent Fitness Test (30-15 IFT).

Figure 7: A forest plot of the effects of SSG training on RSA performance (total sprint time).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Screening
Eligibility
Included
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Additional records identified through other sources (n=0)
Records after duplicates removed (n=7873)
Records screened (n=7873)
Records excluded (n=7776)
Full-text articles assessed for eligibility (n=97)
Full-text articles excluded, with reasons (n=81)
Studies included in qualitative synthesis (n=16)
Studies included in meta-analysis (n=15)
Studies included of intermittent endurance (n =4)
Studies included of sprint performance (n = 10)
Studies included of agility performance (n= 7)
Studies included of VO2max (n =6)
Studies included of Jump performance (n = 8)
Studies included of RSA (n = 2)

Figure 1

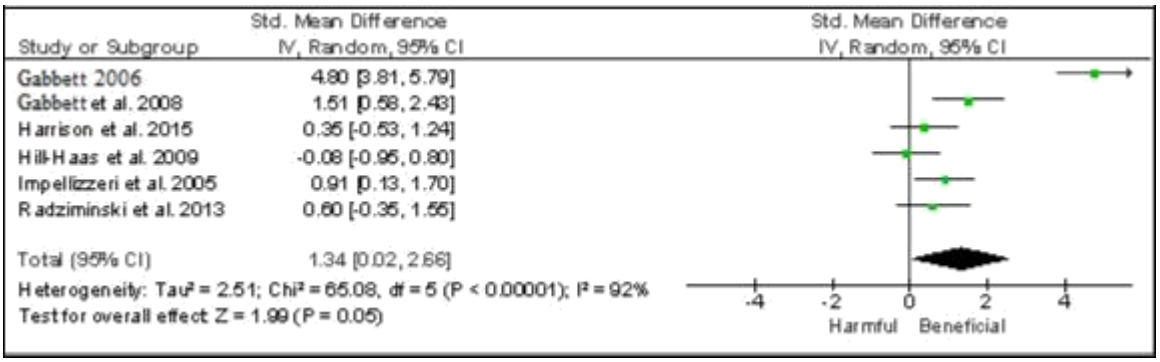
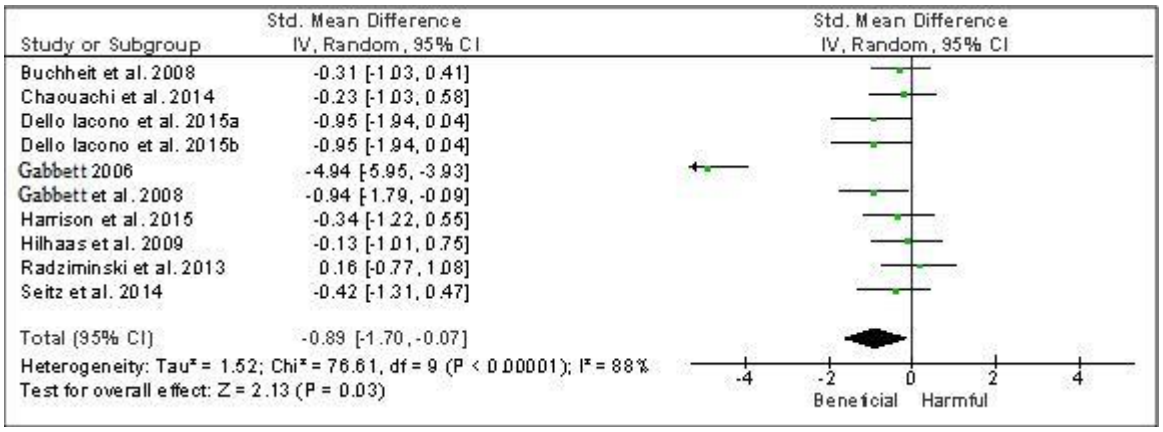


Figure 2



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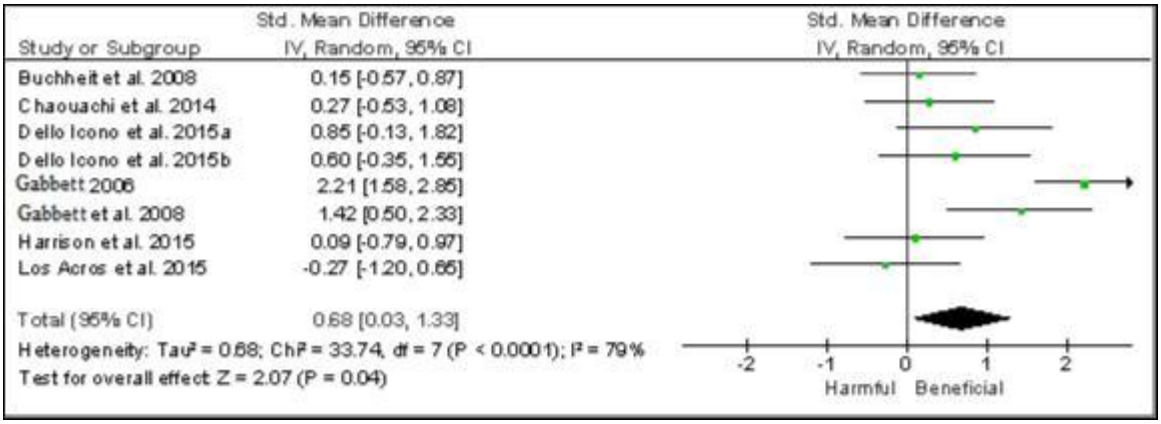

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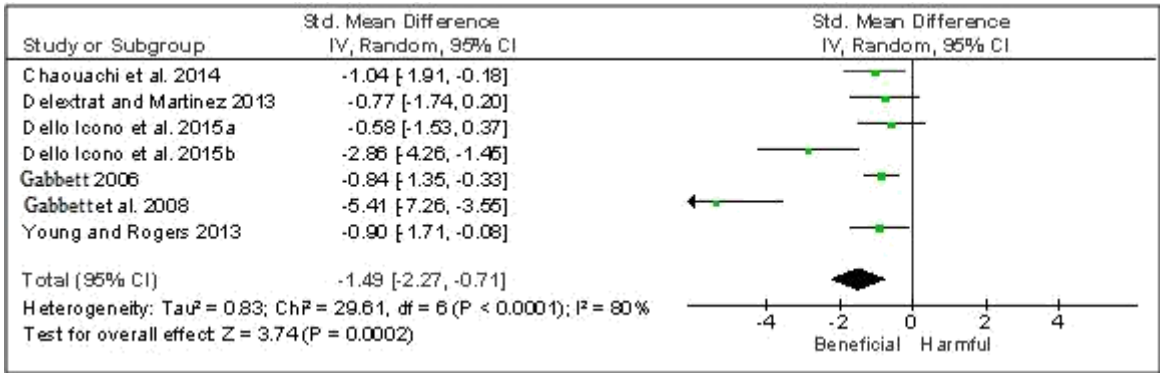

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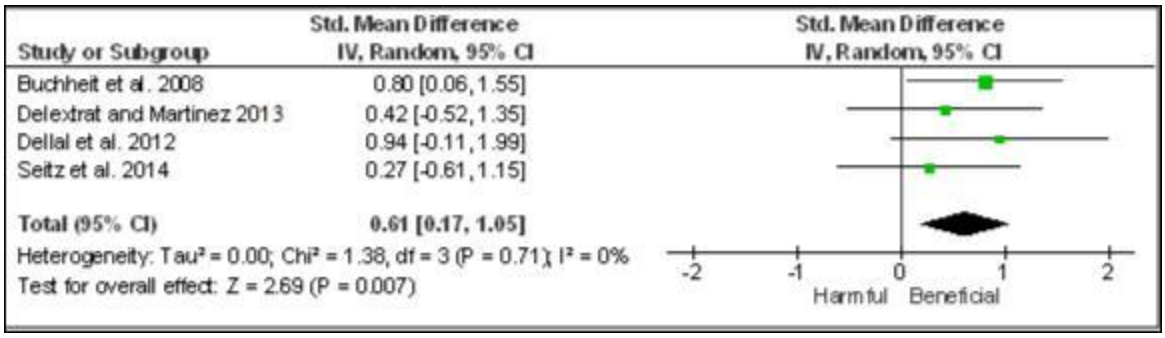

Figure 6

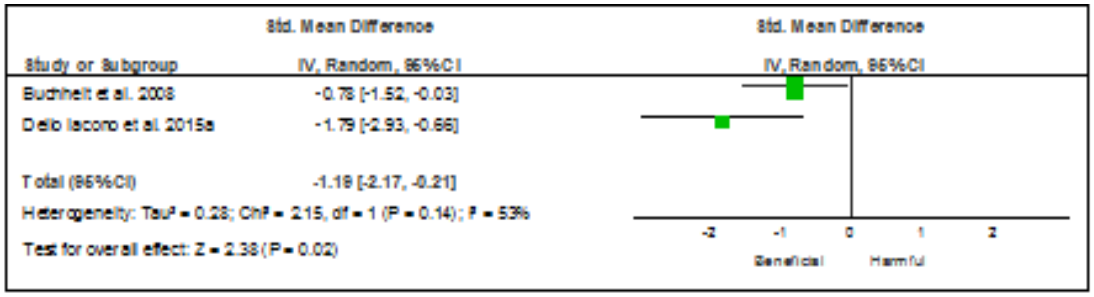

Figure 7